Exploring stakeholder collaboration in the context of local energy systems

A research on the underlying factors influencing stakeholder collaboration, to improve the further deployment of local energy systems on Dutch business parks.

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FAKTON ENERGY

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Thesis report by

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Faculty of Architecture and the Built Environment · Delft University of Technology

Preface

As a young girl, I was always fascinated by architecture. While my friends were drawing and doing crafts, I would create floor plans of imaginary houses. Even at the beach, without paper or pen, I traced full-scale house layouts in the sand to experience the design in real life. The built environment has always had a special impact on me. This was one of the reasons why I started my Bachelors at the faculty of Architecture at TU Delft. However, during my Bachelors, I discovered that I mainly enjoyed the initial phases of design projects. What will the building look like, who will use it and what impact will it make on its environment? The later phases of refining and detailing the design plans were not the parts that really motivated me. Therefore, I decided to not pursue a Masters in Architecture, but in Management in the Built Environment. Designing our environment, improving spaces for people and nature, and taking on the responsibility for these changes, perfectly aligned with my interests.

Next to this initial interest, my interest in the sustainability transition also developed in the recent years. Being conscious about our environment, and our impact on it is something that is resonating with me more and more each day. However, I also believe that we should have a positive mindset to this transition to effectively address it as society. Solutions that are not only appealing to the climate, but also the people living in that climate should be found. It is more worthwhile to focus your energy on that than trying to change an entire population. This statement is especially true, in my opinion, in the built environment, as housing is described as a basic need for all. However, the building industry is also one of the most polluting industries out there. Therefore, solutions need to be created that not only provide for our building needs but also advance the sustainable transition. This created the aim for my master thesis.

The local energy system, is such a solution. It does not only provide solutions for end-users dealing with the burden of net congestion, but also promotes renewable energy sources and transitions our systems and regulations to be more future-proof. Therefore it positively affects the built environment as well as the sustainable transition. As became evident in my research, the technical aspect has already been solved, I can proudly say as a TU Delft student. It is the social aspect that presents the greatest difficulty today. Combining my *Management* skills on a topic related to the *Built Environment* at a *Technical University* with a technical background, ties everything together perfectly for my thesis.

I hope my thesis offers clarity to a diverse audience: to those seeking to learn more about local energy systems, to stakeholders testing their networks against my proposed network, and to individuals who have never considered the impact of energy systems on our built environment, both physically and socially.

Although my name is the only one after ”author”, I got a lot of support when writing this thesis. First and formal, I would like to thank my supervisors from the TU Delft, Henk Visscher and Erwin Mlecnik. Their guidance tested my independence once again. One of my weaknesses is asking the right questions to get the most valuable answers. A master thesis is an individual project, and it was my responsibility asking for help at the times I needed it. Something I hope I improved upon in this process, but probably need to work on in the future. Next to that, I would like to thank Michiel van Dam, my supervisor from my graduation internship company: Fakton Energy. Michiel worked on multiple local energy system projects, providing valuable feedback from practice. Next to that, as Michiel is a TU Delft Alumni, he always tried to match that practical experience while channeling his academic point of view.

Lastly, I would like to thank Bart and Job Swens, for providing me with the technical background information, energy system tutoring, and motivations to make a change in a field I know best: the built environment.

”The secret of change is to focus all of your energy not on fighting the old, but on building the new”
- Socrates

