Achieving Inclusion within Smart Energy Cities

A case study on the smart energy domain of the city of Amsterdam

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Preface

Before you lies the MSc thesis “Achieving Inclusion within Smart Energy Cities”, a research based on an embedded case study into the smart energy domain of the city of Amsterdam. This thesis was written in pursuit of the Management of Technology programme at Delft University of Technology and provides recommendations on how to achieve inclusion within smart energy projects in Amsterdam in order to become an inclusive smart energy city. This research was conducted between April and August 2021 and defended on the 31st of August 2021 in Delft.

First of all, my gratitude goes to my first supervisor Thomas Hoppe because of his guidance and support during this project. I would also like to thank my advisor Negar Noori and my second supervisor Marijn Janssen for offering me their expertise. During my graduation period I was always able to contact them and ask content or planning related questions. Furthermore, my thanks goes to the respondents of my interviews for their time, knowledge and enthusiasm. In particular I would like to thank Hans Roeland who has taken the time out of his busy day to help me and connect me with a great amount of the interviewees. Finally, I would like to thank my parents and my friends who always support me and help me with everything they can.

In addition, I would shortly like to reflect on the past two years as a Management of Technology student at TU Delft. The master program really suited me and it gave me a lot of new insights on where my interest lies and the direction I want to go after my graduation. In the first year I met a lot of new students on campus from various nationalities which was very inspiring. In the second year of the master, the education was online due to corona, which was different but for me not necessarily detrimental. I experienced the second year of the master as the most interesting and educational because the specialization, electives, and the graduation project offered me the opportunity to deepen my understanding on self-chosen topics. Also, online education required independent planning and careful management of relationships which contributed to my personal development and which will certainly be of use in my future career. I hope you will enjoy reading this thesis.

Summary

The Dutch transition towards carbon-neutral cities is in full swing and the share of local solar and wind energy is growing rapidly, as well as the electrification of heating, cooling and mobility. Amsterdam is getting the energy transition started and is a forerunner when it comes to developments within the smart energy domain. As a result, multiple smart energy projects are carried out and will be carried out in Amsterdam in order to make Amsterdam a smart energy city. However, it is still unclear in what way these technological developments influence local communities and businesses and how we make sure vulnerable groups are not pushed out, isolated, and marginalised from important urban services, amenities, commercial flows en jobs. This brings us to the concept of inclusion and the need to build inclusive cities. Inclusion exists in many forms but in the smart energy domain mainly ensuring equal rights and equal participation of all citizens including the most vulnerable groups, remains a challenge. Moreover, ensuring that people who are disadvantaged and have a low income also share in growing prosperity as a result of technology development and eliminating inequities by providing information and financial support, is often not a main concern in smart energy projects which results in smart energy cities being not inclusive. Therefore, the main research question in this thesis is as follows: "How can inclusion be achieved within the smart energy domain of the city of Amsterdam in order become an inclusive smart energy city?".

This thesis consists of a theoretical chapter in which a theoretical framework is used that aims at mapping the pillars of an inclusive smart energy city. This framework is used in the empirical part of the thesis in order to find out to what extent inclusion is present within smart energy projects in Amsterdam and how inclusion can be achieved. This empirical part of the thesis consists of an embedded case study that involves two smart energy projects in Amsterdam that are chosen as sub-units of analysis. The first sub-unit of analysis is the Local Inclusive Future Energy (LIFE) project and the second sub-unit of analysis is the Lighthouse City Amsterdam Project. Data is collected through documents and interviews. The interviews are conducted as part of qualitative research and analysed using ATLAS.ti. The results of the case study showed that despite the fact that participation and inclusion are often part of smart energy project plans, effectively achieving it remains a challenge. Challenges related to inclusion identified in this research are the gap between technology and society, limitations as a result of regulations, the rise of inequality, and the existence of different perspectives. Nevertheless, these challenges can be faced by using the theoretical framework as a guideline and in this way meet the objectives of an inclusive smart energy city.

This research found that creating a smart energy city that is inclusive at the same time is initially about preserving its accessibility and affordability by primarily focusing on social, economic, and political inclusion through close collaboration of stakeholders and careful development and implementation of smart energy solutions through collaborative planning, consumer behavior management, and data and energy management by making use of supportive tools and technologies. It is essential to define inclusion as a theoretical concept before the start of a project in order to make sure every stakeholder is on the same page with respect to inclusion. In addition, it is important to include all parties involved from the beginning, including citizens, by being transparent about objectives, interests, and individual values. Focus on uniting the social and technological stakeholders of a project and prevent the emergence of a gap between society and technology. The Government, both national and local, plays a decisive role when it comes to achieving inclusion within smart energy projects in Amsterdam and should therefore be closely involved.

This study is of value for academics, project developers, and policy makers and has societal and academic relevance. This research has a significant contribution to the smart energy domain of the concept of smart city. It combines a subject related to the energy transition with ethics and anthropology of technology through the development of an integrated theoretical framework

that can be used by other researchers and practitioners. It therefore contributes to not only the technological side but also the social side of the smart energy domain, giving it an extra pillar to study: inclusion. The recommendations of the present study for project managers provide a starting point for a structural integration of inclusion within smart energy project development by using the theoretical framework of the inclusive smart energy city. Besides this, the recommendations provide solutions to decrease a part of the challenges related to achieving inclusion identified in this study. Recommendation for policy makers also involve using the theoretical framework and incorporate the pillars and conditions of an inclusive smart energy city in their policies.

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Chapter 1: Introduction

Prior to this thesis a literature review is carried out which resulted in certain similarities with the paper that was written for the master thesis preparation course of the MoT program. This overlap is present in the introduction, methodology, and theoretical chapter of this thesis. This paper can be found in the reference list under Werf (2021).

This chapter will provide the problem statement, the research objective, goal, and questions, and the outline of the thesis.

1.1 Problem Statement

Over the past few decades, the world has experienced rapid urbanisation. Due to the overall population growth, the percentage of people living in cities is growing (Janda, Johnson, Lemaire, Fennell, & Tomei, 2019). Urbanization is expected to continue with around 60% of the world population living in cities, in 2030. This on the one hand, results in cities being responsible for climate change, and on the other hand cities contributing to innovation. Cities are a source of creativity and complex ecosystems where different players with diverse interests are encouraged to collaborate in order to ensure a sustainable environment and a high quality of life. Cities supported by learning, technology, and innovation contributed to the emergence of the concept of smart city (Macke, Casagrande, Sarate, & Silva, 2018). In generic terms, smart city is an urban environment that utilises information and communication technologies (ICT) and other related technologies in order to improve performance efficiency of regular city operations and quality of services provided to urban citizens (Silva, Khan, & Han, 2018).

As in the rest of the world, in the Netherlands towns and cities are growing which causes pressure on public facilities and growing infrastructures. Therefore, in 2016 the Netherlands requested the NL Smart City Strategy which is part of the National Smart City Strategy in order to develop multiple programs for different areas in the Netherlands. These programs involve the realization of sustainable homes and buildings, securing the city's mobility and accessibility, and healthy urbanisation which entails improvements of air quality. The lead in the implementation of these programs was taken by the four largest cities, with Amsterdam as a forerunner when it comes to the adoption of the smart city concept (SmartCityHub, 2017). The first driver for adopting the smart city concept was climate change and therefore Amsterdam developed the Amsterdam Smart City program which predominantly aims at reducing CO_2 emissions. Therefore, the smart energy domain has been the first and one of the most important domains within Amsterdam as a smart city (Noori, Hoppe, & de Jong, 2020). An upcoming concept in urban development is the smart energy city which can be defined as "a city that aims at optimizing urban energy systems and improving the quality of life of citizens" (Mosannenzadeh, Bisello, et al., 2017).

When handled properly, urbanisation creates opportunities for an increase in the quality of life of citizens and results in economic growth. However, while urbanisation is a driver for the global economy and combats climate change, it can also cause inequality and exclusion within cities (Asian Development Bank, 2011). In many cases smart cities are not accessible for a part of the citizens. Therefore, it has been acknowledged that there is a need to create inclusive smart cities (Asian Development Bank, 2011). In order to detect and manage the different problems related to inclusion, it is important to have an accurate awareness about the current state of urban accessibility (Pérez-Delhoyo, García-Mayor, Mora, Gilart-Iglesias, & Andújar-Montoya, 2017).

Due to rapid urbanisation, cities are getting overpopulated and therefore energy shortages arise. As a result, smart energy solutions are used in order to overcome these problems. In this way, smart energy cities are created. However, the use of these technologies result in problems with respect to inclusion. Not everyone is able to use these technologies and live in an environment where certain technological developments take place. From the literature it became clear that including all citizens in smart energy cities remains a challenges and a lot of information is missing when it comes to the development of inclusive smart energy cities. Therefore, this research will address these challenges and will try to map how inclusion can be achieved within a smart energy city.

1.2 Research Objective, Goal, and Questions

The objective that this research aims to fulfill is to investigate in what way inclusion needs to be taken into account in the development of a smart energy city in order to become an inclusive smart energy city.

The literature review, executed in preparation of this research, showed that a knowledge gab arises due to the lack of information on inclusion within the smart energy domain of smart city projects in Amsterdam and in general, and the acknowledgement that building inclusive cities is still an exploratory pathway. In this research the various dimensions of inclusion and the problems that occur in each dimension, will be linked to the building blocks of a smart energy city and their corresponding features. In this way, a theoretical framework of an inclusive smart energy city is developed. Furthermore, the smart energy domain of the city of Amsterdam will be researched through a case study involving two smart energy projects. In this way, it can be explored how theory relates to reality and how inclusion can be achieved within the smart energy domain of the city of Amsterdam by using the theoretical framework. The main research question is as followed:

"How can inclusion be achieved within the smart energy domain of the city of Amsterdam in order become an inclusive smart energy city?".

In order to answer this question, five sub-questions have been formulated:

1. What is the meaning of inclusion as a theoretical concept?
2. What are the key aspects of an inclusive smart energy city?
3. What is the effect of technology development in the smart energy domain on the extent to which it is an inclusive smart energy domain?
4. How can the theoretical framework that is conceived in this research be used to evaluate to what extent inclusion is present within current smart energy projects in Amsterdam?
5. What are the challenges for achieving inclusion in smart energy projects in Amsterdam?

Research question 1 aims at exploring and identifying the meaning of inclusion as a theoretical concept. To do so, a framework for an inclusive city will be used and five dimensions of inclusion will be identified. Research question 2 will firstly explore the key aspects of a smart energy city through the use of another theoretical framework. Subsequently the two frameworks will be integrated in order to cover the key aspects of an inclusive smart energy city. Research question 2 will result in the development of the theoretical framework that will be applied in the empirical part of this thesis. The answers to research questions 3, 4, and 5 will be identified through the use of the case study method and aim at using the framework and exploring the link between technology development and inclusion and the challenges with respect to inclusion within the smart energy domain of the city of Amsterdam. This will lead to an answer to the main research question.

1.3 Outline of the Thesis

This thesis consists of 7 chapters. Chapter 1 contains the problem statement and the aim of the thesis, concluding with the research questions. Chapter 2, the theoretical chapter, discusses multiple theoretical concepts and entails the development of the theoretical framework. In Chapter 3 the research approach and design is explained and the way data is managed and analysed is addressed. Chapter 4 contains a description of the case study, its sub-units of analysis, and a stakeholder analysis. In chapter 5, the results of the empirical research will be presented, and in chapter 6 results obtained in the empirical part of the research research will be reflected to the theoretical framework. Finally, in chapter 7 the research questions will be answered and limitations will be discussed. Chapter 7 will also provide the academic discussion and the results of the research with respect to its academic and societal relevance. Lastly, recommendations will be given for further research, project developers, and policy makers.

Chapter 2: Research Methodology

In this chapter the methodology will be presented that is used for this research. First an explanation of the research approach will be given. Next, the case study will be introduced. Third, an explanation will be given on how the data needed for this research is selected, collected, treated, and analysed. In addition, data management will be discussed entailing which programs are used to analyze and store the data.

2.1 Research Approach

To answer the research questions described in section 1.2, several research strategies are required. Before doing qualitative research some theoretical development is required. Accordingly, the empirical research is preceded by a theoretical chapter. As explained in the previous chapter, the theoretical part consist of a literature review, which is already done before the start of this research, and the development of a theoretical framework through the combination of existing frameworks and leads to answering research questions 1 and 2. In the theoretical chapter a theoretical framework is developed. This framework represents the different features of an inclusive smart energy city. Through this framework, the different dimensions of inclusion are explained together with the principles of a smart energy city. This framework can be used when analysing smart energy projects in Amsterdam which will be done in the empirical part of this thesis. With the use of this theoretical framework it can be determined to what extent Amsterdam is an inclusive smart energy city. Research question 4 covers the use and aim of the framework.

The empirical part consists of a case study for the city of Amsterdam that will help to understand the role of inclusion within multiple smart energy projects in Amsterdam. Through case studies researchers are able to see the phenomenon and its context as a whole in contrast to quantitative research such as surveys or experiments (Baxter & Jack, 2008). With the use of both theory and a case study, research questions 3, 4, and 5 can be answered. Besides this, the case study will provide additional information to answer research question 1 and 2. The next section will go deeper into the case study method.

In order to gather data in an orderly manner and show the movements and actions during this thesis a qualitative research flow chart is conducted to act as a map to get from the beginning of inquiry to the end of a conclusive understanding. The flow diagram of the detailed research process is illustrated in figure 2.1.

2.2 Embedded Case Study Research Design

As stated in the previous section, the method that is used to study to what extent the different dimensions of inclusion are present in smart energy projects in Amsterdam and what role technology development plays with respect to inclusion, is the case study method. A case study is chosen because the case cannot be considered without context. Yin (2013a) states that the research design of a case study should be applied when a researcher want to answer questions that investigate why something is the case, or when you are not able to influence people's behavior within a study. In addition, a case study can be used when the researcher wants to study a phenomenon with contextual conditions, or when there is no clear distinction between the context and the phenomenon of the study. When using the case study method the researcher dives into a specific situation and aims at identifying the role of the participants in that specific situation. Therefore, this method should be applied when real world situations are researched and critical research questions are addressed (Baxter & Jack, 2008). Yin (2013a) defines multiple case study designs such as the single case study and the multiple case study design. These variants have similar methodological framework. In this thesis, the Amsterdam case is used to study not only a particular situation but also in order to gain insights into the challenge of realising an inclusive smart energy city. Within the city of Amsterdam a number of smart energy projects are carried

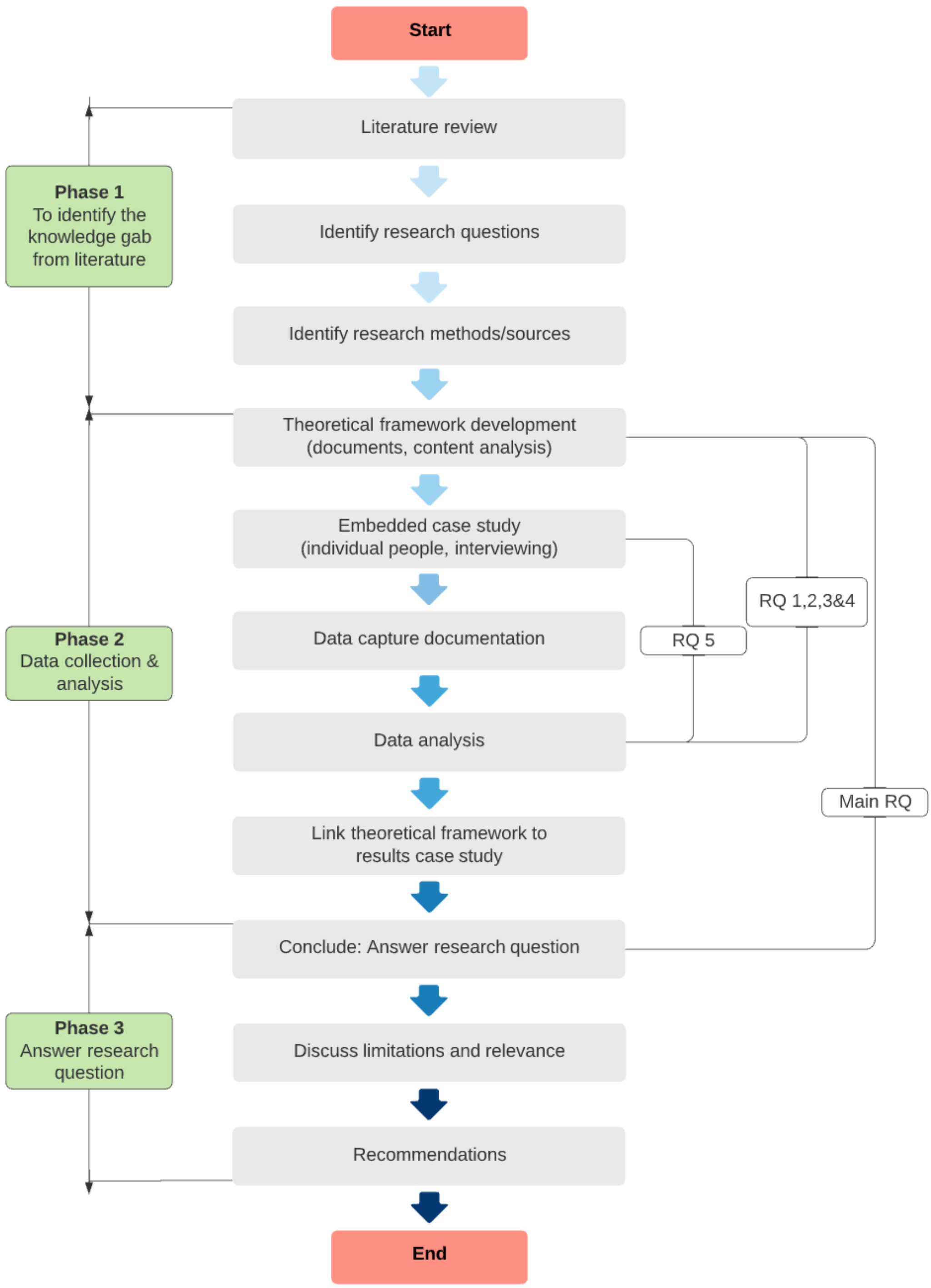

Figure 2.1: Research Flow Diagram

out and during the case study interviews with multiple experts in the fields of smart energy and inclusion will be conducted. Since this study takes place in one environment, but there are multiple sub-units of analysis, a single embedded case study methodology is considered (Yin, 2013a). In addition, multiple sub-units of analyses are chosen because this provides more reliable research results. The embedded case study is a research method that is build on multiple sources of evidence. The data retrieved from the case study needs to be assembled through theoretical framework development, as introduced in chapter 3, data collection and analysis (Yin, 2013a). The situation as it is in a specific field in a specific city is observed. Opinions and feelings are explored through the use of interviews and in this way the situation is examined as a whole.

2.2.1 Case Selection

In this subsection the case is selected and the sub-unit of analysis is determined in order to answer the research questions. The case is a phenomenon that occurs in a certain context and can be seen as the unit of analysis Miles and Huberman (1994).