F.A. Berkouwer
Delft, June 2024

Abstract

Due to the increase of renewable energy sources and electrification, the traditional electricity grid cannot provide for our transition to a more sustainable future. One of the main problems is net congestion, as the net has reached its capacity, with an even further predicted increase in the future. As the expansion of the current net is not fast enough to keep up with the increase in energy supply and demand, there is a need to manage our energy more efficiently. Compared to other alternatives, the use of local energy systems seems to be the most promising one. In reaction to this, the Dutch government is implementing a new measure: the Group Contract (Groeps-TO), making it possible for business parks to share their electricity, and therefore implement a local energy system. In anticipation of this, numerous pilot initiatives in the Netherlands have explored electricity sharing through various approaches. This facilitated the opportunity for conducting research on this innovative implementation. However, there remains a gap in the research on the understanding of stakeholders and their interdependent relations and collaborations, in the context of local energy systems. This understanding is important to eventually stimulate further implementation of local energy systems, and thus tackling net congestion. Therefore, the research question of this thesis is: *What underlying factors influence stakeholder collaboration to improve further deployment of local energy systems on business parks?*. This research composes of a literature review, four case studies including 18 semi-structured interviews with actors and a questionnaire distributed among the located companies on the business park. Additionally, a focus group session was conducted with experts in the field of local energy systems, to validate the findings. The results of these findings provide insights into the stakeholder collaboration and their underlying factors. The Strategic Niche Management theory (Schot & Geels, 2008) was used to unravel the underlying factors with, next to vision and learning activities, a focus on the social network, which has been identified as the primary barrier to the sustainable transformation of Dutch business parks. Additionally, by using the Multi Actor Network analysis (Gerding et al., 2021), insights into stakeholder collaboration and actor relationships have been discovered. Furthermore, barriers and enablers of stakeholder collaboration in the context of local energy systems were observed in the case studies. By analysing the factors: vision, learning activities and barriers and enablers, an adjusted and generalized actor network has been proposed for local energy systems on Dutch business park. This actor-network provides valuable insights into the actors of these projects, and their mutual relations. These insights contribute to the ultimate goal, to pave the way for the wider adoption of local energy systems within business parks in the Netherlands.

Keywords: Local Energy System, Stakeholder collaboration, Business parks, Renewable Energy Sources, Energy Hub, Smart Grid, Actor Network, Electricity.

F.A. Berkouwer
Delft, June 2024

Contents

Nomenclature

List of Abbreviations

ACM (Authority for Consumers and Markets (NL: Autoriteit Consument & Markt)

CBC Capacity Limited Contract (NL: Capaciteits Beperkend Contract)

CEP Clean Energy for all Europeans Package

DSO Distribution System Operator

ECO Ecofactorij

ESCO Energy Service Company

GDS Closed Distribution System (NL: Gesloten Distributie Systeem)

Groeps-TO Group Contract (NL:Groeps-Transportovereenkomst

GTV Contracted capacity (NL: Gecontracteerd vermogen

HES Hessenpoort

LES Local Energy System

MLP Multi Level Perspective

RVO The Netherlands Enterprise Agency (NL: Rijksdienst voor Ondernemend Nederland)

SNM Strategic Niche Management

STP Schiphol Trade Park

THO Tholen

TSO Transmission System Operator

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1 Introduction

1.1. Increase of Renewable Energy Sources

As a part of mitigating climate change, The Netherlands, among other countries, has signed the Paris Agreement to aim for a rise in global temperature of less than 2 degrees Celsius (UNFCCC, 2015). This reduction in temperature rises is mainly influenced by the CO2 emissions worldwide. Energy production, and therefore indirectly our energy usage, is considered responsible for a large part of the CO2 emissions due to their remaining reliance on fossil fuels. The reduction in carbon emissions can be achieved by reducing our energy demand by 1) making our energy use more efficient and 2) covering the remaining energy demand with renewable energy sources. This focus on using renewable energy sources as the source of our energy goes in parallel with the electrification of products that rely on fossil fuels. Traditional cars running on gas are being swapped with electric cars and the heating systems in our homes are being electrified by heat pumps, cutting off the gas supply. Buildings play a pivotal role in energy system transition, as they are responsible for 42% of global energy use and 36% of global greenhouse gas emissions (European Commission, n.d.-a). Although technologies have improved the efficiency of the energy use of buildings, and buildings need to comply with strict certification on their energy performance, it is projected that approximately 80% of the building stock in 2050 will consist of existing buildings (World Economic Forum, 2022). Therefore, there is a great opportunity to contribute to the energy transition within our existing building stock. In alignment with this perspective, political views support this energy transition as the reliance on other countries for energy production is no longer the preferred strategy (Rekenkamer, 2023), and renewable energy sources open up the opportunity to become self-sufficient as a country.

To become less reliant on fossil fuels, a sharp increase in renewable energy sources and especially electricity, for example, solar or wind energy, can be seen (Ministerie van Economische Zaken en Klimaat, 2022). However, the energy production of these renewable energy sources is reliant on the weather conditions and therefore brings a lot of variety into the energy systems. The medium of this energy is electricity. The electricity system was once designed where supply always followed demand (Ma et al., 2019; Rijksoverheid, 2022), and therefore bringing balance into the grid. An important factor in this system is that the grid can only transfer electricity, and not store it. Because of the variable character of renewable energy sources and their dependency on external conditions, there is no perfect equilibrium between demand and supply, creating an imbalance in the electricity system (NetBeheer Nederland, December 5, 2023). Therefore, there is a shift of focus towards a system where demand follows supply (Rijksoverheid, 2022). Furthermore, there is an increase in our electricity usage (Ministerie van Economische Zaken en Klimaat, 2022), as electric vehicles and heat pumps, for example, are integrating more into the built environment. The increase in supply and demand can be seen in Figure 1.1 and Figure 1.2.