Nowadays, many cities are profiled as smart such as Hamburg, Paris, Vienna, Barcelona, Bilbao, and Dubai. These are all global cities that are facing challenges with respect to urbanization. These challenges include overall gentrification, social segregation in disadvantaged neighborhoods, and less social cohesion and interaction. Each city has its own strategy when it comes to becoming a smart energy city. Amsterdam handled an other strategy than other smart cities because of the development of the Amsterdam Smart City (ASC) program. This is an interactive platform that aims at connecting people and organizations in order to become potential partners and stimulate smart energy project development. In this way the city of Amsterdam acts both as facilitator, funder, project partner and eventually end customer (Mancebo, 2019). As a result, the Dutch transition within the smart energy domain towards carbon-neutral cities is in full swing and the share of local solar and wind energy is growing rapidly, as well as the electrification of heating, cooling and mobility. The City of Amsterdam has clearly expressed its sustainability ambitions and wants to become climate neutral (CityofAmsterdam, 2021). In contrast to other cities, the city of Amsterdam is motivated to get rid of natural gas due to the huge problems occurring in the northern parts of the Netherlands caused by earthquakes as a result of gas drillings. This became an urgent topic within Amsterdam's policies. Therefore, Amsterdam's smart energy domain is advanced in comparison with other Dutch cities and therefore the capital city is a forerunner when it comes to developments within the smart energy domain due to the large amount of smart energy projects that are on the agenda. The city of Amsterdam aims at being circular by 2050, which entails controlling all of its resources, energy, water, materials, food and waste flows the city is connected to. In addition Amsterdam aims at being clean by getting rid of toxic fumes, and the city has decreased the number of deaths and losses in life expectations as a result of polluting emissions (Dobbelsteen et al., 2019). Amsterdam adopted the smart energy city policy as a result of climate change with as main goal reducing CO_2 emissions. Just now, the concept of the smart energy city also involves pillars that preserve the quality of life of its citizens (Noori et al., 2020). As a result, multiple problems related to inclusion have been acknowledged. Therefore, in this research, the selected case is the smart energy domain of the city of Amsterdam.

In this case study, two specific sub-units of analysis have been selected in order to research the role of inclusion within smart energy projects in Amsterdam. As described in the previous section, these two sub-units are embedded which makes this an embedded case study. The first sub-unit of analysis is the Local Inclusive Future Energy (LIFE) project. This project is carried out in Amsterdam's Zuidoost (South East) neighborhood also known as ArenAPoort, including Venserpolder and the Urban Interactive District. This because it is an upcoming neighborhood facing rapid developments, including new business parks, homes, and commercial areas making it one of the top three busiest locations of the capital city. Inclusion is an important pillar within their project plan mainly due to the diverse nature of this area and the aim to let all citizens benefit from the technological developments (AMSInstitute, 2020). The second sub-unit of analysis is the Lighthouse City Amsterdam project in the Buiksloterham area in Amsterdam North. This neigbourhood used to be one of an industrial kind but has now turned into a smart energy district with low carbon emissions. This project in funded by the EU and aims at optimizing local energy balances (Atelier, 2021). Inclusion is not one of the pillars of this project which makes the approach totally different from the LIFE project. Therefore, comparing these two projects will provide insights on to the extent to which inclusion is present in each project and how inclusion is reflected in the smart energy domain of the city of Amsterdam. Section 4.1 contains a more comprehensive overview of the case and a description of the two smart energy projects that have been selected as sub-units of analysis.

2.3 Data

2.3.1 Data Selection

It is characteristic for case study research to use multiple types of data sources such as documentation, direct observations, archival records, interview results, and artifacts (Yin, 2013a). Together this data can provide insights for the researcher on the phenomenon as a whole. Using different data sources results in more reliable results which adds strength to the research and provides a better understanding of the case (Baxter & Jack, 2008).

Yin (2013a) specifies three principles for data collection: to use multiple sources of evidence, to maintain a case study database, and to maintain a chain of evidence. For the purpose of reliability multiple sources will be used, most notably content analysis of documentation and, if available, archival records and interviews. Most likely the data collection will lead to a lot of overlap. Documentary is used in almost every type of case study. There are multiple types of information retrieved from documents. With the use of documentation a better understanding of the current situation of the case can be created (Yin, 2013a). Archival records in the form of computer files can be used to determine in what way inclusion is already present in smart energy projects in Amsterdam. The most important information source of this case study is the interview. This because the interviews will provide in depth specific information on the case.

2.3.2 Data Collection

Table 2.1 presents the link between research question, the type of information, the source, and the data collection methods.

Table 2.1: Data collection

Research Question	Information	Sources	Methods
1. What is the meaning of inclusion as a theoretical concept?	Data Knowledge	Documents	Content analysis
2. What are the pillars of an inclusive smart energy city?	Data Knowledge	Documents	Content analysis Interviewing Qualitative data analysis
3. What is the effect of technology development in the smart energy domain on the extent to which it is an inclusive smart energy domain?	Data Knowledge	Documents Individual people	Content analysis Interviewing Qualitative data analysis
4. How can the theoretical framework that is conceived in this research be used to evaluate to what extent inclusion is present within current smart energy projects in Amsterdam?	Data Knowledge	Documents Individual people	Content analysis Interviewing Qualitative data analysis
5. What are the challenges for including inclusiveness in smart energy projects in Amsterdam?	Knowledge	Individual people	Interviewing Qualitative data analysis

The interviews are conducted as part of qualitative research using a case study method. The interviews are carried out in a semi-structured, open-ended manner. Mason (2011) states that an interview guide must be developed according to the topics covered in the research. In the present study the interview questions are based on the research questions and the theoretical framework using the key aspects of inclusion and the relation with technology development. However, in between the interview questions there is room for a natural conversation so that the researcher can touch upon unexpected topics (Mason, 2011).

After connecting with a member of the LIFE project and the Lighthouse project, "snowball" sampling was used to identify additional interviewees (Bryman, 2012). After each interview the interviewee was asked for recommendations regarding potential useful respondents in the light of the research topic. In this way, interviewees from multiple fields and different projects are reached in order to get a broad view on the case. 13 interviews were held and took place using Zoom or Microsoft Teams and were audio-recorded using the IPhone Dictaphone application. Each interview took approximately 45 minutes. Table 2.2 gives an overview of the respondents and their correspondent organisation.

Table 2.2: List of Respondents

Name Indication	Organisation
Respondent 1	AMS Institute
Respondent 2	Atelier
Respondent 3	Amsterdam Smart City
Respondent 4	University of Amsterdam
Respondent 5	Municipality of Amsterdam
Respondent 6	Energy Lab Zuidoost
Respondent 7	Coforce
Respondent 8	University of Utrecht
Respondent 9	Municipality of Amsterdam
Respondent 10	LIFE
Respondent 11	Spectral
Respondent 12	Coforce
Respondent 13	Municipality of Amsterdam

2.3.3 Data Management and Treatment

The interviews were recorded and subsequently analysed and transcribed using the program ATLAS.ti 9.1.0 Mac, by ATLAS.ti Scientific Software Development GmbH (ATLAS.ti, 2018). This program creates codes and sub-codes and was therefore crucial for the analysis of the interviews. The research questions and the different pillars of the theoretical framework conducted in chapter 3, have been used as codes. In order to fulfil the TPM Delft University of Technology data management and ethics policy, the transcripts and quotes retrieved from the analysis are anonymized.

2.3.4 Data analysis

Coding is used to analyse the interviews. These codes were based on the research questions and the different pillars of the theoretical framework. This coding helped in analyzing the data and gave insights into the practices, experiences, and motivations of stakeholders, and the current state of the art with respect to inclusion within smart energy projects in Amsterdam. The theoretical framework and the interviews are used to make a stakeholder analysis, presented in 4, containing a selection of relevant stakeholders within the smart energy domain of Amsterdam. In addition, a power-interest grid is conducted.

The theoretical framework conducted in chapter 3 reflected the research questions developed in 1, and served as base for the design of the case study and its objectives. The framework and the research questions were therefore in important guideline for the identification of the case and the collection of data. To link the data retrieved from the empirical part of the study to the theoretical framework, ATLAS.ti 9.1.0 Mac software is used (ATLAS.ti, 2018). Subsection 2.3.3 provides more information on Atlas.ti and how it is used. As visualised in figure 2.1, data analysis was a crucial part with respect to answering research 1 through 4. After the empirical research is conducted, the case study results are linked to the theoretical framework in order to answer research question 5.

2.3.5 Quality of Research Design

In order to make sure a research design represents a logical set of statements, Yin (2013b) distinguishes four concepts that can be used to test the confirmability, credibility, data dependability, and trustworthiness of your research. Firstly, during case study research the investigator could fail to be objective when data is collected which results in a low construct validity. This can be prevented through the use of multiple sources of evidence, or by creating a chain of evidence, as explained in section 2.3.1. Moreover, Yin (2013b) discusses internal validity which has to do with causal relationships and is only found in explanatory research, and therefore inapplicable to this exploratory research. The third test deals is about the generalizability of your research results and is called external validity. In this research, a theoretical framework is conducted previous to the empirical research and is used as a frame of reference for the case study results. Yin (2013b) calls this "analytic generalization", which can be used in single-case or multiple-case studies. Analytic generalization showed that the theoretical framework conducted in this thesis appeared to have multiple pillars that are reflected in the case study. However, Yin (2013b) states that it is recommended to use multiple cases because often single-case studies offer a poor basis for generalizing. This also applies for this research due to the fact that the case study took place in one city and besides this, it is exploratory research. The external validity of this research would have been higher when two or more cases were used. The final test involves the objective to be sure that a study has the same results every time the data collection procedures are repeated. Yin (2013b) refers to this as reliability which aims at minimizing errors and biases. Dealing with documentation and developing a data base for your case study can contribute to reliability because it enables the use of an accurate case study protocol. Due to the exploratory nature of this research and the fact that it involves only one case, the results will have in comparison a high degree of validity and a low degree of reliability and replicability.

2.4 Conclusions

The methodology applied in this thesis involves answering the research questions through the use of the theoretical framework of an inclusive smart energy city which is conducted in this research, and an embedded case study on two smart energy projects in Amsterdam: the Local Inclusive Future Energy (LIFE) project and the Lighthouse City Amsterdam project. Data is collected through documents and interviews and subsequently analysed using content analysis and qualitative data analysis. 13 interviews are conducted, transcribed, and coded with the use of ATLAS.ti. Moreover, a stakeholder analysis and a power-interest grid will be presented in chapter 4. Due to the exploratory nature of this research and the fact that it involves only one case, the results will have in comparison a high degree of validity and a low degree of reliability and replicability.

Chapter 3: Theoretical Framework Development

The aim of this chapter is to conduct a theoretical framework of an inclusive smart energy city through the integration of two existing frameworks regarding on the one hand an inclusive city, and on the other hand a smart energy city. In order to do so, this chapter will first explain what inclusion means as a theoretical concept. Subsequently, a theoretical framework of an inclusive city provided by Danni, Jong, Schraven, and Wang (2021) containing five dimensions of inclusion will be introduced, and multiple problems related to each dimension will be mapped. Furthermore, the pillars of a smart energy city will be identified through the use of the framework developed by Mosannenzadeh, Di Nucci, and Vettorato (2017). Before these two frameworks will be integrated into one theoretical framework of an inclusive smart energy city, this chapter will also address the theoretical relation between inclusion and technology development.

3.1 Inclusive City Framework

3.1.1 The concept of Inclusion

As a result of fast urbanization, Janda et al. (2019) affirm that managing this process in a successful way is becoming more and more important. Besides this, the benefits of urbanization must be shared and adverse impacts must be minimized. This will require policies that ensure inclusion of all citizens of the urban environment (Janda et al., 2019). Espino (2015) refers to inclusive cities as the need to plan and design cities so that vulnerable social groups are not pushed out, isolated, and marginalised from important urban services, amenities, commercial flows and jobs. Powers (2017) concurs but adds that the concept of inclusion in cities always has a spatial dimension and it basically stands in opposition to urban segregation. Silver (2015) distinguishes the concept of social inclusion which refers to a process encouraging social interaction between people with different socially relevant attributes or an impersonal institutional mechanism of opening up access to participation in all spheres of social life. This definition is a more general one but can be linked to the definition of Espino (2015) regarding inclusive cities because the 'spehres of social life' Silver (2015) is referring to, can include life in urban environments. Furthermore, Longworth, George, and O'Dell (2019) recognise a third form of inclusion that has to be taken into account in order to let all citizens benefit from, and also contribute to, a growing economy as a result of urbanisation. Economic inclusion entails economic growth that is distributed fairly across society and creates opportunities for all (Longworth et al., 2019). In addition, Danni et al. (2021) identify a fourth and a fifth form of inclusion, environmental and political inclusion. Environmental inclusion aims at making sure not only current generations but also future generations have access to natural resources and the environment. Political inclusion or inclusive governance covers the laws and regulations that is needed in order to realise an inclusive city.

3.1.2 Five Dimensions of Inclusion

As stated in the previous section, Danni et al. (2021) identify five dimensions of inclusion and the interrelationships between these different dimensions through a theoretical framework of an inclusive city. This framework is chosen in this research because it is based on literature with respect to inclusive cities through the use of a bibliometric analysis and an interpretive literature review. This resulted in an accurate exploration and examination of the inclusive city concept and the link between its different dimensions. Appendix A provides a visualisation of the initial framework developed by Danni et al. (2021). The five dimensions of inclusion identified in this framework will first be explained and then be integrated in the theoretical framework of an inclusive smart energy city. In this way, the concept of inclusive city will be defined and used to provide insights in to what extend the different dimensions of inclusion are present within a smart energy city.

Social inclusion involves ensuring equal rights and equal participation of all citizens, including the most vulnerable groups (Asian Development Bank, 2011). Furthermore, it focuses on increasing development opportunities in an equal way and considering the needs and preferences of social members. Social inclusion preserves civil participation and sustainable migration. Sustainable migration entails ensuring that people have a place to live and make sure no one is evicted against their will. Public participation involves the extent to which social acceptance and integration is present. Moreover, protection and security of their rights, especially when a person is located in a vulnerable or threatening situation, should be accessible for all individuals and social groups (Danni et al., 2021).

Economic inclusion provides opportunities with respect to economic growth in terms of the creation of jobs and making sure urban residents can benefit from economic growth (Asian Development Bank, 2011). Economic inclusion is about everyone having an equal share in rising prosperity, also people who are disadvantaged or have a low income. Rapid urbanization and industrialization can cause economic inequities with respect to labor market relations and resource allocation. Economic inclusion entails eliminating these inequities and has the objective of realizing a reasonable distribution of income, equal job opportunities, and the provision of labor market information. This can be done through the support of local Governments who can invest in construction and services, encourage migrants to work in different industries in cities, organizing training courses and provide employment opportunities for people in underdeveloped regions (Danni et al., 2021).

Spatial inclusion is achieved when each individual has equal access to public space and the essential living environment. This entails surrounding land, housing, streets, infrastructure and facilities. Whether public space, physically and socially, is open for everyone influences the amount of spatial inclusion. ICT plays an important role when it comes to the accessibility and sustainability of cities because innovative technologies improve urban infrastructures which increases accessibility with respect to housing and public spaces. These technologies are a solution to the problem of fast urbanization and can provide sufficient space for the citizens living in the inclusive city. (Danni et al., 2021).

Environmental inclusion aims at making sure not only current generations but also future generations have access to natural resources and the environment. In this way, both interests are preserved. Furthermore, the dimension of environmental inclusion emphasizes the interrelationship between the allocation of resources, environmental pollution and responsibilities. Many local Governments take environmental inclusion into account in their policies and it is often seen as the reason to start building smart cities in the first place. Many parties such as communities and social organizations are part of environmental assessment and are involved in decision making processes. Therefore, it can be seen that these groups play an important role when it comes to addressing environmental issues such as climate change, air pollution, and sewage disposal. In this way, residents are able to take the environmental principles into consideration and take on environmental responsibilities. In order to preserve environmental inclusion it is crucial to secure the environment's well being and ensure the sustainability of urban space (Danni et al., 2021).

Political inclusion is mainly about the extent to which people feel a sense of belonging and identity within a city. It is about acceptance and acknowledgement. This relates to civil and political rights and is connected to issues with respect to democracy, political involvement, human rights, and national identity. It is therefore important to realise sustainable innovation which requires careful information exchange between local governments and inhabitants. In this way, they will have a voice and their political rights are preserved. The most important aspects of political inclusion are democracy, justice, and freedom which are reflected by governance, political participation, sustainable innovation, and political empowerment (Danni et al., 2021).

3.1.3 Problems related to Inclusion

When analysing these five dimensions it can be seen that these types of inclusion partly overlap but mostly complement each other. From both a political and an intellectual perspective, creating an inclusive city is a very complex process. This because of its different dimensions for which secure coordination is required with respect to governance, policy making and stakeholder management (Danni et al., 2021). Therefore, realising an inclusive city remains a challenge. As a result, problems with respect to inclusion occur in each dimension. Makushkin, Kirillov, Novikov, Shaizhanov, and Seidina (2016) have also recognised the problematic nature of inclusion within modern cities. These problems involve among others the gap between infrastructures, incomplete social policies, and migration and demographic issues. The most common problems that are identified from the literature are listed in 3.1.

Table 3.1: Problems of Spatial, Social, Economic, Environmental, and Political Inclusion

Factors	**Problems**
Spatial Inclusion	• Lack of access to essential infrastructure and services (Asian Development Bank, 2011). • The gap between the production and the economic and sociocultural infrastructure. • The problem of standards of infrastructure and social services. • The problem of correlation of natural and artificial: The ratio of natural and man-made components of the environment, aesthetic problems sociogenic landscape, regulation of metabolic processes. • Problems of housing (Makushkin et al., 2016).
Social Inclusion	• No equal rights and participation. • Lack of opportunities for the urban poor. • Greater demand for voice from the socially excluded (Asian Development Bank, 2011). • Priorities and targeted social policies. • Issues of environmental awareness and behavior (Makushkin et al., 2016).
Economic Inclusion	• Social problems locating production: Problems of the city size, the problem of mono-functional and young cities and urban areas. • Migration and demographic issues. • Problems of urban infrastructure: Transport, landscaping, housing, recreation and others. • The social structure of employment problems. • The problems of labor mobility (Makushkin et al., 2016).
Environmental Inclusion	• Compromising the needs of future generations for environment and natural resources. • Separable relationships between allocation of resources, environmental pollution and responsibilities. • No maintenance of the natural and reproductive qualities of urban space (Danni et al., 2021).
Political Inclusion	• Issues of democratic institutions, human rights, political participation, and national identity. • No sustainable innovation • No effective communication between local governments and citizens (Danni et al., 2021).

3.2 Smart Energy City Framework

The concept of 'smart energy city' has emerged from urban development and has the objective of increasing the quality of life of citizens while improving the performance of energy systems within the city. Mosannenzadeh, Bisello, et al. (2017) found that it is crucial to have a conceptual core that is consistent and well defined and in this way a smart energy city will be interpreted in an accurate way and successfully be implemented. This resulted in the development of a theoretical framework. This framework is chosen in this research because it defines smart energy city development not only in a theoretical context, but also in terms of practical solutions. The framework developed by Mosannenzadeh, Bisello, et al. (2017) consists of five pillars for smart energy city development: smart energy principles, collaboration of stakeholders, application of ICT and integration of hard and soft domain, sustainability evaluation, and objectives. Appendix B provides a visualisation of the smart energy city framework developed by Mosannenzadeh, Bisello, et al. (2017). This section will explain the pillars 'smart energy principles' and 'collaboration of stakeholders'. Furthermore, it will discuss the pillar 'application of ICT and integration of hard and soft domain' in two separate sections divided into smart energy solutions and technologies, and the integration of solutions. The pillars 'sustainability evaluation' and 'objectives' will be discussed in section 3.4.

3.2.1 Smart Energy City Principles

An important domain within the concept of smart city is the smart energy domain. Mosannenzadeh, Bisello, et al. (2017) defines "a city that exploits recent opportunities in technology and economy in order to provide citizens with a better quality of life, while addressing urban energy challenges such as climate change, shortage of energy resources, and inadequate and deteriorating energy infrastructure", as a smart energy city. In addition, the smart energy city preserves three main principles namely energy conservation, energy efficiency, and renewable energy. Energy conservation entails lowering the demand in energy, and at the same make sure useful energy services stay constant and no unnecessary services are needed. Improving energy efficiency entails a decrease in energy consumption for the same amount of services or an increase in energy consumption while having a higher amount of services. Renewable energy refers to energy systems that are sustainable and in this way prioritize natural energy sources instead of energy sources retrieved from fossil fuels (Mosannenzadeh, Bisello, et al., 2017).

3.2.2 Collaboration of Stakeholders

Every party or individual that is affected or involved in project development is called a stakeholder. The stakeholders within a smart energy city can be grouped into service providers, target groups, and decision makers. Decision makers are influential parties or individuals that are responsible for decision making on divergent bureaucratic levels with respect to the adoption of policies and the determination of integration measures. These policies and measures often affect the direction and strategy of smart energy projects, which makes decision makers a very important stakeholder group. Service providers provide energy related or energy management services. This stakeholder group consist of both individuals, organizations, and businesses. The last stakeholder, target groups, includes persons or groups within the smart energy city that will be influenced by the policies and plans that follow from smart energy city development and will use the good, service, or technology.

Table 3.2: Stakeholder Groups within a Smart Energy City

Stakeholder Groups		
Service Providers	**Target Groups**	**Decision Makers**
Utilities	Owners	Policy Makers
Energy Service Companies	Tenants	Local Administrations
Network Operators	Citizens	Financial Institutions
ICT Companies	Consumers	(Social) Housing Companies
Construction Companies		R&D institutions and
Consultants and Experts		Universities
Planners, Architechs, and Technicians		Citizens and Citizens' Initiatives

Collaboration of key stakeholders is a predominant pillar of a smart energy city. Close collaboration of stakeholders can be supported by communication infrastructures and collaborative tools in order to make sure collaborative relationships are fostered. In this way, mutual understanding and harmony between stakeholders can be achieved and joint decisions will be made. This will result in the adoption and acceptance among target groups which makes it easier to realize decisions. According to Mosannenzadeh, Bisello, et al. (2017), the smart energy city provides bottom-up collaboration and therefore inclusion can be achieved and solutions for urban problems will be found. In addition, a smart energy city aims to unite multiple dimensions of rule setting with respect to urban governance. Especially solving problems regarding collaboration between public and private sectors by not only focusing on shared investments and creating new business models (Mosannenzadeh, Bisello, et al., 2017).

3.2.3 Smart Energy Solutions and Technologies

Through the collaboration of different stakeholders, the application and integration of smart energy solutions can be managed and realised (Mosannenzadeh, Bisello, et al., 2017). The combination of multiple smart energy technologies can form a smart energy system within a Smart City and is called the hard domain. A smart energy system consists of three independent building blocks: the intelligent integration of decentralized renewable energy sources (low-carbon generation), efficient distribution, and optimized power consumption (Mohanty, Choppali, & Kougianos, 2016).

Table 3.3: Building Blocks of a Smart Energy System

Smart Energy System		
Low-Carbon Generation	**Efficient Distribution**	**Optimised Consumption**
Wind	Electricity Grid	Energy Storage
Solar	Energy Trading	Smart Metering
Hydrogen	ATES Based Infrastructure	E-mobility

Renewable energy sources such as wind, solar and hydrogen energy are important in order to sustain non-renewable energy sources, while minimizing adverse effects on the environment (Silva et al., 2018). Besides this, is it important to realise efficient distribution channels within the smart energy system through the use of a smart infrastructure. The information infrastructure serves as the backbone for a smart energy system and provides the system with information on energy consumption and provider rates. Through the use of certain information infrastructures a smart grid can be used, which can be seen as the core of a smart energy system (Mohanty et al., 2016). Through a smart grid, the actions and behaviors of all users that are connected can be integrated efficiently. In this way, efficient, economic, and sustainable energy systems can be ensured. A sustainable energy system decreases energy losses, increases the quality of energy supply, and is more safe, secure, and accurate. Smart grids are able to integrate energy from both renewable and non-renewable sources. A smart grid enables a two-way interchange where both information and electricity, through the electricity grid, can be exchanged. This provides opportunities for among others, energy trading and the use of Aquifer Thermal Energy Storage (ATES) technologies. These technologies are used for cooling and heating of buildings. Through ATES thermal energy is stored and recovered in the subsurface (Rodríguez-Bolívar, 2015). The third building block of a smart energy system is optimizing consumption which can be done through efficient usage and storage of energy, smart metering, and E-mobility (Mohanty et al., 2016). Smart metering aims at controlling and managing energy consumption data and enables two-way communication between the user and the service provider. E-Mobility, or electro mobility enables the use of vehicles and fleets that drive on electricity instead of fossil fuels. This is done by using electric power train systems, linked infrastructures, in-vehicle data, and information and communication technologies (Kabalci, 2019).

The three building blocks must interrelate in order to realize a smart energy system that preserves the core principles of a smart energy city (Mohanty et al., 2016). The smart energy solutions that are being addressed in this thesis are listed in table 3.3

3.2.4 Integration of Solutions

The third pillar of the smart energy city, according to Mosannenzadeh, Bisello, et al. (2017), is the integration of the smart energy solutions described in the previous section, through the use of technologies in the soft domain. This can be done through collaborative planning, consumer behavior management, and energy and data management. Close collaboration of stakeholders has already been emphasized in subsection 3.2.2 and can benefit from solutions with respect to collaborative planning. This because tools and technologies associated with collaborative planning can support coordination within projects and can provide efficient and clear communication of all kinds of information such as data, knowledge, and ideas among stakeholders. In addition, collaborative decision making will be empowered because these tools and technologies in the soft domain entail decision support systems, scenario analysis tools, and simulations programs (Mosannenzadeh, Bisello, et al., 2017). Consumer behavior management is very important because it provides solutions to identify consumer's needs and preferences with respect to their energy consumption. Tools and technologies can be used to retrieve information and create awareness among stakeholders about energy supply and demand and they can provide insights into the options with respect to the reduction of energy use. In addition, certain tools and technologies can be used to change consumer behavior. The last solutions in the third pillar provide the management of data and energy with the aim of optimizing the overall energy system. These solutions consist of multiple tools, instruments, and technologies that enable analysis, management, forecasting, and monitoring of smart energy city domains through the collection, processing, storage, and transformation of information and data (Mosannenzadeh, Bisello, et al., 2017). The tools and technologies in the soft domain can be united through the use of a platform. A platform can serve as a base or infrastructure upon which applications, technologies or processes are developed for the end-user (Mohanty et al., 2016).

3.3 Inclusion through Technology development

From the five dimensions of inclusion identified by Danni et al. (2021), multiple problems with respect to inclusion are mapped in table 3.1 in section 3.1. Some of these problems can be solved by the use of smart energy technologies applied in the hard domain of a smart energy city. In order to research which technologies could contribute to inclusion, the smart energy solutions that are listed in table 3.3 addressed in section 3.2.3 are compared with the five dimensions of inclusion identified by Danni et al. (2021). This is visualised in appendix C.

As stated in section 3.1 *spatial inclusion* is achieved when every citizen as equal access to public space and the essential living environment (Danni et al., 2021). E-mobility could be a solution to the problems that occur as a result of spatial exclusion because communication technologies and connected infrastructures are for example used to enable electric vehicles to provide accessible transport between residential areas, public places and facilities (Bakker, Maat, & Trip, 2014). In this way, urban infrastructures are improved and cities become more accessible and sustainable. Other technologies that contribute to the development of urban infrastructure in the form of efficient distribution are the use of an electricity grid and ATES based infrastructures (Rodríguez-Bolívar, 2015).

Social inclusion focuses on guaranteeing equal rights and participation of all citizens and increase development opportunities also for the urban poor and other disadvantaged groups. Smart energy solutions that contribute to efficient energy distribution such as an electricity grid and ATES systems can increase the social inclusion within a smart energy city when handled properly. Local governments have to make sure that all citizens have access to heating and electricity provided by these technologies. The same goes for renewable energy technologies such as systems that produce wind, solar and hydrogen energy. When buildings owned by social housing associations have, for example, solar panels on the roof people will get out of their houses when the sustainable energy is shared with the whole building. It could lead to a feeling of cohesion (Wallace, Vincent, Luguzan, Townsend, & Beel, 2017). Besides this, when housing corporations are able to invest into smart efficient energy technologies, running costs can be reduces and savings opportunities arise for the urban poor. However, it can also cause energy poverty and social inequality. When these investments are not done by external organisations, those who cannot afford the investments into smart, efficient energy technologies will be stuck with increasingly large energy bills, since the growing costs of grid infrastructure upgrades are socialized in the Netherlands (Makushkin et al., 2016).

Economic inclusion provides opportunities with respect to economic growth in terms of the creation of jobs and making sure urban residents can benefit from economic growth (CouncilEconomicAdvisors, 2021). An electricity grid provides the efficient distribution of energy which can be stored when necessary. Energy storage results in a more sustainable use of energy and therefore a reduction in energy costs which contributes to the ability to share in gains in welfare. The same goes for the technologies that produce the energy that can be stored. Renewable energy technologies make it possible for disadvantaged and low income people to share in rising prosperity as a result of the use of a decrease in energy costs and therefore they will have lower energy bills (Steffen, Beuse, Tautorat, & Schmidt, 2020). In addition, they can consume more energy because they have produced it themselves. This again, is only the case if they don't have to invest in the technology themselves. Another technology that can contribute to a more reasonable distribution of income is smart metering due to the fact that digital monitoring of consumption data results in a decrease energy costs. A common problem with respect to economic inclusion is a lack of equal access to job opportunities and the social problem of labor mobility (Makushkin et al., 2016). E-mobility can contribute to people's mobility and accessibility to places in the area. In this way, job opportunities could arise and labor mobility is stimulated.

Environmental inclusion aims at making sure not only current generations but also future generations have access to natural resources and the environment. In this way, both interests are preserved. Meanwhile, the dimension of environmental inclusion emphasizes the interrelationship between the allocation of resources, environmental pollution and responsibilities (Danni et al., 2021). All smart energy solutions described in section 3.2 contribute environmental inclusion. Technologies that enable optimised consumption will prevent energy from being lost and therefore maintain the natural and reproductive qualities of urban space and improve the quality of the living environment. The same goes for technologies that enable efficient distribution and renewable energy.

Political inclusion or inclusive governance primarily relates to serious issues of democratic institutions, human rights, political participation, and national identity. Furthermore, it supports information sharing between local governments and citizens, and makes sure that every citizen is involved in decision making and thus has a voice (Danni et al., 2021). Sustainable innovation, political participation and political empowerment are crucial aspects of political inclusion and therefore accurate governance and policy is required. Problems with respect to political inclusion but also the problems regarding the other dimensions of inclusion referred to in section 3.1, can be solved through the use of technologies that support decision makers by policy making including collaborative planning, consumer behavior management, and data and energy management in the soft domain explained in section 3.2. Technologies in the soft domain of a smart energy city can contribute to coordination, as well as communication of data, knowledge, and ideas among stakeholders (Mosannenzadeh, Bisello, et al., 2017). Furthermore, it can enable co-creation and other modes of citizens' participation. In addition these technologies and tools can contribute to the optimisation of the energy system as a whole, from the sides of both energy supply and energy demand and will in turn result in inclusion in different ways.

3.4 Theoretical Framework Inclusive Smart Energy City

In order to map the pillars of an inclusive smart energy city, a theoretical framework is created. As repeatedly explained, this is done by combining the framework of the inclusive city defined by Danni et al. (2021) with the smart energy city framework designed by Mosannenzadeh, Bisello, et al. (2017). Figure 3.1 provides a visualisation of the framework conducted in this research. The main components are the five dimensions of inclusion, collaboration of stakeholders, smart energy solutions and technologies, integration of solutions, governance and policy, and the objectives of a smart energy city. This section will explain how and why the two frameworks are integrated, what the aim of the framework is, and how it can be used. Appendix D provides a comprehensive visualisation of the integration of the two frameworks.

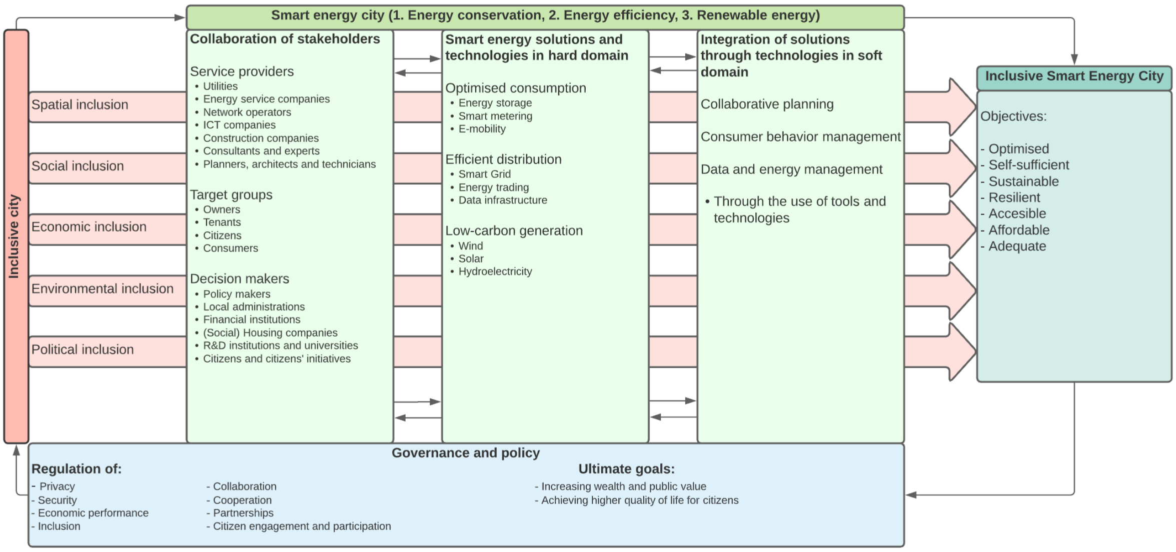

Figure 3.1: Inclusive Smart Energy City Framework

3.4.1 Inclusive City

Section 3.2 pointed out that according to the smart energy city framework of Mosannenzadeh, Bisello, et al. (2017), five pillars must be considered among which the 'sustainable evaluation' pillar. Mosannenzadeh, Bisello, et al. (2017) emphasizes that a smart energy city is part of the sustainable city, and that the changes as a result of urban technology development are only smart if four aspects are ensured: including economic, environmental, and social costs and benefits on different spatial levels and this must be in the short–to-long term. This view follows on from four of the dimensions of inclusion identified by Danni et al. (2021), described in section 3.1.2. Therefore, for this research and the development of an inclusive smart energy city framework, the pillar 'sustainable evaluation' of the smart energy city framework is substituted by the inclusive city framework.

As stated in section 3.1, the inclusive city seeks to eliminate urban exclusion, inequality and discrimination. The inclusive city framework focuses on how inclusion can be achieved through the coordination and involvement of local stakeholders and making sure each stakeholder can contribute to inclusive urban prosperity in their own way. As a result, smart city development will have inclusion in its core which shifts urban transformations from a technology driven environment, where only a small group of citizens has access to vital resources, to a human driven environment where also the vulnerable groups are taken into account and therefore also can benefit from technological innovation (Danni et al., 2021). In order to cover the essence of the inclusive city and the need to take inclusion into account from the beginning in smart energy city development, the five dimensions are continued through the whole framework and are visualised in red in figure 3.1.

3.4.2 Smart Energy City

Section 3.2 identified three main principles of a smart energy city: energy conservation, energy efficiency, and renewable energy, that can be pursued by considering three main pillars: collaboration of stakeholders, application of smart energy solutions and technologies, and the integration of solutions through technologies. These components of a smart energy city and the corresponding main principles are visualised in green in figure 3.1.

3.4.3 Governance and Policy

Rules and regulations are required when building an inclusive smart energy city. Therefore governance and policy play an important role. Due to the many different components that comprise the smart energy city (collaboration of stakeholders, application of smart energy technologies, integration of solutions through new technologies described in section 3.2, and at the same time make sure the five dimensions of inclusion are preserved in order to meet the objectives, a much stronger intelligence function is required for coordination. Nowadays, due to the rapid developments of new technologies, governance also relates strongly to privacy, smart energy security as well as economic performance, inclusion and a host of issues that are being changed by new ICT. The role of planning and policy making includes regeneration, mobility, economic development, and housing, and involves questions of the operation of utilities, the access of citizens to services, health, education, indeed any functions which have a spatial effect on the city in terms of location and movement (Batty et al., 2012). The existence of efficient and effective governance is essential for the development of an inclusive smart energy city. The Government can take different roles and the involvement of local Governments is crucial in inclusive smart energy project development. First of all, the Government can play the role of coordinator and uniting different interests and stakeholders together to establish close collaboration. Besides this, it can play the role of funder, which can entail the funding of infrastructure and pilot projects. Lastly, the Government can play the role of regulator. In this regard it must ensure that common standards and regulations are determined. In addition, governance and policy entails creating an urban environment that is interactive and based on information in which every citizen can participate in order to achieve a higher quality of life of its citizens. The the ultimate aim of such governance and policies is increasing wealth and public value (Rodríguez-Bolívar, 2015). Therefore, governance and policy should encapsulate collaboration, cooperation, partnership, citizen engagement and participation, and is therefore incorporated in blue in the framework in figure 3.1.

3.4.4 Objectives

The components of the smart energy city consist of multiple smart energy technologies, solutions, and infrastructures that form energy systems from the source where energy is generated to the point where energy is consumed. Solutions such as the electricity grid and thermal and gas networks, have been designed, developed, and operated. Careful integration of these technologies is crucial for the achievement of an optimised smart energy system. Furthermore, smart energy project developers and smart energy cities in general try to increase their energy self-sufficiency by ensuring that they are able to satisfy local energy demands in the urban area of interest. Therefore, smart energy systems must be sustainable and should be able to operate under strict requirements with respect to energy efficiency with renewable energy as source. The integration of new technologies and changing the architecture of energy systems provides the opportunity to improve a system's resilience to climate change or other hazards. However, the most important objectives of an inclusive smart energy city focus on addressing the demand for energy services in order to satisfy the final goal of ensuring the well-being of the citizens. In order to meet the demand for energy services, a city's accessibility must be preserved. However, only their accessibility is not in itself sufficient. The energy service should also be affordable, especially for the vulnerable groups in the smart energy domain. Lastly, the energy services must be adequate (Mosannenzadeh, Bisello, et al., 2017). The latter is in line with the essence of the objectives of the inclusive city. Therefore, together with the main targets of a smart energy system, the integration of the two frameworks results in the following objectives of an inclusive smart energy city: optimised, self-sufficient, sustainable, resilient, accessible, affordable, and adequate. The objectives are visualised in figure 3.1 in dark green.