These two aspects could lead to situations where the supply becomes bigger than the demand or the other way around. On the one hand, there is the increased production of electricity by renewable energy sources, and on the other hand, there is an increase in our electricity demand (Ministerie van Economische Zaken en Klimaat, 2022). These two situations together seem more like a synergy than an actual problem, as there is an increase in demand but there is also an increase in supply. However, these two situations do not occur at the same time, and make use of a net that is not designed for these aspects.

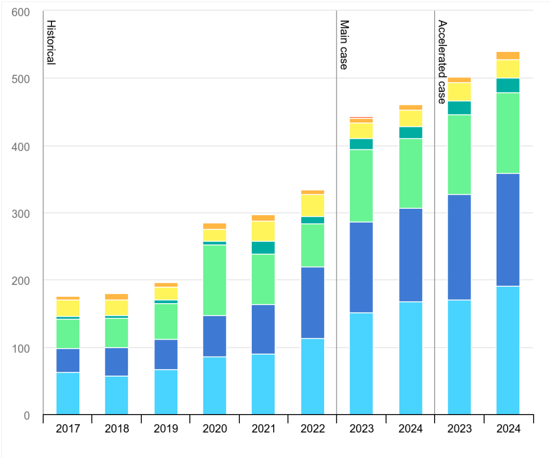

Figure 1.1: RES electricity production 2017-2024 (IEA, 2023a)

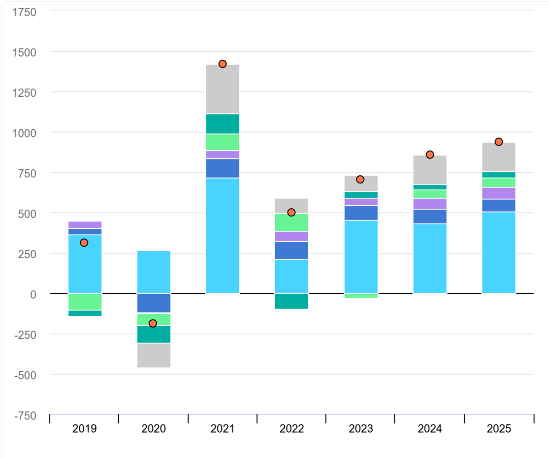

Figure 1.2: Global electricity demand 2019-2025 (IEA, 2023b)

1.1.1. Net Congestion

The increase in electricity demand and the increase in variable supply of renewable energy sources is where net congestion occurs. Net congestion has been described by Tennet, the national network operator as: *"the demand for the transmission of electricity, exceeds the available transmission capacity of the existing grid"* (Tennet, n.d.). Numerous newspapers in the Netherlands have covered stories on this topic (NOS, 2022), and more and more grids in the Netherlands are overloaded, resulting in longer waiting lists for grid connections or even canceled projects (Algemene Rekenkamer, 2022; Ministerie van Economische Zaken en Klimaat, 2022). This highlights the relevance of the problem. The increase in Renewable Energy Sources, however, is stimulated, as it offers a more sustainable production of energy than fossil fuels. Due to the further growth of electrification on both the demand and supply side to meet the European net-zero objectives in 2050, the problem of net congestion will only increase (European Commission, 2022). In Figure 1.3 the regions where the problems of net congestion occur have been made visible. The map on the left illustrates the congested areas during the feed-out scenario, where electricity is supplied from the main network to the user. The map on the right illustrates the feed-in scenario, where electricity is transmitted from generators to the main net.