3.4.5 Aim and Use of the Framework

As stated in chapter 1, it has been acknowledged that there is a need to build smart energy cities in such a way that inclusion in its various forms is taken into account. However, the literature points out that little is said about the combination of the concept of inclusion and the concept of smart energy. Therefore, in this research a theoretical framework is created in order to close this gap in literature and provide a tool that can be used in a theoretical context to explore and examine to what extent there is an inclusive smart energy city, but also in terms of practical solutions by using the framework as a guide to achieve inclusion within smart energy projects. The combination of pillars including both inclusion and smart energy, and the theoretical and practical context in which the framework can be used, makes it beneficial for academics, practitioners, and policy makers. This is the largest contribution of the theoretical framework conducted in this research.

By carefully considering each pillar of the framework and the interrelation between the different pillars, a deeper understanding will be created with respect to what inclusion as a theoretical concept means and how it related to technology development. Moreover, the stakeholder groups within the smart energy domain will be identified and mapped and collaboration between these stakeholders will be emphasized. It is crucial to make sure every stakeholder is aware of the five dimensions of inclusion and has an equal understanding of the concept from the beginning of the project. Furthermore, the framework includes the identification of smart energy technologies and solutions that can be used with different purposes within a smart energy city. These technologies and solution should be integrated carefully whereby again collaboration of stakeholders is very important. The framework stresses that through close collaboration collaborative planning, consumer behavior management, and data and energy management must be realised in order to integrate the smart energy solutions and technologies in the hard domain, and at the same time preserve the five dimensions of inclusion. Dependent on the city of interest, different rules and regulations apply which makes governance and policy an important pillar of the framework and has to be considered by each stakeholder and through the whole progress of the process. Inclusive smart energy city development is in many ways dependent on and influenced by regulations including collaboration, security, economic performance, citizen engagement and participation. Governance in inclusive smart energy city development entails the mechanisms whereby societal actors and state actors interact and coordinate to regulate issues of both technological and societal concern.

The arrows visualised in figure 3.1 indicate that using this framework is not about ticking boxes but about considering each pillar and the interrelationship between each pillar carefully. In this way, from an academic point of view, it can be researched whether the objectives are present and to what extent there is an inclusive smart energy city. From a practitioner's point of view, the framework can be used as a guide to achieve inclusion within smart energy projects and can be deployed to reach the objectives of an inclusive smart energy city. In addition, policy makers can use the framework and incorporate the pillars and conditions of an inclusive smart energy city in their policies in order to create policies that encounter exclusion within the smart energy domain. In this thesis the framework will be used in the empirical part of the research to explore and examine to what extent inclusion is present within the smart energy domain of the city of Amsterdam.

Chapter 4: Case Study: Amsterdam Smart Energy City

In this chapter the case and the two sub-units of analysis are described. Furthermore, a stakeholder analysis is carried out and a power-interest grid is created in order to gain a better understanding of the environment of the case study.

4.1 Case Description

4.1.1 The City of Amsterdam

As explained in section 2.2.1, Amsterdam developed a significantly different strategy when it comes to becoming a smart energy city compared to other smart cities and resulted in the Dutch transition towards carbon-neutral cities being in full swing and the rapid growth of share of local solar and wind energy, as well as the electrification of heating, cooling and mobility. Amsterdam is getting the energy transition started and is a forerunner when it comes to developments within the smart energy domain compared to other Dutch cities due to the large amount of smart energy projects that are on the city's agenda. However, there is a mismatch in the timing of local energy supply and demand due to the implementation of an increasing amount of smart energy technologies which leads to electrical grid congestion, poor power quality and a limit on local renewable energy capacity. DSO Liander forecasts that increasing electrification in the city will result in 17 out of 25 substations in Amsterdam reaching peak overloads in 2030. This puts a limit on installing more local renewable energy systems and presses for costly grid reinforcement, which affects local communities through extensive works, taking up public space and rising electricity prices. Therefore, innovative energy systems enabling flexible storage and usage of energy are needed to relieve grid congestion. As buildings are the main users of energy in an urban context, smart coordinated flexibility across various electrical devices in buildings such as heating, compressors, EV chargers and storage systems can result in significant benefits for local stakeholders, especially when done at a district-scale (AMSInstitute, 2020). As a result multiple smart energy projects are carried out and will be carried out in Amsterdam in order to make Amsterdam a smart energy city. However, it is still unclear in what way these technological developments influence local communities and businesses and how we make sure vulnerable groups are not left out (Pérez-Delhoyo et al., 2017).

By means of the research questions discussed in chapter 1 and the theoretical framework conducted in chapter 3, the empirical part of this research entails an embedded case study that will be carried out in order to gain insights in to what extend inclusion and its five dimensions are taken into account in capital city's goal of becoming a city that is future proof by making Amsterdam more sustainable as soon as possible. The case study consists of two specific sub-units of analysis.

4.1.2 Local Inclusive Future Energy (LIFE) project

The first sub-unit of analysis is the Local Inclusive Future Energy (LIFE) project. The consortium for this project has been deliberately selected to encompass an interdisciplinary perspective by incorporating multiple stakeholders. Addressing the main interests of these key stakeholders and facilitating a multi-disciplinary, collaborative approach is a core focus of the LIFE project. This project is carried out in Amsterdam's Zuidoost (South East) neighborhood also known as ArenAPoort, including Venserpolder and the Urban Interactive District. This is a very upcoming neighborhood where more and more people and businesses move in, and because of these rapid developments this area is becoming one of the most busiest locations in the city. The Zuidoost area is therefore becoming an important economic center for Amsterdam. 15,000 new apartments will be build by 2020 and an additional 35,000 m^2 of office space will be realized which will result in the area facing serious grid capacity challenges because this area is already consuming 10% of the city's gas and requires 5% of the city's power capabilities, while the area only comprises of 2.3% of Amsterdam (Spectral, 2020). New developments and electrification of existing developments will create a significant increase in peak loads. The challenge is to create an efficient, stable, and sustainable energy system that will, at the same time, include all citizens and let no one behind (AMSInstitute, 2020). The LIFE project aims to develop a district-scale energy management platform to resolve grid problems while integrating local stakeholder interests in its design and implementation. The project will realise a replicable, innovative, integrated and future-proof energy system for similar mixed use districts in The Netherlands and abroad. LIFE will accelerate the energy transition by simplifying the integration of different types of sustainable generation into local energy systems. Moreover, the business case of sustainable development will be improved by adding value to flexibility and system performance. The (multi-)energy infrastructure will be optimised and security of supply and avoiding grid reinforcement will be realised. In addition, the project aims to make better use of local sustainable energy (heat and electricity) via smart distribution to the surrounding neighbourhood. Finally, the project is working on inclusion to enable all stakeholders access to the benefits (AMSInstitute, 2020).

4.1.3 Lighthouse City Amsterdam Project

The second sub-unit of analysis is the Lighthouse City Amsterdam project in the Buiksloterham area in Amsterdam North. This project was an initiative that followed from the European Union's Horizon 2020 research and innovation program and was therefore also EU funded (Atelier, 2021). This area was a industrial neighbourhood back in the days and now it is converted into a district that has positive energy and low carbon rates with different purposes. Also the Buiksloterham area is changes in terms of technological developments in the field of efficient energy buildings, renewable and reliable energy technologies are implemented, and smart technology is deployed with goal of providing the opportunity to balance and share local energy among residents and businesses. Green roofs and recycled materials will be used in the new building blocks, and there will be large scale deployment of local PV. In order to manage the local supply and demand of energy, buildings will be equipped with a smart microgrid (GemeenteAmsterdam, 2021). This micro grid enables adaptation and response to the demand, which results in the fact that peak loads can be prevented and the public electricity grid will not be overloaded. This micro grid also facilitates the storage of local renewable energy. The rewards of these benefits can be reaped through an energy market platform that will facilitate peer-to-peer energy trading, community-to-community trading or trading with the wholesale energy markets. Trading can take place among residents or other users of the energy market platform. In addition, the project aims at setting up an energy community and as part of the positive smart energy district, an e-mobility hub will be integrated. This will involve 15 to 20 electric cars, charging points for electric bikes and other electric vehicles. In addition, the project will involve local waste stream treatment by utilizing organic waste for production of biogas (Atelier, 2021).

4.1.4 Project Choice

The first sub-unit in this research is chosen because inclusion is one of the main pillars of the LIFE project and therefore this analysis should provide deeper insights into the effect of technology development on inclusion, challenges related to inclusion, and to what extend inclusion is and should be incorporated in smart energy projects. Besides this, analyzing this project aims at identifying how the different stakeholders involved interact, and look at the concept of inclusion. By studying this project, insights will be gained on how to ensure that the benefits of technology development are shared and adverse impacts are minimised. This also applies for the second sub-unit that will be researched in this thesis. However, this sub-unit is mainly chosen because the Lighthouse City Amsterdam project is of a very different nature than the LIFE project due to the fact that inclusion is not one of the main pillars and the project is funded by the European Union. This results in diverse project approaches with respect to finance, time, interested parties, and objectives. Because the focus of these projects is in opposite ends of the spectrum, it is possible to look at the case from two different perspectives which will provide a clear and realistic image of the smart energy domain of the city of Amsterdam. Therefore, using an embedded case study with only two sub-units of analysis is sufficient.

4.2 Stakeholder Analysis

In section 3.2, Mosannenzadeh, Bisello, et al. (2017) distinguishes three groups of stakeholders that must collaborate in order to create a smart energy city: decision makers, service providers and target groups. The theoretical framework and the interviews are used to make a selection of relevant stakeholders within the smart energy domain of Amsterdam. Stakeholders can be divided into internal and external stakeholders and have different amount of power and interest. After the different stakeholder groups are discussed a power-interest grid will be given at the end of this section.

4.2.1 Decision Makers

European Union

The European Union is an important stakeholder because it has set serious goals with respect to the realization of a sustainable energy sector and the security of energy supply and demand which are clearly reflected in their policies. The EU wants to achieve an integrated energy market so that the challenges in the field of energy will be faced (EuropeanUnion, 2021). These energy policies also apply in The Netherlands and can therefore influence smart energy projects in Amsterdam. For the LIFE project the EU is an external stakeholder because it not directly influences the project. For the Lighthouse city project the EU is an internal stakeholder because this project followed from an initiative of the European Union's Horizon 2020 research and innovation program and therefore the EU was funder of this project (Atelier, 2021). The EU has a relatively high power but low interest in Dutch smart energy projects.

National Government

The Dutch Government is for the same reason an external stakeholder. This stakeholder group includes political parties, Ministry of Economics, Netherlands Authority for Consumers and Markets, home affairs, Infrastructure & Environment, and the Dutch Data Protection Authority. The Dutch Government has a high power and a medium interest due to the Dutch transition towards carbon-neutral cities but nevertheless their interest in these projects is relatively low compared to local governments, businesses, and communities.

Municipality of Amsterdam

The Municipality of Amsterdam has set ambitious clean energy goals for 2030 and 2050, however, the city is rapidly growing, and to reach these goals it is dependent on many (local) stakeholders. The Municipality will obtain essential input from local actors in order to inform future policy measures. The Municipality has significant influence in defining targets that directly impact energy transition efforts, hence it is essential that they are informed and involved in the latest developments within smart energy projects (CityofAmsterdam, 2021). Finally, the city is responsible for retaining low-income inhabitants in their neighborhoods and needs to make sure that the energy transition does not result in greater inequality and energy poverty (GemeenteAmsterdam, 2020). The Municipality of Amsterdam has both a high power and high interest due to the ambitious clean energy goals.

Energy partners

Energy cooperatives, waterboards, project developers, (social) housing associations.

Energy cooperatives focus on the realisation of an for everyone accessible, democratically controlled, and sustainable energy supply. Waterboards are responsible for regional waters, such as canals and polder waterways. Project developers initiate smart energy projects. (Social) housing associations are organisations that build, own, and rent living spaces for people with a low to medium income. These associations are an important stakeholder because they can offer the opportunity to install sustainable energy technologies and solutions on the desired scale. Moreover housing associations are empowered to determine rents and therefore lower both social and financial costs for residents (Mosannenzadeh, Bisello, et al., 2017). Energy partners have in general both a medium power and interest. However, when project developers are involved their power and interest is both high since their success depends on the success of the project. The same goes for energy cooperatives since their focus lies on advocacy.

R&D institutions and universities

AMS, Energy lab Zuidoost, TU Delft, University of Utrecht, University of Amsterdam

The involvement of academia and research institutes will provide an important viewpoint and a depth of knowledge in key topics covered within projects. Different universities such as the University of Utrecht, University of Amsterdam, and TU Delft are involved in multiple smart energy projects in Amsterdam. These stakeholders are clearly active in the LIFE project which is a benefit which is often missed in purely commercial trajectories. While each of the research partners has a different role in LIFE, with TU Delft focusing on development of a digital twin model, UU on new governance structures and replication, and AMS on social engagement and dissemination, the common interest which connects all of these stakeholders is the underlying drive to push the boundaries of the state of the art in research, spread knowledge, and contribute to solutions which will create impact in the sustainable energy transition. The city of Amsterdam, the TU Delft, and the AMS institute came up with the plan to create a consortium that ensures the exchange of information, knowledge, and data between different disciplines, projects, and organizations. This initiative is called Energy lab Zuidoost. Through the Energy lab Zuidoost academics from divergent disciplines are brought together and scientific expertise are connected in order to solve the urban challenges that exist in Zuidoost. As always, dissemination of knowledge through publishing peer-reviewed academic reports and leveraging opportunities to involve Master / PhD students within the project is an important factor for participation in LIFE. While the research partners play an essential role across multiple levels of the project, their degree of influence and role(s) within the project are mostly focused on supporting the needs which will be defined by various end-users and industry partners involved in LIFE (AMSInstitute, 2020). On average R&D institutions and universities have a low power and interest compared to other stakeholders. In the LIFE project this is not the case because the project relies on the research of these organisations and thus have a higher power.

Citizens' initiatives

Owners association, Coforce, de Ceuvel, Schoonschip, Stichting WOON, de Waag, 'om nieuwe energie'

People who are living in the area where smart energy projects are carried out can be tenants or private owners who can be represented by owners associations. Therefore, residents can be both direct and indirect users of technological innovations and can both direct and indirect be influenced by these changes. To make sure residents are represented and have a voice in decision making there are multiple citizens' initiatives in Amsterdam such as de Ceuvel and Schoonschip. These initiatives are active in the Buiksloterham area and aim to realise a sustainable living environment for current en future generations. Waag is looking into the European research project Mobility Urban Values in order to sustain mobility in the neighborhood. In addition, Waag preserves residents' interests and encourages active citizenship by developing transparent, honest, and inclusive technologies.

As the LIFE project focuses on inclusion, local inhabitants within the ArenAPoort will be approached to participate in the project through partner Coforce, a local resident's group. To ensure that the perspectives of even the least energy-aware participants are taken into account, a diverse set of local residents will be involved in the iterative co-creation sessions conducted throughout the project. As local energy collective, 'om nieuwe energie' will play an important role in this process by bringing in knowledge and expertise from other initiatives. Furthermore, WOON foundation provides inhabitants of Amsterdam with information and advice on renting, buying, energy, organisation, and participation. These innovations highly affect citizens and citizens' initiatives in specific neighborhoods, therefore they have high interest. Citizens' initiatives value these projects since it influences their living environment and are in line with their own sustainable objectives. In addition, it can lead to economic benefits in the form of an decrease in energy bills. However, not all citizens care to participate in such projects since they value other things life. Their power however is often low due to the fact that they rely on decision makers.

4.2.2 Service Providers

Grid operators

Liander, Stedin

Liander has the responsibility to facilitate energy supply and demand by providing a reliable and future proof electricity grid at low cost. As a grid operator, Liander plays an imporant role in projects where grid capacity problems are present. Therefore Liander aims to leverage the capabilities of innovative approaches, such as digital twins, in order to better understand the complex interplay of diverse energy systems and their impact on the grid, as well as to inform future investments. This is the case in the LIFE project. This project will not only facilitate better grid planning in the long-term but also more (cost)efficient grid operations through the development of next generation grid management systems. DSO Stedin is involved as knowledge partner to share their knowledge and experience on the LES and learn from the development of the next generation grid management system. As DSOs are one of the most important stakeholders in the energy transition, their needs and perspectives must be addressed. While Liander has a significant degree of influence, as a DSO they are also bound by existing regulations and industry structures, hence any results developed within the LIFE project must fit within the constraints of the regulatory and market framework (AMSInstitute, 2020). Grid operators have both a high power and interest because the smart energy solutions that are part of these projects are all connected to the electricity grid and grid capacity problems have a high impact on organisations such as Liander.

System integrator/technology developers

Spectral

Spectral, the lead system integrator within the project, is a highly mission-driven organization whose core focus is on accelerating the energy transition through the development of smart energy technology. The LIFE project represents an extremely valuable opportunity to work with a wide range of key stakeholders in order to co-develop, test, and validate the smart energy solutions of tomorrow. The collaborative project approach will allow Spectral and other technology developers to gain exposure to a wide range of perspectives in order to refine the functional requirements of future product offerings. The fact that the DSO and a wide range of end-users are involved in the project provides a unique chance to gain market insights and access to information (e.g. grid topology schematics) which is not generally publicly available. As the core developer of the LIFE platform and a number of the associated results, Spectral has a high level of interest and degree of influence in driving the project scope and the opportunity to contribute their energy transition in order to enrich the collaborative research process. In the Light house city project Spectral is mainly focused on pilot locations. The goal is to realise a local energy market and facilitate the exchange of energy between different parties in the Buiksloterham area. System integrators have both a high power and interest because the developments of these projects depend on their efforts and influences the success of the company.

4.2.3 Target Groups

Asset Owners/consumers

JCA, Amsterdam Energy Arena, Ziggo Dome, Municipality of Amsterdam-Smart Mobility Hub, Bus companies GVB/FLIXbus/Connexxion

The involvement of local businesses and asset owners in the ArenAPoort is an essential ingredient for the living lab experiments which will be conducted within the LIFE project. For the real estate owners and other commercial businesses, the main interest in participating within the project is the opportunity to increase property value and reduce costs through smart energy interventions. The subset of participants who own relevant energy assets such as, JCA and Connexxion, are interested in understanding how their assets can be optimally managed to increase efficiency and generate additional revenue streams. And while the level of commitment to sustainability goals may vary between partners, based on the huge urgency to accelerate the energy transition, the theme which connects all LIFE partners is the common interest in making an impact and realizing the vision of our sustainable future. Partners who have more direct and tangible benefits have a greater incentive to participate in co-creation of results, however, other linked parties such as, ING and Ziggo Dome, are willing to support though perhaps more neutral with respect to their viewpoints about the planned development activities within the project. As end users and asset owners, this group of stakeholders has an important role to play, though they have a lesser degree of influence within the project when compared to, for example the DSO (AMSInstitute, 2020). Asset owners both have a high power and interest due to the fact that these technology developments can provide substantial income and are connected to their assets. In addition, the asset owners are participating in local energy markets which can also positively influence their business.

Citizens

Tenants, Homeowners, Vulnerable Groups

People who are living in the area where smart energy projects are carried out can be tenants or private owners. Residents can be both direct and indirect users of technological innovations and can be influenced directly or indirectly by these changes. As already explained, residents can be represented and can have a voice in decision making through citizens' initiatives. However, this is not always the case and also for these initiatives it is sometimes hard to reach all citizens in the area of interest. As explained in section 3.1.2, inclusive cities aim at making sure that technology development can benefit all the citizens including vulnerable groups (Mancebo, 2019). The term 'vulnerable groups' is often mentioned in relation to the concept of inclusion especially when it comes to the problems of inclusion identified in section 3.1.3. In general, the term vulnerable groups is associated with elderly, children, poor people, disabled people, etc. From an interdisciplinary perspective a vulnerable group can be defined as a "population within a country that has specific characteristics that make it at a higher risk of needing humanitarian assistance than others or being excluded from financial and social services. In a crisis such groups would need extra assistance, which appeals for additional measures, i.e. extra capacity, as a part of the emergency phase of disaster management" (Kuran et al., 2020).

This definition is reflected in the smart energy domain. With respect to the smart energy domain of the city of Amsterdam, Technotrend (2019) identifies vulnerable groups as people who live in the area of interest and have a migration background and thus experience language barriers resulting in information not being spread. Also, people who have low educational levels, who live in poverty and are unemployed. In Amsterdam's Zuidoost neighborhood where the LIFE project is carried out, the vulnerable groups mainly live in high rise buildings. Concepts such as sustainability, energy, and re-use are low priority targets in these neighborhoods which makes it hard to involve them in the energy transition. This, together with their social and economic backgrounds, makes these residents vulnerable for the consequences of exclusion as a result of smart energy project development (Technotrend, 2019). This is also reflected in the interview results.

4.2.4 Power-Interest Grid

Figure 4.1, shows the power-interest grid of the stakeholders involved in the case study on the smart energy domain of the city of Amsterdam. This tool is used to categorise the stakeholders based on their power or influence and interest in a project. In this way, a better understanding of relationships between stakeholders within smart energy projects is created and can be used in the case study (Ackermann & Eden, 2011).

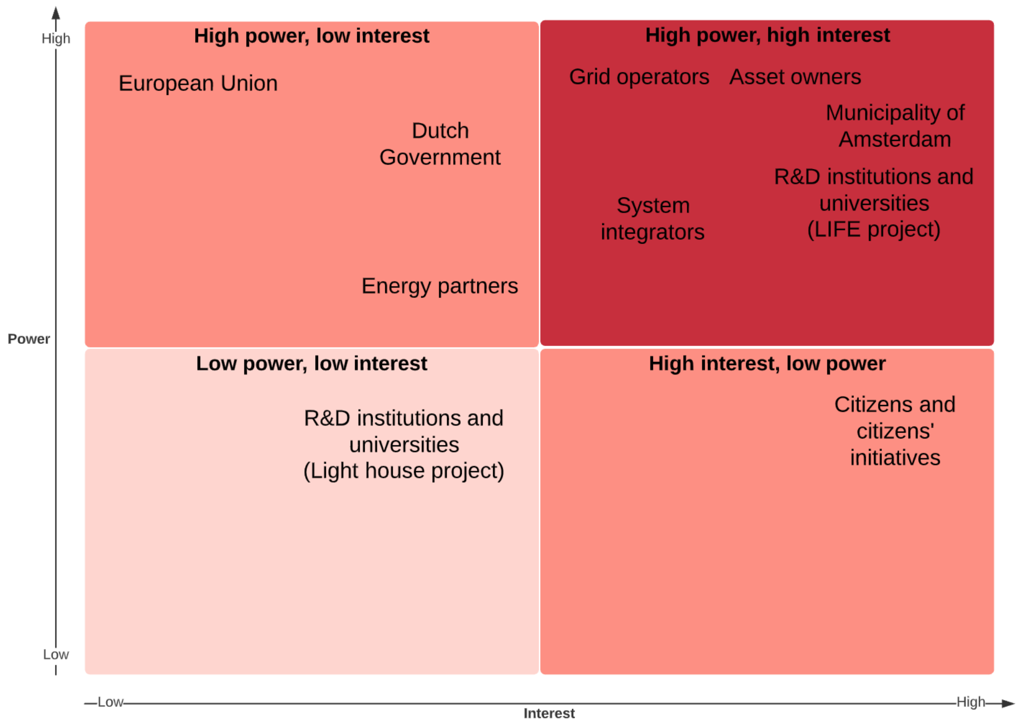

Figure 4.1: Power-Interest Grid

4.3 Conclusions

Amsterdam is getting the energy transition started and is a forerunner when it comes to developments within the smart energy domain compared to other Dutch cities due to the large amount of smart energy projects that are on the city's agenda. However, it is still unclear in what way these technological developments influence local communities and businesses and how we make sure vulnerable groups are not pushed out, isolated, and marginalised from important urban services, amenities, commercial flows en jobs. By means of the research questions an embedded case study will be carried out in order to gain insights in to what extend inclusion and its five dimensions are taken into account in Amsterdam's intends to speed up the process of making the capital city more sustainable and become a future-proof city. The case study consists of two specific sub-units of analysis. The first sub-unit of analysis is the Local Inclusive Future Energy (LIFE) project which is carried out in Amsterdam's Zuidoost neighborhood and aims at to develop a district-scale energy management platform to resolve grid problems while integrating local stakeholder interests in its design and implementation. The second sub-unit of analysis is the Lighthouse City Amsterdam project in the Buiksloterham area in Amsterdam North and is funded by the European Union. The project aims at creating a positive energy district. Moreover, the stakeholder analysis provided information on three stakeholder groups: decision makers, service providers, and target groups. Citizens are an important stakeholder and include, among other, 'vulnerable groups'. In the smart energy domain vulnerable groups are people who live in the area of interest and have a migration background and thus experience language barriers resulting in information not being spread. Also, people who have low educational levels, who live in poverty and are unemployed.

Chapter 5: Case Study Results

The embedded case study consisted of interviews with multiple respondents in several fields within the smart energy domain of the city of Amsterdam. By means of an interview guide, presented in appendix E, based on the theoretical framework and the research questions, results with respect to the concept of inclusion, technology development, the current state of the art, challenges related to inclusion, and realizing inclusion are obtained and described in this chapter. This chapter only contains the empirical results of the interviews.

5.1 The Concept of Inclusion

From the interviews it became clear that each respondent has its own thoughts on the concept of inclusion. Most respondents relate inclusion to equal and fair participation and involvement of all groups in society. Respondent 1 argues that inclusion has to do with two things: stakeholder engagement and inequality. First, it is important to find a strategy to involve all stakeholders when carrying out a smart energy project. Second, inclusion is a synonym for inequality. Respondent 2 relates the concept of inclusion within smart energy cities immediately to gentrification, the demographic displacement and thus exclusion of certain communities resulting in the attraction to cities by people with higher incomes as a result of rapid urbanisation. Respondent 7 indicates that when you are dealing with a cohort of people, you should involve everyone with whatever happens in their environment and is in their interests. This can be businesses and residents but also from a political viewpoint established and local parties. Respondent 10 argues that inclusion is mainly about also involving the less well off section of the population and their preferences. This is line with the opinion of respondent 11 who says that from the viewpoint of the energy transition an inclusive energy system entails that all layers of society can participate and can benefit from these systems.

Most respondents are not familiar with the five dimensions of inclusion as a theoretical concept but can relate to them. Social inclusion is what respondents consider as the most important and common dimension of inclusion. After that, economic inclusion is named most frequently within smart energy projects because in every project the question arises of who pays the bill. Besides this, respondent 6 states that it is important that everyone can participate in rising prosperity and that there is local economic involvement. This not only applies for individuals but also for businesses and entrepreneurs who should have equal market opportunities.

"Inclusion within the smart energy domain entails that no one should suffer from changes as a result of technology development and that everyone should be able to economically and socially benefit from it." (respondent 8)

Respondent 3 however argues that having a say in decision making and sharing costs is what is most important which is covered by the dimension of political inclusion. This requires governance and information provision. Respondent 8 shares this opinion and adds to this that information should contain instructions on how to participate and benefit, also when people do not have the financial means. In contrast to most other respondents, respondent 3 claims that social inclusion is more on the sidelines when it is mentioned in smart energy project plans. Respondent 1 sees political inclusion more as the overarching dimension of inclusion because governance and policies decide what rules and regulations apply in a specific area. Despite the fact that environmental and spatial inclusion are the least recognisable among the respondents, respondent 1 classifies environmental inclusion as the most relevant dimension within the smart energy domain. This because meeting the needs of current and future generations for natural sources and environment and countering climate change and depletion of fossil fuels was the reason to start building smart energy cities in the first place. Respondent 8 defines environmental inclusion as having equal opportunities to improve your living environment and that top down decision making should not negatively affect your living environment. This is also known as climate discrimination. Spatial inclusion is mentioned only a few times under the respondents in connection with the fact that everyone in a specific area should have equal access to infrastructure and technology placed in public space. Infrastructure must be adapted as a result of technology development which can have consequences for people's living environment. Respondent 13 concludes by saying that in any dimension of inclusion, always the same groups of society are left out.

5.2 Technology and Inclusion

The interviews provided several insights on the question to what extent technologies can be inclusive and in what way technology development contributes to inclusion. Respondent 1 argues that this depends on the type of approach with respect to the implementation of smart energy solutions. The approach can be leveling or liberal. Energy is an utility which depends on governance.

"Technology itself is interesting but not that relevant when it comes to achieving inclusion, whether there is inclusion depends on who facilitates the technology and which party has to invest." (respondent 1)

With respect to the LIFE project, respondent 1 says that it is not about which specific technology is needed to make sure energy is generated and stored a sustainable way but about the total costs of ownership of the technologies. The question is if costs are socialized and if governmental institutions facilitate these technologies. Or is there liberal market where parties make profit. Respondent 6 and 7 share this opinion and both argue that inclusion depends on how the technology is developed, is used, what it costs, and how the energy market is organised.

"It is not the technology directly that could lead to inequality and exclusion but it will when there is a lack of adequate organisation and there is no financial solution for people who do not have the financial resources." (respondent 6)

This is line with the experiences of respondent 5 who argues that residents with higher incomes take initiative when it comes to the adoption of smart energy technologies by investing in for example solar panels and heat pumps which results in other residents not being able to keep up. In this way the energy transition could lead on the one hand to economic prosperity and on the other to social and economic inequality. However, respondent 2 states that even if you are not able to invest in smart energy technologies, people who live in areas where smart energy projects are carried out can benefit from cleaner air, a greener street scene, less parking spots in public places and thus less traffic.

Moreover, when technology is properly deployed it could contribute to inclusion. The use of solar panels or batteries can decrease the collective costs of communities which can result in more social cohesion among residents. The same goes for energy trading and the use of smart grids. Respondent 8 argues that smart grid technologies are quite accessible. Consuming energy at off-peak times when energy is cheap could increase inclusion within communities. According to respondent 12, the same goes for smart technologies that facilitate infrastructures such as streetlights. Respondent 1 concludes by saying that besides smart energy technologies, also information technologies play an important roll when it comes to inclusion. It can contribute to inclusion through technology or not, depending on how people get the right or wrong information. Through information technologies people can get misleading information which can result in exclusion. For example, climate change that is not being acknowledged.

5.3 Current State of the Art

Inclusion and participation are concepts that are mentioned often within Amsterdam's smart energy domain. Multiple strategies and organizations are being used in order to realise inclusion. Respondent 9 argues that the Municipality of Amsterdam pays a lot of attention to inclusion policies. There are three pillars sustainable institutes have to comply with: affordable, sustainable, and adequate. Municipalities have high restrictions when it comes to the approval of project development because it is financed by tax money. A council first researches what is in there for the residents in a specific area or for the city of Amsterdam in general.

Respondent 13 adds to this that the Municipality of Amsterdam is doing projects involving sunroofs on housing associations. In this way, tenants are able to benefit from the sustainable energy that is generated by paying 50 euros every month and becoming a member of the energy community. The affordability of the technology is what makes it inclusive. In addition, the municipality of Amsterdam has a separate pillar that focuses on inclusion and an important aspect within this pillar is gentrification. People are scared that they will not be able to pay for buildings that are recently build. Therefore meetings and events are planned in order to explain that there will always be an amount of affordable houses. The Governing Council ensures that new buildings must consist of 40% social, 40% middle-income, and 20% high-income houses. This, in order to reach a minimum of 35% social houses of the total housing stock.

According to respondent 5, current inclusion activities are mainly successful because of the use of intermediaries. Woon is an important group that enter into conversations with citizens locally and receive a lot of subsidy from the Municipality of Amsterdam. In this way, they research what is important for those people before a certain smart energy technology is chosen and implemented. Radio programs and cooking workshops are organised in order to involve citizens and make them familiar with technology. In this way, it becomes clear what these people value. Besides this, energy displays are developed so that residents can check their own consumption and reduce their energy bills. Currently, the starting point is making sure nothing changes for the tenants. If housing associations invest in sustainable energy technologies and this results in an increase in rents, it is required that the tenants' energy bill decreases in order for the housing costs to stay the same.

"Currently Amsterdam is not yet an inclusive smart energy city, but it is well on its way to meet the conditions with respect to inclusion." (respondent 3)

Respondent 3 states that Amsterdam is in reality not yet an inclusive smart energy city and that it is all in the implementation. Smart energy projects are always about ensuring that people begin to figure central in these projects, but in practise no one actually knows how to realise inclusion. Nevertheless, Amsterdam is internationally at the forefront compared to other cities. Inclusion is almost always part of current project plans but unfortunately mostly the technical part is more up front. On the other side you could also say that in The Netherlands everyone has access to heat and electricity so there already is inclusion.

Respondent 1 argues that in the LIFE project inclusion must, among others, be realised through the participation of Coforce. It is important to personally talk to the people in concerned area, and make sure that also (civil) participants such as community organizers, local communities, sports clubs, denominations, local environmental banks are involved. Respondent 7 explains that Coforce uses so called energy commissionaires who represent citizens in Vensterpolder and coach them with respect to participation in decision making. The goal is to lead the energy transition from a bottom up perspective. In this way, it not only stays with leading businesses. By connecting multiple parties distrust is converted into trust. Respondent 13 adds to this that electric vehicles are used to explore the neighborhood and go into conversation with the local community. Besides this, also in this project energy coaches from Woon are involved to talk to people and help them understand and use new technologies.

"Inclusion can only be realised through the success of intermediary and citizens' initiatives." (respondent 13)

In addition, respondent 6 explains that also owner's associations will be involved in order to find out what their preferences are with respect to energy technologies and from which technologies they could benefit. Also TU Delft does research on how different parties can work together and how to find out what each stakeholder needs. In the end LIFE wants to make sure there is an equal distribution of costs and benefits.

Respondent 2 raises the concept of energy communities that are created as part of the Light house city project. Through citizens' initiatives residents will automatically be part of an energy community when they live in a specific neighborhood which in turn fosters inclusion. Respondent 11 says that realising inclusion within the Light house project might be easier then within the LIFE project because the goal of creating a local energy market for all people in Buiksloterham and thus all layers of society will also involve residents who do not have any associations with energy technologies.

5.4 Challenges related to Inclusion

The respondents indicated that there are multiple challenges related to inclusion. These challenges are grouped into five categories.

5.4.1 Gap between technology and society

Challenges related to inclusion arise due to the fact that the technological and social aspects within smart energy projects are often not aligned. Respondent 3 argues that there is a clear difference between projects where inclusion is part of the project from the beginning end where it is not. Moreover, often these smart energy projects are driven by technology. It starts with an organisational problem with respect to the collaboration of the stakeholders that are involved. Second, there is a problem with respect to technology, and in the end there is some focus on how the neighborhood is involved. Many smart energy projects are about testing the technology but at the same time you must monitor how people can use the technology which has to do with awareness. In this way realising inclusion and participation remains a challenge. Also, people who are on the technical side of a project want to innovate but do not look into the social aspects of the project. This is line with the experiences of respondent 8 who says that also in the LIFE project the technology is already being designed without the involvement of the social stakeholders or the residents of Zuidoost.

"Inclusion is part of this project because technology is normally always at the front end, but you can already see that people consider it as an afterthought." (respondent 8)

This is confirmed by respondent 11 who says that the technical stakeholders come together in order to design the technology and at a later stage realise it has to be inclusive as well. From a technical perspective, inclusion is not something that is considered on a regular basis unless the client asks for it. Smart energy projects are often either technology or socially driven, not both.

5.4.2 Limitations as a result of regulations

Respondent 2 explains that the Light house project is funded by the EU which means that there are several restrictions to the project with respect to time, financial resources, and architecture. The size of the apartments build in Buiksloterham can for example not be too big because then they become to expensive. On the other hand they cannot be too small either because then no one ones to live there. Some personal adjustments can be made but co-creation is not possible.

"Due to the directives of this project, vulnerable groups such as the urban poor, people with a migration background, and disabled people are not taken into account which makes realising inclusion a huge challenge." (respondent 2)

Also from the perspective of the Municipality of Amsterdam there are restrictions regarding inclusion. Respondent 5 explains that the Municipality of Amsterdam for example, is not allowed to communicate in a different language and that the benefits of the use of translators do not weigh out the costs. Respondent 10 argues that also for the LIFE project restrictions are imposed by the subsidizer.

"Only academic innovative research is allowed instead of piloting which results in not being able to involve citizens from the beginning and inclusion is hampered." (respondent 10)

5.4.3 Inequality

According to respondent 6, inequality within society arises due to the required investments in sustainable energy solutions such as solar panels and insulation in order to save money on energy bills. As a result, people who cannot afford this will be dealing with high energy costs. Individuals and neighborhoods will therefore not have equal opportunities. This problem is enhanced by the difference between tenants and private owners who do not share the same motivation to invest. Private owners are more often part of the participation process compared to tenants because they invest in their own property. This is confirmed by respondent 7 who says that also in Zuidoost only residents that have investment capacity participate in the energy transition and that there is a clear difference between rental and residential homes.

5.4.4 Different perspectives

Respondent 5 argues that participation in smart energy projects can also be hampered by the fact that citizens have concerns with respect to costs, sustainability of the technological alternative, which option to choose, and nuisance in their living environment. Respondent 12 also recognises this problem. Owners associations are often critical and do not believe the investment in sustainable energy technologies is worth it. They do not understand why you would replace a technology that works by a technology that is still insecure. Such misunderstandings are caused by a lack of correct information which should be done by Municipalities. However, a much bigger challenge occurs when you are dealing with citizens who are illiterate. Respondent 12 explains that in Zuidoost this is a common problem which results in residents not having a voice or being able to participate in any transition in their living environment. Vensterpolder is one of the poorest neighborhoods in Amsterdam. In such a neighborhood you do not know what people's background or domestic situation is. In this area there are a lot of problems that do not occur in neighborhoods with residential houses. Respondent 12 argues that these citizens are surviving in their own way which results in having a whole different perspective on life. The Netherlands is such a prosperous country and therefore many citizens of Zuidoost do not care about technological innovations at all.