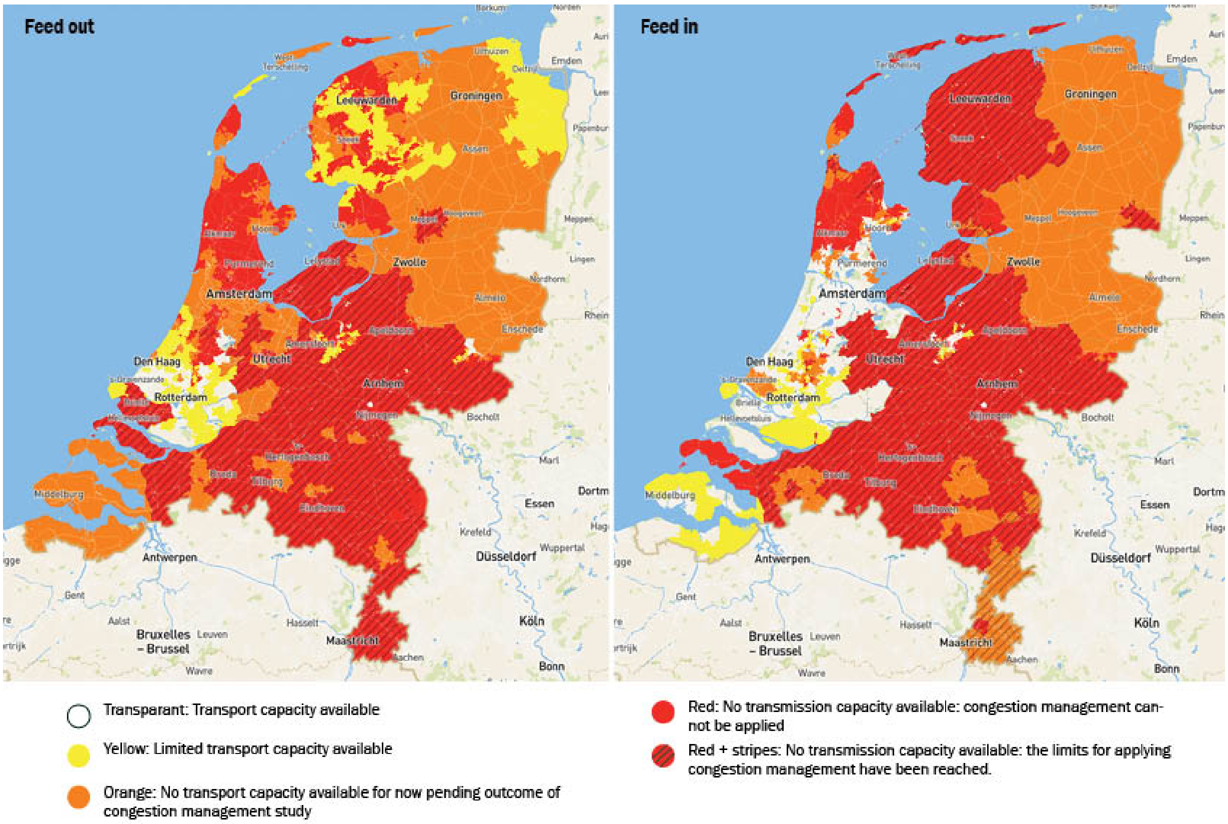

Figure 1.3: Congestion map of the Netherlands. On the left, the feed-out congestion problems, and on the right the feed-in congestion problems (Netbeheer Nederland, n.d.), retrieved on December 5, 2023

An important note when discussing net congestion, is that the congestion only occurs on certain moments of the day, called peak moments. Net congestion occurs at specific moments or periods, when electricity demand is exceptionally high, such as in the evenings when people return home and use electrical appliances simultaneously, or when the electricity supply is exceptionally high. This could happen due to extreme weather events and/or fluctuations in renewable energy production (Ministerie van Economische Zaken en Klimaat, 2022). These peak moments are the reason for the congested electricity grid, however, the rest of the day, there is no surplus on the electricity grid. In Figure 1.4 the energy profile of a random user and their contracted transport capacity (GTV) (what the user can use) can be seen. During the peak hour of this user, their maximum capacity is nearly reached, but during the rest of the day, a lot of capacity remains unused. The network operator aims for a reliable energy network by assigning contract capacities that often exceed actual consumption. This strategy ensures that contracted parties have access to energy during peak times. Consequently, a significant portion of the day sees the grid operating below its capacity. This unused capacity offers flexibility to enhance efficiency and maximize its potential.