"They are happy that they have access to a house and food and do not experience exclusion. Educated and higher income people in the neighborhood share the opinion that everything should be prettier, better, and more efficient but most people do not care." (respondent 12)

"If the language barrier is too big or the budget is too small it might be the case that inclusion cannot be realised at all despite the fact that this is of great importance, especially in large cities." (respondent 8)

However, according to respondent 10, a lack of interest and enthusiasm to participate in smart energy projects occurs in all neighborhoods. It depends on your field of work and personal interests, not necessarily on your neighborhood or income. Respondent 10 adds to this that it is going to be a challenge to live up to the inclusion part of the LIFE project.

"Realising inclusion remains difficult and for smart energy projects in general, having inclusion as one of the pillars might also be about "ticking boxes" in order to get your project plan approved." (respondent 10)

5.5 Realizing Inclusion

Respondent 5 shows that first of all, the energy transition should be affordable, also for vulnerable groups. Insights in costs should be given and technology and society should work together. Respondent 8 explains that these two aspects should both be considered from the beginning of the project. Inclusion must start before a plan is developed and decisions are made. In this way, people's preferences and values can be taken into account. These can be identified by going into the concerned neighborhood and explain what plans are on the table and ask what problems they currently experience and why they would use a certain technology. Surveys, interviews, or meta data can be used in order to gain information and this data can be stored and smartened. Subsequently this data can be translated into the technology. According to respondent 11, the most important thing when doing this is unburden people. Make sure people know where they agree upon.

"The most important part is unburden people, make it simple and concrete." (respondent 11)

This is the responsibility of housing associations together with the technology developer. The technology can be explained on an informative meeting through the use of dashboard for example. An important condition is translating technological issues into ordinary human language. Respondent 13 says that the system integrator has to make sure the smartness is in the technology and not in the use so that everyone is able to benefit from it regardless of the level of education.

According to respondent 7, it is most important to involve people from the first day changes occur. On the one hand, this involves showing people which direction society is going and how this influences their living environment. This entails explaining what is going to happen and this is what we expect from you. Show people that they have a voice and make them feel relevant.

Respondent 1 argues that inclusion within smart energy projects is about economies of scale and costs and benefits. It is important to have a clear value proposition which should contain four questions: 1. Which problem are you solving?, 2. How are you going to solve it, 3. What are the benefits?, 4. What are the alternatives?. In this way, a valuable solutions can be found. Respondent 10 adds to this that the only way to include certain communities is to make clear what is in it for them. Make is easy and concrete. Explain that they could save on their energy bills if they use the washing machine between certain hours. Try to reach this people through channels such as social media, if necessary in different languages. Respondent 12 states that personal contact is the only way to reach this people. You could introduce them to smart energy solutions by organising workshops, mind gaming, but also introduce people to this kind of issues from a young age at schools.

5.6 Conclusions

Most respondents are not familiar with the five dimensions of inclusion as a theoretical concept but can relate to them. Social inclusion is what respondents consider as the most important and common dimension of inclusion. After that, economic inclusion is named most frequently within smart energy projects because in every project the question arises of who pays the bill. The extent to which technology development contributes to inclusion depends on the type of approach with respect to the implementation of smart energy solutions. Furthermore, Inclusion depends on how the technology is developed, is used, how the energy market is organised, and most important what it costs. In other words, it is not about which specific technology is needed to make sure energy is generated and stored in a sustainable way, but mainly about the total costs of ownership of the technology. Inclusion and participation are concepts that are mentioned often within Amsterdam's smart energy domain. Multiple strategies and organizations are being used in order to realise inclusion but according to the respondents is Amsterdam in reality not yet an inclusive smart energy. Furthermore, five challenges related to inclusion are identified: the gap between technology and society, limitations as a result of regulations, the rise of inequality as a result of technology development, and the existence of different perspectives. Inclusion could be realized when these challenges are met and when technological changes are presented to citizens in a simple and concrete way in order to unburden people.

Chapter 6: Theoretical Reflection

Chapter 3 described how two frameworks, one for an inclusive city and one for a smart energy city, are integrated into an inclusive smart energy city framework. This chapter will describe the link between the empirical part of this research, the interview results, and the theoretical part. This link is explored and examined through the use of the theoretical framework which is described in section 3.4.5. In this way it can be determined to what extent Amsterdam can be defined as an inclusive smart energy city and which pillars within the framework where reflected in the case study. Each pillar of the framework will be discussed and the chapter will end with a examination of the extent to which the pillars interrelate within the projects and the objectives of an inclusive smart energy city are reached.

6.1 Inclusive City

In section 3.1 the theoretical concept of inclusion and its five dimensions is explained. The empirical research shows that every interviewee is familiar with the term 'inclusion' but that each interpretation is slightly different. As explained in section 5.1, the five dimensions of inclusion from the theoretical framework is not a concept the interviewees are all aware of, which points out that these dimension are not directly considered in smart energy projects. However, some of the problems related to inclusion identified in table 3.1 are recognized by the respondents and correspond with what they identify as challenges related to inclusion within the smart energy domain described in section 5.4. The problems of housing, no equal rights and participation, a lack of opportunities for the urban poor, issues of environmental awareness and behavior, migration and demographic issues, and the social structure of employment problems identified from the literature are according to the respondents the most common and well-known. These problems are related to both social and economic inclusion (Makushkin et al., 2016). Problems related to political inclusion, such as a lack of political participation and no effective communication between local governments and citizens, are also named by respondents but less frequent (Danni et al., 2021). The problems related to environmental inclusion that are identified by the respondents are confined to the fact that smart energy cities are build in order to compromise the needs of future generations for environment and natural resources (Danni et al., 2021). The problems related to spatial inclusion are not mentioned by any of the respondents.

Furthermore, the theoretical framework describes that the concept of inclusive city focuses on how inclusion can be achieved through the coordination and involvement of local stakeholders and making sure each stakeholder can contribute to inclusive urban prosperity in their own way. As a result, smart city development will have inclusion in its core which shifts urban transformations from a technology driven environment, where only a small group of citizens has access to vital resources, to a human driven environment where also the vulnerable groups are taken into account and therefore also can benefit from technological innovation (Danni et al., 2021). The results of the case study described in section 5.4 however, point out that the coordination of participation of local stakeholders in practice remains a challenge due to contrasting values. In addition, the results from the case study show that technology is still often at the center of smart energy projects in Amsterdam due to the fact that these projects are technology driven and people think of inclusion as something that can be considered at a later stage. Moreover, section 4.2.3 defined the term 'vulnerable groups' and how this is reflected in the smart energy domain of the city of Amsterdam. Technotrend (2019) identified vulnerable groups as people who live in the area of interest and have a migration background and thus experience language barriers resulting in information not being spread. Also, people who have low educational levels, who live in poverty and are unemployed (Technotrend, 2019). This is confirmed by respondent 12 who argues that sustainability is a low priority in Amsterdam Zuidoost which makes it hard to involve them in the energy transition and makes these residents vulnerable for the consequences of exclusion as a result of smart energy project development.

6.2 Collaboration of Stakeholders

Collaboration of stakeholders is one of the pillars of the theoretical framework described in section 3.4 and is identified as a paramount characteristic of an inclusive smart energy city. From the theory it became clear, collaborative relationships create mutual understanding and harmony between stakeholders. This will result in the adoption and acceptance of joint decisions among target groups which makes it easier to realize decisions (Mosannenzadeh, Bisello, et al., 2017). This is clearly demonstrated in the results of the case study as well. Just like in the theoretical framework, the stakeholder analysis distinguishes three stakeholder groups: decision makers, service providers, and target groups. Within smart energy projects in Amsterdam there are the project developers, technology developers, people who use the technology and citizens' initiatives. Project developers work together with universities and R&D institutions in order to optimise the project plan. Project plans have to be approved by local Governments and licences must me permitted. When it comes to area development in Amsterdam, respondent 5 explains that the Municipality collaborates with housing associations, owners associations, and private individuals in order to realise participation. In addition, they use legal services to solve problems for tenants and owners (GemeenteAmsterdam, 2020). Smart energy projects can have advantages and disadvantages for a neighborhood. Therefore, project developers should carefully consider what impact the implementation of the project has on residents and when this is negative, how to prevent or minimize it. According to respondent 8, this can only be done through the collaboration stakeholders which is mainly about taking responsibility. Within smart energy projects there is always a triangular relationship between the initiator, the policymaker, and the people affected by the developments which has to be an equal relationship. The right stakeholder has to take responsibility at the right time in order to involve all parties concerned and realise inclusion.

Respondent 9 points out that within the LIFE project inclusion of all stakeholders is a high priority. It is therefore important to have a clear vision on what each party represents, what their goals and interests are, and compare them. Different objectives and values between stakeholders are always present within projects and therefore collaboration can be hampered. Divergent interests can have a negative effect on the results of the project. The importance of collaboration of stakeholders also emerges from the interview with respondent 2. In the Light house project, project developers closely work together with the technology developer and a research institution is collaborating with citizens' initiatives in order to figure out what the impact of the project will be on residents and future residents (Atelier, 2021). These results must give insights in stakeholder involvement and participation and must create understanding and consensus among stakeholders. In this way joint decisions that are more acceptable among target groups are generated and results in a more effective implementation of the projects plan. Multiple respondents emphasize the importance of the collaboration with intermediaries that stand between technology and society such as Coforce, stichting WOON, and de Waag. Without these parties the realisation of an inclusive smart energy city would not be possible because only through these parties residents' needs and preferences can be identified. In collaboration with the technology developer these needs and preferences can be translated into the technology. In turn, the technology developer works together with other service providers such as grid operators and energy parties in order to dovetail the technical elements within the project. From the case study, it would appear that all stakeholders are interconnected and interrelated in order to ensure optimum progress of the project. However, the interview results show that there still is a gap between 'technical' and 'social' stakeholders within smart energy projects and that especially between these stakeholder groups close collaboration is important. This is in reality difficult to attain. The theoretical framework highlights bottom-up collaboration and inclusion at the core of a smart energy city in order to create solutions for urban problems (Danni et al., 2021). This is in line with the argument of respondent 7 who makes clear that the energy transition should start bottom-up from society, from the residents' house, in order to prevent only leading businesses being involved.

6.3 Smart Energy Solutions and Technologies

The theoretical framework points out that through the collaboration of stakeholders, the application and integration of smart energy solutions in the hard domain can be managed and realised (Mohanty et al., 2016). The three independent building blocks of a smart energy system are clearly reflected in the case study on the city of Amsterdam. As stated in section 4.1, the share of local solar and wind energy is growing rapidly, as well as the electrification of heating, cooling and mobility (AMSInstitute, 2020). The Municipality of Amsterdam connects homes to heating networks and supports the use of solar en wind energy. These heating networks are implemented on a district scale and aim at delivering heat and hot water to buildings, both businesses and homes. In Westpoort and in Diemen, power plants are located where heat is generated and currently the city of Amsterdam is investigating which plant is the most sustainable. There are also plans on the table regarding the development of a biomass plant in Amsterdam and connecting this plant to the heat network. Using heat networks instead of natural gas will halve CO_2 emissions also when burning fossil fuels generates this heat (GemeenteAmsterdam, 2021).

The city of Amsterdam has ambitious goals when it comes to generating sustainable energy from solar energy. In the last ten years the number of solar panels in the capital city has exponentially increased. Amsterdam has envisioned installing solar panels on every suitable roof in order to generate 400 MW of solar energy on 50% of roof surface in 2030. Roofs suitable for the installation of a large amount of solar panels are for example park and ride locations or other existing infrastructure. With respect to wind energy, Amsterdam currently has a capacity of 66 MW of wind energy and strives to generate an additional 50 MW in multiple additional areas. As part of the Amsterdam Smart City program the city has its focus on technological innovations in the field of smart heating and electricity grids, and emphasizes the importance of getting rid of natural gas (CityofAmsterdam, 2021).

However, besides low-carbon generation the mismatch in the timing of this local supply and demand asks for efficient distribution and optimised consumption of energy. In both sub-units of analysis studied in this thesis the three building blocks of a smart energy system can be recognized. The LIFE project aims to locally resolve these grid capacity problems. Smart energy technologies involved in the LIFE project are among others wind turbines, solar panels, a hydrogen hub, a smart grid, smart meters, ATES based infrastructures, V2G and E-bus charging points, and batteries. The energy assets which are already present within the area, lay the foundations for the Platform (AMSInstitute, 2020). The lighthouse project aims at installing renewable and reliable energy technologies and solutions which should enable energy sharing and trading among local residents and businesses. There will be large scale deployment of local PV. In order to manage the local supply and demand of energy, buildings will be equipped with a smart microgrid. This micro grid enables adaptation and response to the demand, which results in the fact that peak loads can be prevented and the public electricity grid will not be overloaded. This micro grid also facilitates the storage of local renewable energy. The rewards of these benefits can be reaped through an energy market platform that will facilitate peer-to-peer energy trading, community-to-community trading or trading with the wholesale energy markets. (Atelier, 2021).

6.4 Integration of Solutions

The integration of smart energy technologies in the hard domain can be done through the use of technologies in the soft domain. Besides the use of technology, this pillar involves collaborative planning, consumer behavior management, and energy and data management. Collaborative planning can support coordination within projects and can provide efficient and clear communication of all kinds of information such as data, knowledge, and ideas among stakeholders (Mosannenzadeh, Bisello, et al., 2017). According to respondent 9, there is no type of data management tool like a dashboard that could facilitate collaborative planning within the LIFE project but adds that it would be a great addition. However, a product management plan accessible for all partners containing milestones and schedules is on its way. Tools and technologies that enable and facilitate collaborative decision making, such as simulations, and scenario analysis tools are mentioned by respondent 6. By experimenting together in different 'Living Labs', Energy Lab Zuidoost develops and tests new innovations in a real-life environment which helps to understand what works and how to scale and implement the smart energy solutions from the hard and soft domain.

Consumer behavior management is very important because it provides solutions to identify consumer's needs and preferences with respect to their energy consumption. Tools and technologies can be used to retrieve information and create awareness among stakeholders about energy supply and demand and they can provide insights into the options with respect to the reduction of energy use. In addition, certain tools and technologies can be used to change consumer behavior. (Mosannenzadeh, Bisello, et al., 2017). Respondent 6 argues that with respect to consumer behavior management it is most important to have a clear vision on who is going to use the technology, and in the case of the LIFE project the platform. A significant amount of energy must be traded on the platform. Potential users such as owners associations, businesses, and citizens' initiatives must be informed about their energy consumption and their options with respect to reduce energy use. Consumer behavior must be managed locally in order to reduce investment costs and the area benefits from the innovations that take place. It is a complex process due to energy management of different parties that are connected to the platform (Mosannenzadeh, Bisello, et al., 2017). A tool that is used to provide insights in energy consumption to consumers is a smart meter. Respondent 11 explains that the platform aims at solving grid capacity problems whereby the focus lies on large assets. The preliminary draft of the technology should take into account possible future smart energy technologies that might be implemented and what the effects might be on residents. Therefore, technology developers must collaborate with intermediaries and local businesses to be able to incorporate this in the design of the technology.

The theoretical framework shows that solutions in the domain of energy and data management aim at optimizing the overall energy system. These solutions consist of multiple tools, instruments, and technologies that enable analysis, management, forecasting, and monitoring of smart energy city domains through the collection, processing, storage, and transformation of information and data (Mosannenzadeh, Bisello, et al., 2017). As stated before in both projects an energy management platform is build in order to resolve grid problems. In the Light house project the energy market platform will allow residents and other users to trade peer-to-peer, community-to-community with the wholesale energy markets. Respondent 11 explains that the platform must enable peak shaving and is used as a tool to optimize the overall energy system. Besides this, it enables storage, processing, and transformation of data through the use of algorithms. The platform is also called a smart community platform and contains visualised dashboard tool for energy communities such as Schoonschip or business parks to gain understanding of the energy flows and provide insight into the smart grid.

6.5 Governance and Policy

The theoretical framework shows that due to the many different components that comprise a smart energy city (collaboration of stakeholders, application of smart energy technologies, and integration of solutions through new technologies), and the need to ensure the five dimensions of inclusion are preserved in order to meet the objectives, governance and policy play an important role within smart energy project in Amsterdam. The results of the case study confirm the theory that the Government can play different roles within projects (Batty et al., 2012). In the Light house project, the Government plays the role of funder since it is part of the EU research and innovation project (Atelier, 2021). In the LIFE project the Government plays the role of regulator which entails making sure that common standards and regulations are in place (AMSInstitute, 2020). Besides this, many respondents hold the Government responsible for information provision and the extent to which citizens are involved in decision making. Inclusive governance is a synonym for political inclusion which is related to major issues of democratic institutions, human rights, political participation, and national identity. It supports information sharing between local governments and citizens, and makes sure that every citizen is involved in decision making and thus has a voice (Danni et al., 2021). However, practise shows that from a governmental perspective increasing wealth and public value and achieving higher quality of life for citizens remains challenges due to all the various values and interests of the stakeholders involved and the complex nature of an inclusive smart energy city.

6.6 Interrelation of Pillars and Objectives

As explained in section 3.4.5, a deeper understanding will be created with respect to what inclusion as a theoretical concept means and how it related to technology development, when each pillar of the framework and the interrelation between the different pillars is considered carefully. The interview results show that within the projects each pillar is indirectly considered but that the interrelation between pillars that should follow from close collaboration of stakeholders remains a challenge. The concept of inclusion is not well defined and not all stakeholders are on the same page when it comes to the definition of the concept. This results in the fact that inclusion is not considered from the beginning of the project which is crucial and should be the case according to the theoretical framework developed in this research. Collaboration of stakeholders should enable this, and should provide secure collaborative planning, consumer behavior management, and data management in order to integrate the smart energy solutions and technologies in such a way that the five dimension of inclusion are preserved. Respondents share the opinion that this is currently not sufficient in smart energy projects in Amsterdam. This results in the fact that reaching all seven objectives described in the theoretical framework, is currently not feasible. The objectives optimised, self-sufficient, sustainable and resilient are highlighted in the case study when is comes to technology development and the implementation of smart energy projects, and are considered as present in the smart energy domain of the city of Amsterdam. However, the case study revealed that with respect to inclusion only three objectives are relevant: accessible, affordable, and adequate. These objectives also appear to be the biggest obstacles for the realisation of inclusion. As stated in section 5.4, accessibility is a problem as a result of the gap between technology and society but also because of a lack of interest or understanding due to among others language barriers. Besides this, the problem of affordability plays an important role in the adoption of technology which hampers inclusion which is also explained in section 5.4. Together with adequate and sustainable, these two objectives correspond with the inclusion pillars of the Municipality of Amsterdam. When comparing theory and practise, it appears that creating an inclusive smart energy city is mostly about preserving accessibility and affordability. Reflecting the theoretical framework to the results of the case study shows that the framework is a useful tool to explore en examine which collaborations, processes, and objectives within a smart energy project should need more attention, are missing, or are present, in order to make sure inclusion and smart energy development co-exist within cities.

6.7 Conclusions

Inclusion is not considered from the beginning of the project which is crucial and should be the case according to the theoretical framework developed in this research. Collaboration of stakeholders should enable this, and should provide secure collaborative planning, consumer behavior management, and data management in order to integrate the smart energy solutions and technologies in such a way that the five dimension of inclusion are preserved. Reaching all seven objectives described in the theoretical framework, is currently not feasible. The objectives optimised, self-sufficient, sustainable and resilient are highlighted in the case study when is comes to technology development and the implementation of smart energy projects, and are considered as present in the smart energy domain of the city of Amsterdam. However, the case study revealed that with respect to inclusion only three objectives are relevant: accessible, affordable, and adequate. These objectives also appear to be the biggest obstacles for the realisation of inclusion. When comparing theory and practise, it appears that creating an inclusive smart energy city is mostly about preserving accessibility and affordability. Reflecting the theoretical framework to the results of the case study shows that the framework is a useful tool to explore en examine which collaborations, processes, and objectives within a smart energy project should need more attention, are missing, or are present, in order to make sure inclusion and smart energy development co-exist within cities.

Chapter 7: Conclusions and Discussion

7.1 Answer to the Research Questions

The goal of this study is to answer the question "How can inclusion be achieved within the smart energy domain of the city of Amsterdam in order become an inclusive smart energy city?" by developing an theoretical framework and conducting a single embedded case study on the smart energy domain of the city of Amsterdam. To do this, five sub-questions are proposed. 1) What is the meaning of inclusion as a theoretical concept?; 2) What are the key aspects of an inclusive smart energy city?; 3) What is the effect of technology development in the smart energy domain on the extent to which it is an inclusive smart energy domain?; 4) How can the theoretical framework that is conceived in this research be used to evaluate to what extent inclusion is present within current smart energy projects in Amsterdam? 5) What are the challenges for achieving inclusion in smart energy projects in Amsterdam? The following sections answer these questions.

What is the meaning of inclusion as a theoretical concept?

The process of fast urbanization requires careful management. Besides this, the benefits of urbanization must be shared and adverse impacts must be minimized. This requires policies that ensure inclusion of all citizens of the urban environment. There are multiple meanings of inclusion from a theoretical perspective. Inclusive cities involves the need to plan and design cities so that vulnerable social groups are not pushed out, isolated, and marginalised from important urban services, amenities, commercial flows and jobs. Five interrelated dimensions of inclusion are identified. Social inclusion involves ensuring equal rights and equal participation of all citizens, including the most vulnerable groups. Furthermore, it focuses on the increase of equal development opportunities for everyone and considering the needs and preferences of social members. Economic inclusion involves creating jobs and giving urban residents the opportunity to enjoy the benefits of economic growth. Economic inclusion makes it possible for all people, especially the disadvantaged and typically low-income people, to share in rising prosperity which entails to share in and contribute to gains in welfare and well being. Spatial inclusion involves ensuring that all individuals have equal access to the essential living environment enveloping land, streets, housing and public infrastructure and facilities. Spatial inclusion often depends on the extent to which public space, physically and socially, is open for everyone. Environmental inclusion aims at making sure not only current generations but also future generations have access to natural resources and the environment. In this way, both interests are preserved. Furthermore, there is an inseparable relationships between allocation of resources, environmental pollution and responsibilities which is enhanced by the dimension of environmental inclusion. Political inclusion is about citizen's sense of belonging and identity and their empowerment.This relates to civil and political rights and is connected to issues with respect to democracy, human rights, political participation, and national identity.

What are the key aspects of an inclusive smart energy city?

Achieving an inclusive smart energy city starts by putting the five dimensions of inclusion at the core of inclusive smart city development which results in a shift in urban transformations from a technology driven environment, where only a small group of citizens has access to vital resources, to a human driven environment where also the vulnerable groups are taken into account and therefore also can benefit from technological innovation. From a theoretical perspective the vulnerable groups within the smart energy domain are people who live in the area of interest and have a migration background and thus experience language barriers resulting in information not being spread. Also, people who have low educational levels, who live in poverty and are unemployed. Furthermore, the three main principles of a smart energy city; energy conservation, energy efficiency, and renewable energy, have to be pursued by considering three main pillars: collaboration of stakeholders, application of smart energy solutions, and the integration of solutions through technologies. These components include energy systems in the hard domain of the inclusive smart energy city. Making sure these systems and its different elements are carefully integrated is crucial for achieving a smart energy city that is optimized. This requires collaboration of stakeholders that results in understanding and consensus building between the parties involved. Furthermore, smart energy project developers and smart energy cities in general try to increase their energy self-sufficiency by ensuring that they are able to satisfy local energy demands in the urban area of interest. Therefore, smart energy systems must be sustainable and should be able to operate under strict requirements with respect to energy efficiency with renewable energy as source. The integration of new technologies and changing the architecture of energy systems provides the opportunity to improve a system's resilience to climate change or other hazards. The integration of smart energy systems is part of the soft domain and can be done through consumer behavior management, collaborative planning, and energy and data management. The soft domain consists of tools and technologies that contribute to the coordination and communication of data, knowledge, ideas among stakeholders, collaborative decision making, and must provide insights for stakeholders with respect to their energy consumption profile, the possibilities regarding consuming less energy, and the use of other smart energy technologies and solutions. In addition, from both the energy supply and energy demand side, the soft domain includes actions that make sure the overall energy system is optimized. However, the most important objectives of an inclusive smart energy city focus on addressing the demand for energy services in order to achieve the objective of ensuring the well-being of the citizens. The demand for energy services can be met through the preservation of a city's accessibility. However, accessibility is not sufficient on its own. The energy service should also be affordable, especially for the vulnerable groups in the smart energy domain. Lastly, the energy services must be adequate. Therefore, the objectives of an inclusive smart energy city are optimised, self-sufficient, sustainable, resilient, accessible, affordable, and adequate. In order to ensure these objectives governance and policy is required to cover citizen engagement and participation, collaboration, partnerships, and cooperation with the main goal of increasing public value and wealth so that the quality of life of citizens will be improved.

What is the effect of technology development in the smart energy domain on the extent to which it is an inclusive smart energy domain?

The extent to which technology development contributes to inclusion depends on the type of approach with respect to the implementation of smart energy solutions. Furthermore, Inclusion depends on how the technology is developed, is used, how the energy market is organised, and most important what it costs. In other words, it is not about which specific technology is needed to make sure energy is generated and stored in a sustainable way, but mainly about the total costs of ownership of the technology. Residents with higher incomes take initiative when it comes to the adoption of smart energy technologies which results in other residents not being able to socially and financially benefit from technology development. In this way the energy transition could lead on the one hand to economic prosperity and on the other to social and economic inequality. However, when technology is properly deployed it could contribute to inclusion. The use of smart energy technologies can decrease the collective costs of communities which can result in more social cohesion among residents. Technology development can also contribute to environmental sustainability and the accessibility of public transport, public places and facilities. In addition, information technologies play an important roll when it comes to inclusion. It can contribute to inclusion, depending on how people get the right or wrong information. Through information technologies people can get misleading information which can result in exclusion.

How can the theoretical framework that is conceived in this research be used to evaluate to what extent inclusion is present within current smart energy projects in Amsterdam?

By carefully considering each pillar of the framework and the interrelation between the different pillars, a deeper understanding will be created with respect to what inclusion as a theoretical concept means and how it relates to technology development. Moreover, through the use of the framework the stakeholder groups within the smart energy domain can be identified and mapped and collaboration between these stakeholders will be emphasized. It is crucial to make sure every stakeholder is aware of the five dimensions of inclusion and has an equal understanding of the concept from the beginning of the project. Furthermore, the framework includes the identification of smart energy technologies and solutions that can be used with different purposes within a smart energy city. These technologies and solution should be integrated carefully whereby again collaboration of stakeholders is very important. The framework stresses that through close collaboration collaborative planning, consumer behavior management, and data and energy management must be realised in order to integrate the smart energy solutions and technologies in the hard domain, and at the same time preserve the five dimensions of inclusion. Dependent on the city of interest, different rules and regulations apply which makes governance and policy an important pillar of the framework and has to be considered by each stakeholder and through the whole progress of the process. Inclusive smart energy city development is in many ways dependent on and influenced by regulations including collaboration, security, economic performance, citizen engagement and participation.

The arrows in the framework indicate the interrelated nature of the framework and that using it is not about ticking boxes but about considering each pillar and the interrelationship between each pillar carefully. In this way, from an academic point of view, it can be researched whether the objectives are present and to what extent there is an inclusive smart energy city. From a practitioner's point of view, the framework can be used as a guide to achieve inclusion within smart energy projects and can be deployed to reach the objectives of an inclusive smart energy city. In addition, policy makers can use the framework and incorporate the pillars and conditions of an inclusive smart energy city in their policies in order to create policies that encounter exclusion within the smart energy domain. In this thesis the framework is used in the empirical part of the research to explore and examine to what extent inclusion is present within the smart energy domain of the city of Amsterdam. Using the theoretical framework showed that it is a useful tool to identify which collaborations, processes, and objectives within a smart energy project should need more attention, are missing, or are present, in order to make sure inclusion and smart energy co-exist.

What are the challenges for achieving inclusion in smart energy projects in Amsterdam?

Challenges related to inclusion arise due to the fact that the technological and social aspects within smart energy projects are often not aligned. Moreover, often these smart energy projects are driven by technology and are about testing the technology but at the same time you must monitor how people can use the technology which has to do with awareness and behavior. In this way achieving inclusion and participation remains a challenge. Also, people who are on the technical side of a project want to innovate but do not look into the social aspects of the project. Furthermore, inclusion within smart energy projects is often hampered by restriction. Due to directives with respect to time, financial resources, and architecture determined by the initiator or funder of a project it can be difficult to involve vulnerable groups such as the urban poor, people with a migration background, and disabled people which makes realising inclusion a huge challenge. Other restrictions follow from rules and regulation from the Government or local Municipalities. Another challenge identified is the rise of inequality within society as a result of the required investments in sustainable energy solutions in order to save money on energy bills. Individuals and neighborhoods will therefore not have equal opportunities. This problem is enhanced by the difference between tenants and private owners who do not share the same motivation to invest. Participation in smart energy projects can also be hampered by the fact that citizens have concerns with respect to costs, sustainability of the technological alternative, which option to choose, and nuisance in their living environment. However, the biggest challenge is including people who are illiterate or speak another language which results in residents not having a voice or being able to participate in any transition in their living environment. Figuring out people's needs, preferences, and what their background is is challenging because it differs for each person. People's perspectives in life is of great influence to the extent to which inclusion can be achieved. Many people do not care about innovation and technology development which makes it hard to reach and include these people.

How can inclusion be achieved within the smart energy domain of the city of Amsterdam in order to become an inclusive smart energy city?

The theoretical framework conducted in this thesis, represented in figure D.1 in chapter 3, can be used in smart energy projects in Amsterdam in order to obtain the objectives of an inclusive smart energy city. This can be done by considering each pillar carefully. In this research the framework is applied in the case study on two smart energy projects in Amsterdam.

The case study showed that the five dimensions of inclusion as a theoretical concept are not all well known and are not consciously considered in smart energy project development in Amsterdam. This should be the case because the theory shows that an interrelationship between these dimensions exists and when each dimension is considered urban exclusion, inequality and discrimination can be reduced. Moreover, with respect to the smart energy domain, mainly the problems related to social, economic, and political inclusion lead to difficulties. In order to deal with these difficulties, collaboration of stakeholders is required. Currently there is still a divide between the social and technological side of smart energy projects. Therefore the social and technological stakeholders should more often closely work together and should both be included from the beginning of the project. This entails sharing their interests and make sure objectives are known among all parties involved. In this way, the gap between technology and society can be bridged and divergent interests and perspectives of both businesses and citizens can be taken into account. This will result in smart energy solutions in the hard domain of the framework that take needs and preferences of all stakeholders into account. Furthermore, it is important that these smart energy solutions are well developed from a technical point of view in order to realise a smart energy system that is optimised, self-sufficient, sustainable and resilient. These conditions preserve the first four objectives of an inclusive smart energy city.

With respect to the realisation of an inclusive smart energy city, the case study showed that mainly the integration of these solutions in the soft domain of the framework is of great importance. This concerns collaborative planning, consumer behavior management, and data and energy management through the use of multiple tools and technologies. This pillar is so important because it entails the coordination and implementation of the smart energy project and it determines to what extent it is inclusive. Inclusion must be considered before a project plan is developed and decisions are made. This in particular means including citizens that live and work in the area of interest by identifying their needs and preferences. This can be done by going into the concerned neighborhood and provide them with information regarding the envisaged district developments. In addition, it is important to find out what problems citizens currently experience and what their perspectives are on smart energy technology use and development. Surveys, interviews, and other research methods can be used to gain information. This data can be stored and smartened, and subsequently be translated into the technology. The case study showed that an important starting point, when it comes to the implementation of a smart energy project, is to unburden citizens that live and work in the concerned neighborhood. This involves the provision of clear information and user friendly tools and technologies. When reaching out to citizens it is important to present a clear value proposition and show people what is in it for them. Make sure they know where they agree upon by giving insights in costs and benefits, and show people that they have a voice and make them feel relevant. An important condition is translating technological issues into ordinary human language. It is crucial that the smartness is in the technology and not in the use of the technology so that everyone is able to benefit from it regardless somebody's background. As stated before, tools and technologies in the soft domain can be used to support collaborative planning, consumer behavior management, and data and energy management. The case study found that currently the use of certain technologies is minimal. Nevertheless, tools and technologies that help coordination, as well as communication of data, knowledge, and ideas among stakeholders and enable management, analysis, forecasting, and monitoring of the different pillars of an inclusive smart energy city, should be identified and considered.

Also, whether a smart energy city is inclusive highly depends on rules and regulations with respect to funding, authorisations, and information, determined by the Government. The case study revealed that challenges related to inclusion arise due to limitations as a result of rules and regulations and that the extent to which inclusion is presents within smart energy projects depends on who finances or facilitates the project. In addition, the adoption of smart energy solutions depends on the provision of information to citizens. These requirements rely on the role of the Government and therefore the Government has a huge influence on the accessibility, affordability, and adequacy of smart energy solutions. Accordingly, the Municipality of Amsterdam plays an important role when it comes to achieving inclusion within smart energy projects and therefore is close collaboration and consultation with this stakeholder required. When this is the case, also the last three objectives of an inclusive smart energy city will be preserved: accessible, affordable, and adequate. From the case study, these objectives appear to be the biggest obstacles for the realisation of inclusion. Accessibility is a problem as a result of the gap between technology and society but also because of a lack of interest or understanding from different parties. Besides this, as already been said, the problem of affordability plays an important role in the adoption of the technology which hampers inclusion and can cause inequality among people. Therefore, creating a smart energy city that is inclusive at the same time is initially about preserving its accessibility and affordability by primarily focusing on social, economic, and political inclusion through close collaboration of stakeholders and careful development and implementation of smart energy solutions through collaborative planning, consumer behavior management, and data and energy management by making use of supportive tools and technologies.

7.2 Limitations

Also this academic research is subject to limitation. The limitations of this study are identified and will be addressed in this section.

The theoretical part of this thesis reflects on inclusion as a theoretical concept and a smart energy city framework in a broader context but the empirical part of this study focuses on inclusion within the smart energy domain of the city of Amsterdam. This research had to follow restrictions with respect to time constrains and together with the case study design this was the motivation for the choice of scope of the present research. The findings of this study are addressed to smart energy projects in Amsterdam. Therefore, the results of this study are not completely generalizable to other contexts. Moreover, the case study consists of 13 interviews with experts in several fields. This however is not such a huge number and therefore it might influence the representativeness. of the results. In addition, next to smart energy project development in Amsterdam in general, only two smart energy projects are studied, which also holds implications for the representativeness. The various interpretations on the concept of inclusion and what it means to each person individually result in a complexity that makes it difficult to unambiguously conclude on how and when inclusion is achieved. In addition, there are a lot of external factors such as the type of neighborhood of interest and residents' background, that influence how easily inclusion can be achieved.

Furthermore, a limitation of this research is that the observations were limited to the digital environment as it was not possible to go for field work and talk in person to the interviewees. This could have been of value in terms of observations with respect to dynamics at meetings, information evenings, in the concerned neighborhoods etc. Also, the LIFE project has just started so there is still much uncertainty and some aspects related to inclusion are not yet well-understood. For the Light house project there was limited access to background information. Therefore the exact outline of the project, its capabilities, limitations, underlying assumptions etc, were unclear and made it hard to critically compare the two projects and kept the analysis of this sub-unit on a global level. The analysis was mainly based on reports that where publicly available and on the information provided by interviewees.

Finally, interviews and thematic coding are data collection tools that also involve limitations because these methods depend on the interpretation of the researcher and the interview questions can influence the answers of the respondents and can therefore cause biases. The questions will shape the arguments of the interviewees. Moreover, time and circumstances can change and the perceptions of the respondents are subjective (Alshenqeeti, 2014).

7.3 Academic Discussion

In the current debates regarding climate change it has been acknowledged that urbanisation results changes in economic, social, and environmental contexts. Through these changes opportunities with respect to sustainability can arise and the development of smart energy cities can result in a more efficient use of resources. However, nowhere is the rise of inequality clearer than in urban areas, where wealthy communities coexist alongside the urban poor (UnitedNations, 2021). In many cases smart energy cities are not equally accessible for its citizens and multiple problems related to inclusion have been identified (Asian Development Bank, 2011). Despite the fact that the need to build inclusive cities has been recognized, current literature shows that the direct link between inclusion and the smart energy domain appears to be poorly researched. The theoretical framework of a smart energy city developed by Mosannenzadeh, Bisello, et al. (2017) demonstrates this. Multiple aspects related to inclusion are part of the pillars of the smart energy city. However, the concept of inclusion is neither reflected in the main principles nor highlighted in the objectives. And yet this research showed the importance of considering inclusion as a main pillar and from the beginning of a project in order to achieve it. Furthermore, it can be seen that the 'social side' of smart energy projects is often considered to be inferior to the 'technological side' due to the fact that these projects are mostly technology driven (Obrecht, Kazancoglu, & Denac, 2020). This is also confirmed by respondents involved in the smart energy projects studied in this thesis. Moreover, just as in the general debate regarding the acknowledgement to build inclusive smart energy cities, interviewees share the opinion that inclusion has to be considered in smart energy project. However, just as the identified knowledge gap in literature with respect to this matter, no one has a clear vision on how to actually achieve inclusion within the smart energy domain. When it comes to the city of Amsterdam, the Municipality has multiple policies that focus on participation of citizens, including the vulnerable groups defined in section 4.2.3, in the energy transition (CityofAmsterdam, 2021). But also on a local scale there is no clear guideline on how to unite technology and inclusion within smart energy projects. Just as there is a clear vision on how to develop a smart energy city, there is, from an academic perspective, a clear vision on how to develop an inclusive city. The framework of Danni et al. (2021) has inclusion in its core and shifts urban transformations from a technology driven environment, where only a small group of citizens has access to vital resources, to a human driven environment where also the vulnerable groups are taken into account and therefore also can benefit from technological innovation. Through the integration of the framework of an inclusive city and the framework of a smart energy city, an inclusive smart energy city framework is created which aims at eliminating urban exclusion, inequality, and discrimination while ensuring urban energy systems that are optimized. The added value of this research is therefore the closure of the knowledge gap in literature between the concept of inclusion and the smart energy domain. The next section will go deeper into the academic and societal relevance of this research.