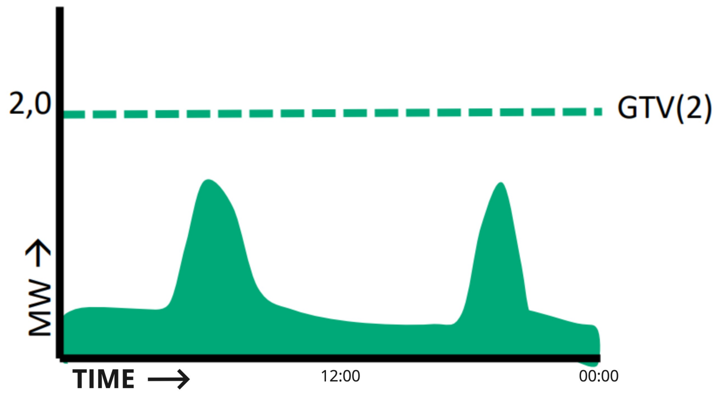

Figure 1.4: Energy profile of a random user (Netbeheer Nederland, 2023)

1.2. Congestion prevention

As the growing pressure on the electricity net is predicted to grow even further in the upcoming years to reach the national and European sustainability goals, the Dutch national government has published a report, National Action Program Net Congestion (Landelijk Actieprogramma Netcongestie), to prevent congestion on the electricity grid (Rijksoverheid, 2022). The report aims for three main purposes: 1) quicker realization of energy network extensions, 2) steering for better grid utilization, and 3) expanding flexible capacity. To achieve this, a focus needs to shift towards solutions that promote both efficiency and flexibility in energy usage, alongside the stimulation of governmental parties and grid operators (Rijksoverheid, 2022). One of the biggest contributors to the energy demand in the built environment is the industry sector. Their processes running sometimes 24/7 require a lot of energy. Most of these industrial buildings in the Netherlands are grouped in business parks. In 2021, around 3800 business parks existed in the Netherlands (TNO, 2022). The potential of the CO2 reduction of these business parks could be big as they were accountable for 1/3th of the national electricity consumption and half of the national gas consumption in 2019 (TNO, 2022). Therefore, one sector to focus on for promoting both efficiency and flexibility in energy usage and stimulation of governmental parties and the grid operator in these projects would be the business parks, as they offer a large impact on the total energy consumption. As a follow-up, in October 2023, a letter by the Dutch Minister of Economic Affairs and Climate, Rob Jetten, was issued announcing 'unorthodox measures' (Ministerie van Economische Zaken en Klimaat, 2023). These measures entail offering new contracts to business parks, enabling them to collectively manage their energy consumption and production at a local level, thus easing the burden on the grid.

1.3. Local Energy systems

One of the most promising solutions for utilizing the grid more efficiently is the local energy system (a more detailed explanation of local energy systems will be given in the literature review, specifically Section 3.2). The local energy system is an energy system in which consumers can use, generate, and store electricity by using 'smart' tools. Energy, data, and communication flows in both ways, in order to deliver sustainable, economical, and secure electricity supplies efficiently. This means that if one building produces electricity with its solar panels, but has no electricity demand, the electricity can be directed to a neighbor connected to the local energy system grid with an electricity demand, without utilizing the main grid that is congested. This tries to solve the balance between supply and demand on a local level, before entering the regional or national grid. By using 'smart' IT systems, the grid balances local production, storage, and usage of electricity. Additionally, the electricity demand of a building can be reduced through methods such as improved insulation or the use of smart tools. In a pilot project like Schoonschip , the implementation of a local energy system has significantly reduced the total electricity demand from the main grid to just one-fifth of the previous requirement (Schoonschip, 2023). This substantial reduction is attributed to the effective utilization of the local energy system, which now addresses the majority of the electricity needs within the community. This example illustrates the potential impact of a local energy system in reducing the burden on the grid.

1.4. Collaboration on business parks with a local energy system

As the efficiency of a local energy systems has been proven, and the new measure by the Ministry of Economic Affairs and Climate will be implemented, the first steps to implementing a local energy systems can be taken on business parks. For this further implementation, a prioritization in terms of urgency of barriers to making business parks more sustainable has been carried out (CE Delft, 2023). In Figure 1.5 the results of this research can be seen. The main barrier that stands out is the low organizational structure and complex stakeholder processes. The experts estimate that 90% of the Dutch business parks are inadequately organized for a sustainable transition. Most of these business parks have no legal entity, and therefore no central responsibility. The lack of collaboration among stakeholders presents a significant barrier, hindering their ability to come together and address sustainability challenges collectively, like the challenges posed by net congestion, particularly affecting industrial parties heavily reliant on electricity consumption. This calls for a close collaboration, between all the involved stakeholders on the business park with a local energy system. As this is a new practice to almost all business parks, companies or business park organizations have no clear idea where to start, who to involve and what this collaboration should look like (CE Delft, 2023). Furthermore, literature emphasizes the need for better understanding of these stakeholders, their needs, and their mutual relation (Ma et al., 2019), as the complex multi actor processes form the main barrier for a sustainable transition of Dutch business parks (CE Delft, 2023). Therefore, in accordance with Ma et al. (2019), there needs to be a focus on stakeholders' position in the network, and their relations in between.

Figure 1.5: Prioritization in terms of urgency of barriers to making business parks more sustainable (CE Delft, 2023)

1.5. Problem statement

The problem addressed in this thesis is the lack of understanding of complex multi-actor processes in local energy systems. Understanding the actors and their interdependent relationships is essential to gain insights into how these networks operate. This knowledge can enhance collaborations and contribute to the further deployment of local energy systems and overall sustainable transformation. Various actors, often from different organizations, form an inter-firm network to operate a local energy system. This research will explore the dynamics of these inter-firm networks and the underlying factors influencing stakeholder collaboration in business parks with local energy systems. The insights gained will support the broader adoption of local energy systems in business parks across the Netherlands.

1.5.1. Deliverable

By examining the actor networks of four case studies, and the underlying factors: vision, learning activities and barriers and enablers, an adjusted and generalized actor-network will be proposed. This actor-network provides valuable insights to the need for understanding these complex multi actor processes.

1.6. Research questions

To support the problem statement, research objective, and deliverable, the following main research question is formulated as follows:

How can underlying factors influence stakeholder collaboration to improve further deployment of local energy systems on business parks?

This research question will dive into these complex multi actor processes, and aims to gain a better understanding of these stakeholder collaboration and underlying factors.

1.7. Scope

The scope of this research will be narrowed down to business parks in the Netherlands, as the group contract makes it only possible for business parks to integrate shared energy. For households, more strict rules apply and are not included in this first step towards a more efficient energy system. Therefore, the case studies used in this research are all implemented local energy system projects, and thus already have a network in place. This way, these nodes and connections can be analyzed and valuable information can be generated.

Furthermore, this research will only focus on electricity. Although there are other methods of transporting or using energy (like hydrogen and heat), this research gives an answer to the problem of net congestion, in which electricity plays a role. Next to that, the group contract makes it possible to share energy in the form of electricity for business parks. As stated in the introduction, the greatest impact resides in the built environment, given its status as the largest energy consumer. Within this context, business parks stand out as the primary consumers of energy and electricity.

1.8. Reading Guide

This thesis aims to address the main research question presented in Section 1.6 by first exploring the subject matter and reviewing the existing literature in Chapter 3. Afterwards, the methodology of the research and the research design will be discussed in Chapter 2. The empirical part of the research will be set out in Chapter 4, where the results of the four case studies will be set out, followed by the findings and the conclusions in Chapter 7, followed by the recommendations in Section 7.3. The discussion and limitations of the research will be discussed in Chapter 8.

2

Research Design and Methodology

This chapter focuses on the design of the research. The conceptual framework will be presented, dividing the research into three parts: theoretical research, empirical research and synthesis. Furthermore, data collection and processing and the data analysis will be described to contribute to the transparency of the research and therefore its validity.

As local energy systems on business parks is quite a novel activity, not much is yet known about the collaboration between the involved actors. However, the complex stakeholder processes form the main barrier to the sustainability transformation of business parks. This thesis aims to gain more insights into the collaboration of stakeholders in such environment. Because of this approach, the nature of this research is exploratory, as some facts are known but due to its early stage, more information is needed. Case studies and and a expert focus group will be used to capture these insights to evaluate the current practices and generalize findings. This methodology aligns with the exploratory nature of the research, as it does not assume preconceived notions but rather adapts and evolves in response to the dynamic local energy system landscape. For this, the following research question has been developed:

How can underlying factors influence stakeholder collaboration to improve further deployment of local energy systems on business parks?

Several sub-questions have been formulated to support this main research question:

1. What factors stimulate the further deployment of local energy systems?
2. What are the current practices of collaboration on business parks?
3. What are the barriers and enablers within stakeholder collaboration?
4. To what extent do these collaborations facilitate the underlying factors?