7.4 Academic and Societal Relevance

As discussed in the previous section, the literature review showed that there is a lack of literature on the role of inclusion within smart energy projects and what the impact of technology development is on inclusion within cities. Furthermore, it appeared that there is a lack of clear guidelines for achieving inclusion. The present study shows how practitioners look at the concept of inclusion, what they currently do in terms of inclusion, and what challenges they experience in real-life smart energy projects. It provides descriptions of how these challenges are experienced and what thoughts there are with respect to overcoming these challenges. Moreover, the interviews provided insights into how decision making processes within this domain occur and they confirmed the relevance of the theoretical framework.

The recommendations of the present study provide a source for a structural integration of inclusion within smart energy project development by using a theoretical framework of an inclusive smart energy city. Besides this, the recommendations offer suggestions to face and handle a part of the challenges related to achieving inclusion, identified in this study. This study is therefore helpful for academics, project developers, and policy makers and has both societal and academic relevance.

This thesis was written as part of the MSc Management of Technology (MoT). This research covers both the management and technology component because it involves the question of how to manage the integration of smart energy technologies in order to achieve inclusion. This research has therefore a significant contribution to the field of Management of Technology. This research combines a subject related to the energy transition with ethics and anthropology of technology through the development of an integrated theoretical framework that can be used by other researchers and practitioners. It therefore contributes to not only the technological side but also the social side of the smart energy domain, giving it an extra pillar to study: inclusion. Also within the MoT program the gap between technology and society is a recurring theme.

Next to academics, this research can be used by project developers and other stakeholders within a project, who can use the framework as guidelines in order to conduct a project that is an inclusive smart energy project. In addition, it can be used by policy makers who can include these insights in the policies they make. This will enlarge the accessibility and affordability of smart energy cities, which in turn will contribute to the extent to which it is an inclusive smart energy city.

7.5 Recommendations

7.5.1 Recommendations for Future Research

The two projects that are studied in this thesis are both not yet completed. A recommendation would be to repeat this research after the projects are finished in order to compare the two moments in time and determine whether the envisaged objectives are obtained. In this way, the adequacy of the theoretical framework will be tested. In addition, it would be interesting to interview the respondents again when the projects are implemented to find out how they have experienced the progress of the project and to what extent inclusion is achieved. Also, this study only involves two projects. Future research on multiple projects in various socioeconomic neighborhoods would provide more insights into to what extent the theoretical framework is generalizable and the adoption of technology and the achievement of inclusion depends on geographical, political and cultural contexts. This will result in a more representative view on the topic of this study. Furthermore, future research could involve using the framework and results of this study to explore to what extent it is applicable in other Dutch cities.

7.5.2 Recommendations for Practitioners

Recommendation for practitioners involve using the theoretical framework as a guideline to achieve inclusion within a smart energy project and meet the objectives of an inclusive smart energy city. Define inclusion as a theoretical concept before the start of a project in order to make sure every stakeholder is on the same page with respect to inclusion. In addition, obviously not all stakeholders operate at the same time during a project. However, it is important to include all parties involved from the beginning, including citizens, by being transparent about objectives, interests, and individual values. Focus on uniting the social and technological stakeholders of a project and prevent the emergence of a gap between society and technology. In addition, use tools and technologies in the soft domain to support collaboration and implementation.

Recommendation for policy makers also involve using the theoretical framework and incorporate the pillars and conditions of an inclusive smart energy city in their policies. Policies that encounter exclusion in a specific context will benefit from being more sensitive since it will provide a deep understanding of the values, concerns, needs and preferences of people. If you assume that these aspects have a positive influence on the policy. If this is the case, using the pillars of the framework in policy making can result in an increase of acceptability of the policies and projects. Furthermore, this study can be used by policy makers in order to gain insights into the perspectives of different stakeholders within smart energy projects on inclusion and technology and project development which in turn can also be included or considered in policy making. For both project developers and policy makers, it is important to pay extra attention to the vulnerable groups identified in section 4.2.3 and in the case study.

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Appendices

Appendix A: Inclusive City Framework

Figure A.1 presents the framework of an inclusive city developed by Danni et al. (2021) and is used in this research for the development of the framework of an inclusive smart energy city.

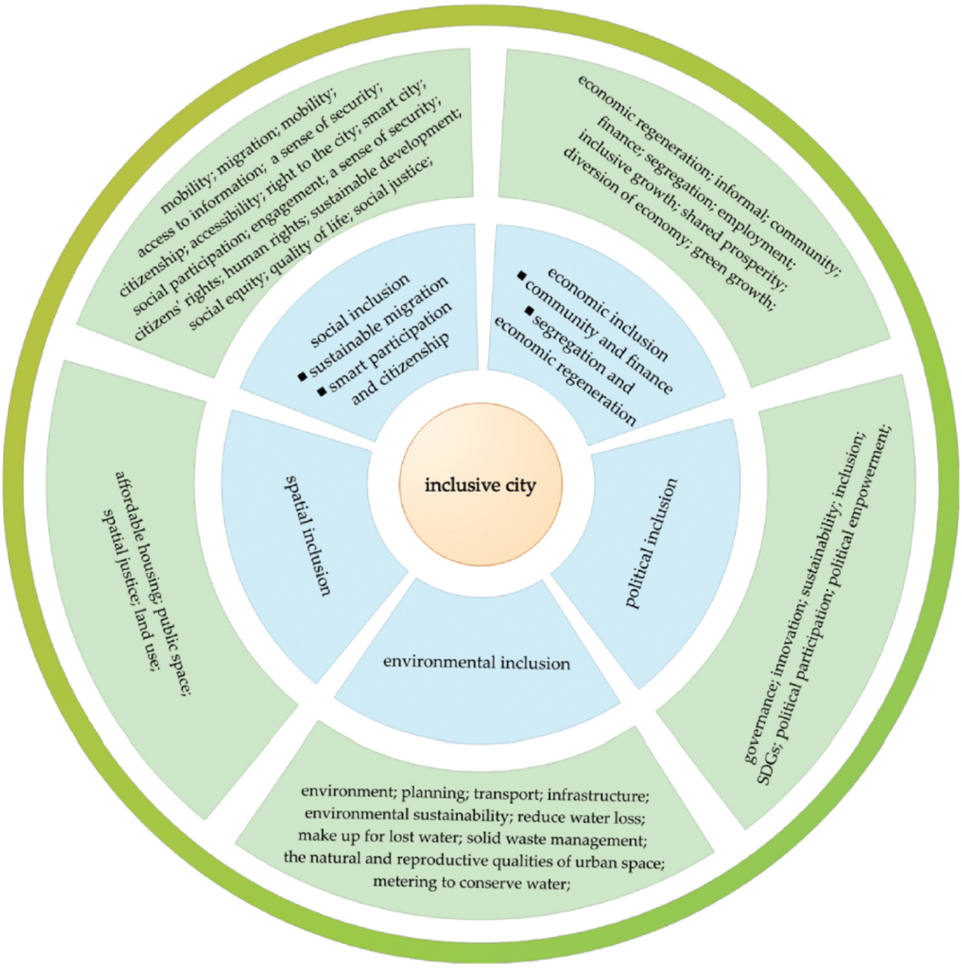

Figure 6. A multidimensional conceptual framework of the inclusive city.

Figure A.1: Inclusive City Framework Development

Appendix B: Smart Energy City Framework

Figure B.1 presents the framework of a smart energy city developed by Mosannenzadeh, Bisello, et al. (2017) and is used in this research for the development of the framework of an inclusive smart energy city.

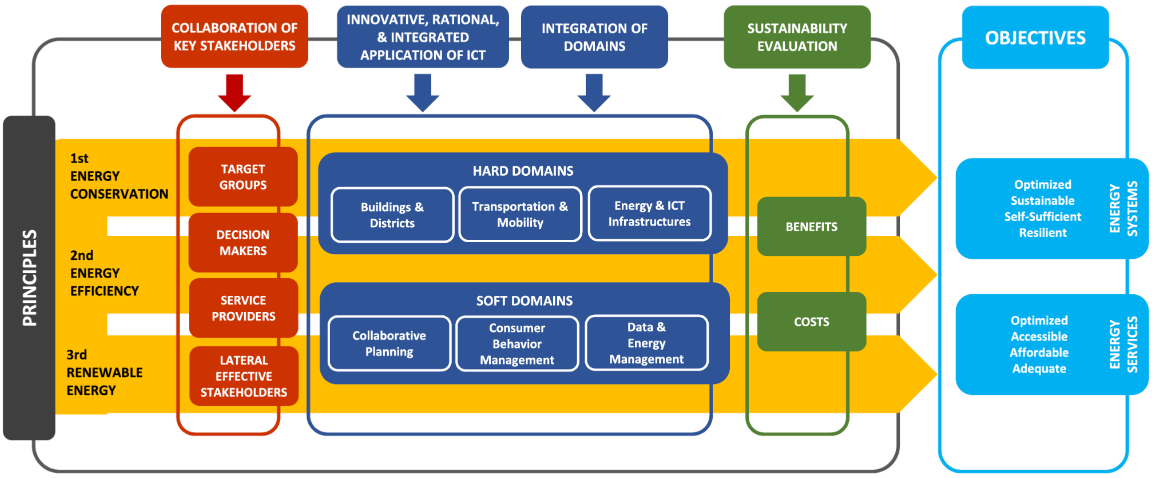

Fig. 2. Smart Energy City (SEC) Development: the black outer box passes through SEC general principles; three yellow arrows reflect SEC energy specific principles pointing to the light blue box showing SEC objectives. The small red boxes indicate SEC key stakeholder groups, small dark-blue boxes indicate SEC domains of intervention, and small green boxes reflect SEC sustainability evaluation aspects. ICT stands for Information and Communication Technology.

Figure B.1: Inclusive City Framework Development

Appendix C: Effect Technology Development on Inclusion

Figure C provides a table that is developed in order to obtain an indication of the relation between the problems regarding inclusion and multiple smart energy technologies and solutions.

		Smart Energy City (Hard Domain)								
		Optimised Consumption			Efficient Distribution			Renewable Energy		
Type of Inclusion	Problems	Energy Storage	Smart Metering	E-Mobility	Electricity Grid	Energy Trading	ATES based infrastructure	Wind Energy	Solar Energy	Hydrogen
Spatial Inclusion	- Lack of access to the essential infrastructure and services. - Problems of housing. - The problem of standards of infrastructure and social services. - The gap between the production and the economic and sociocultural infrastructure. - The problem of correlation of natural and artificial.			+. Can contribute to equal acces to the essential living environment (public infrastructures and facilities)	+. Improvement of urban infrastructure can contribute to accesibility and sustainability through increasing acces to public spaces and housing for all.		+. Improvement of urban infrastructure can contribute to accesibility and sustainability through increasing acces to public spaces and housing for all.			
Social Inclusion	- Lack of opportunities for the urban poor. - No equal access to social resources (e.g., employment, insurance, education, information). - Issues of environmental awareness and behavior. - Public participation.			+- Can contribute to equal development opportunities and public participation when handled properly and subsidised by local governments	+- Can contribute to equal development opportunities and public participation when handled properly and subsidised by local governments		+- Can contribute to equal development opportunities and public participation when handled properly and subsidised by local governments	+- Can contribute to equal development opportunities and public participation when handled properly and subsidised by local governments. Get out of their houses when shared with the whole building. When able to incest into smart efficient energy technologies, running costs can be reduces and savings opportunities arise. However, it can also cause energy poverty and social inequality. Those who cannot afford the investments into smart, efficient energy technologies will be stuck with increasingly large energy bills, since the growing costs of grid infrastructure upgrades are socialized in the Netherlands		
Economic Inclusion	- Migration and demographic issues - No equal access to job opportunities. - Social problems of labor mobility. - No reasonable distribution of income.	+ Technologies could give urban residents the opportunitiy to enjoy the benefits of economic growth as a result of sustainable energy technologies that reduce energy costs	+ Digital monitoring of consumption data can contribute to a decrease in energy costs and therefore a reasonable distribution of income.	+ Can contribute to people's mobility and accessibility to places in the area which can contribute to job opportunities.	+ Makes it possible for disadvantaged and low income people to share in rising prosperity as a result of the use of an decrease in energy costs and therefore they will have lower energy bills. They can consumer more energy because they have produced it themselves. Only if they don't have to invest in the technology themselves.			+- Makes it possible for disadvantaged and low income people to share in rising prosperity as a result of the use of a decrease in energy costs and therefore they will have lower energy bills. They can consume more energy because they have produced it themselves. Only if they don't have to invest in the technology themselves.		
Environmental Inclusion	- Allocation of resources. - Environmental pollution. - Compromising the needs of future generation for environment en natural resources. - No maintenaince of the natural and reproductive qualities of urban space.	+ Contributes to the needs of current and future generations for natural sources and environment. Contributes to maintaining the natural and reproductive qualities of urban space and improving the quality of the living environment.			+ Contributes to the needs of current and future generations for natural sources and environment. Contributes to maintaining the natural and reproductive qualities of urban space and improving environmental quality			+ Contributes to the needs of current and future generations for natural sources and environment. Contributes to maintaining the natural and reproductive qualities of urban space and improving environmental quality		
Political Inclusion/Inclusive Governance	- Issues of demographic institutions, human rights, political participation, and national identity. - No sustainable innovation. - No effective communication between local governments and citizens.	**Governance and policy** Both technologies in hard and soft domain								

Figure C.1: Technology Development and Inclusion

Appendix D: Framework Development

Figure D.1 provides the comprehensive visualisation of the integration of the framework of an inclusive city developed by Danni et al. (2021) and the framework developed by Mosannenzadeh, Bisello, et al. (2017) of a smart energy city. It can be seen that the pillar 'collaboration of stakeholders' is specified by distinguishing three stakeholder groups. Furthermore, the hard domain is specified by the identification of multiple smart energy technologies and solutions. The soft domain consists of the integration of these solutions and technologies through collaborative planning, consumer behavior management, and data and energy management. The 'sustainable evaluation' pillar is substituted by the inclusive city framework of Danni et al. (2021), and the pillar 'governance and policy' is added. The integration of these two frameworks form the theoretical framework of the inclusive smart energy city (presented in chapter 3, figure 3.1) that meets the objectives of both the inclusive city and the smart energy city.

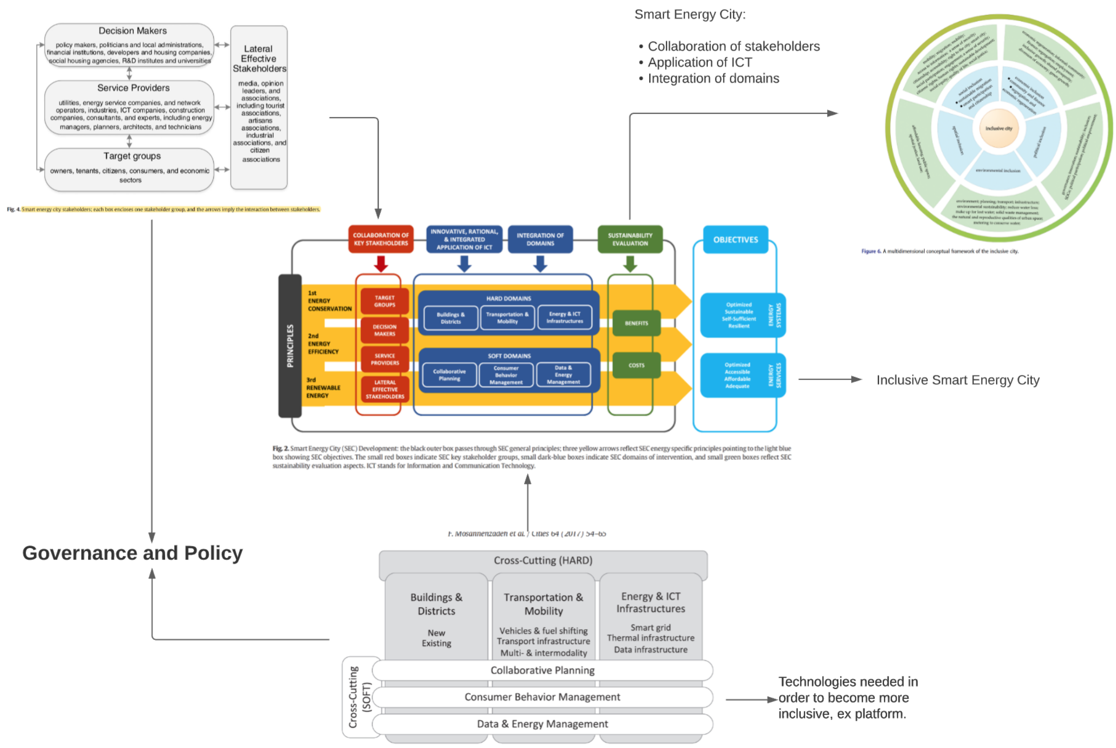

Figure D.1: Inclusive Smart Energy City Framework Development

Appendix E: Interview Guide

Vragenlijst Inclusive Smart Energy City

Deze vragenlijst heeft als doel inzicht te verkrijgen in de belangrijkste aspecten rondom inclusie binnen het smart energy domein van het concept Smart City.

1. Kunt u kort omschrijven wat uw functie is?
2. Indien van toepassing, kunt u een korte omschrijving geven van het project waar u bij betrokken bent?
3. Wat verstaat u onder de volgende dimensies van inclusie:
   (a) Social inclusion
   (b) Economic inclusion
   (c) Environmental inclusion
   (d) Spatial inclusion
   (e) Political inclusion
4. Wat zijn volgens u de belangrijkste aspecten rondom inclusie met betrekking tot het smart energy domein?
5. Welke dimensies van inclusie zijn volgens u het meest belangrijk en het meest van toepassing binnen het smart energy domein? En waarom?
6. Welke technologische innovaties binnen het smart energy domein (denk hierbij aan slimme en duurzame energie technologieën maar ook informatietechnologieën) dragen volgens u bij aan de verschillende dimensies van inclusie en welke juist niet?
7. Waarom dragen deze innovaties wel/niet bij aan de verschillende dimensie van inclusie?
8. De energietransitie kan enerzijds leiden tot economische voorspoed en anderzijds tot energieschaarste en sociale ongelijkheid. Dit is o.a. afhankelijk van de investering die gedaan moet worden in slimme efficiënte energie technologieën. Hoe kunnen volgens u de mensen bereikt worden die niet over de mogelijkheid beschikken om een dergelijke investering te doen zodat ze wel kunnen meeprofiteren van de voordelen van deze technologieën?
9. Wie zijn naar uw mening de meest belangrijke en invloedrijke stakeholders binnen smart energy projecten met betrekking tot inclusie? En waarom?
10. Wat zijn mogelijke strategieën die kunnen worden ingezet om potentiele partijen die willen deelnemen aan smart energy projecten te betrekken en hoe kunnen deze partijen worden geïdentificeerd in de eerste plaats?
11. Hoe kan men (civiele) actoren zoals opbouwwerkers, lokale gemeenschappen, sportclubs, kerkgenootschappen, lokale milieuclubs etc. betrekken in smart energy projecten?
12. Heeft u nog suggesties met betrekking tot het benaderen van andere (praktijk) experts voor meer relevante informatie? Of eventuele relevante documenten?