2.1. Research approach

2.1.1. Research aim

As emphasized in the letter sent by the Ministry of Economic Affairs and Climate (Ministerie van Economische Zaken en Klimaat, 2023), the problems of the electricity grid in the Netherlands keep rising. As a result, the country is dealing with net congestion locally, and several building projects must be postponed or even cancelled, simply because there cannot be a connection made to the electricity grid. With the alarming climate crisis and housing crisis, the problem of net congestion needs to be solved rather sooner than later. As a response, the group contract makes it possible for users in business parks to share the capacity on the grid. This implies that individuals will need to collaborate, sharing their electricity and exploring innovative ways of working together, collectively taking responsibility for their shared capacity. This thesis contributes to the solution of these problems by exploring how these actors within local energy system projects collaborate, and providing a adjusted, generalized actor network for these kind of project. This actor network gives insights in the yet unknown network of these complex multi-actor networks. The aim of the research is to explore how these actor networks are influence by the projects vision, learning activities and barriers and enablers, to contribute to the further deployment of local energy system projects, as a way to use our energy systems more efficiently and battle net congestion.

2.1.2. Research output and goals

The output of this research conducts a generalized, adjusted actor network to gain insights into stakeholder collaboration on business parks operating with a local energy system. This generalized actor network is derived from existing local energy system projects on business parks, and is influenced by the vision, learning activities and barriers and enablers. Analyzing the actor network allows to identify (key) actors and their relations between each other. This is crucial for addressing barriers and enablers in collaboration. The presence of barriers such as a lack of information-sharing and complex stakeholder processes underscores the importance of researching the actor network. By focusing on the actor network of a project, a deeper understanding of the underlying factors can be gained contributing to the further deployment of local energy systems.

2.2. Research methods

To give an answer to the research question formulated, a conceptual framework is developed. The research approach has been divided into three parts: the theoretical research the empirical research and the synthesis. The first sub research question will be answered in the first part, followed by the second, third and fourth sub research question in the second part. In the last part, the findings will be synthesized to formulate an answer to the main research question. An overview for the research design can be seen in Figure 2.1. The methods used for the research are the literature review, case studies, including semi-structured interviews and questionnaires, and a expert focus group.

2.2.1. Theoretical research

The first part of the research formulates an answer to the first research question. For this part, a literature study will be conducted. First, the concept of the local energy system will be explained, to gain better understanding of the concept and the context. This will provide the researcher and reader with an sufficient knowledge base of the topic. After this, the literature will focus on theoretical backing for the first research question, providing an answer to the underlying factors to stimulate the further deployments of local energy systems. The literature will not focus primarily on local energy systems. Instead, it will adapt insights from these systems within a broader context to understand how novel concepts are stimulated. These underlying factors provide further ground for research on the stakeholder collaboration. Lastly, the literature review identifies the barriers and enablers in stakeholder collaboration that have already been researched. These uncovered barriers and enablers will be used to provide as a base in the interviews, for uncovering the barriers and enablers of specific projects.

2.2.2. Empirical part

Building on the theoretical part, the empirical part formulates an answer to the second, third and fourth research questions. To provide an answer to these questions and to apply the theory to practice, a multiple case study is performed. The case studies provide insights into the current practices of local energy systems on business parks. By incorporating multiple cases, allows for an inter-case study as well as an cross-case analysis. Furthermore, it improves the validity for the results (Gustafsson, 2017). For the research, four cases have been researched. The case studies consist of semi-structured interviews, questionnaires and desk research.

Case selection

As the sharing of energy is legally not yet possible in the Netherlands, as explained in Section 3.3, only a few pilot local energy system projects have been implemented at the moment. As the research focuses on stakeholder collaboration on business park operating on a local energy grid, the case selection specifically focuses on projects where the projects is established and operational, and therefore the network is already operating. Only those projects with an active operation have been included in the study. As the number of these cases is limited, and there is no list of the realized local energy system projects (as many of them are bottom-up approaches, and not centrally organized), the selected cases were discovered by desk research and inventory meeting with experts.

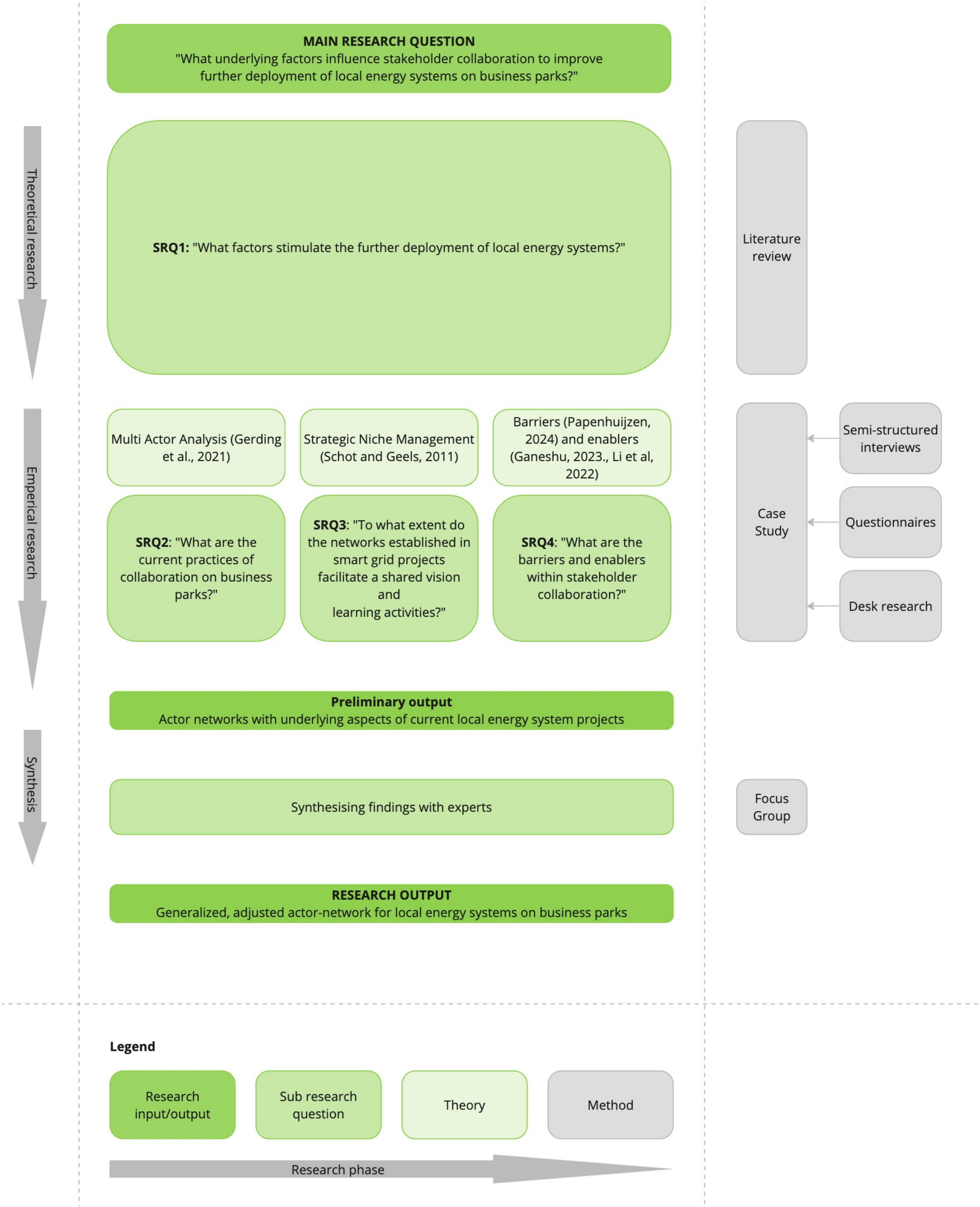

Figure 2.1: Conceptual research framework

For the case selection, it was important to have a diverse set of cases, as this results in better generalizability of the findings, especially in exploratory research. As this research mainly focuses on the relation between stakeholders, diversity was mainly sought in the initiator of the project and the contracts or relations between the actors in the project. Based on these criteria, the following four cases were selected, see Table 2.1.

Table 2.1: Case selection

Name project	Location	Initiator	Contract type	Phase
Schiphol Trade Park (STP)	Hoofddorp	Business park developer (SADC)	Group Contract	Exploitation
Hessenpoort (HES)	Zwolle	Business Park organization	Group Contract	Exploitation
EcoFactorij (ECO)	Apeldoorn	Company	GDS	Exploitation
Slabbecoornpolder en Welgelegen (THO)	Tholen	Municipality	Group contract	Exploitation

Next to the characteristics described in Table 2.1, there is also a difference in network operator, as each region in the Netherlands is assigned by its own responsible regional network operator. Regional network operators need to bind to strict rules; however, being different organizations, there is a possibility that their differences might have an influence on the project. In Figure 2.2 the location of the selected cases can be observed.

Figure 2.2: Locations of the case studies (STP = Schiphol Trade Park, HES = Hessenpoort, ECO = Ecofactorij, and THO = Tholen)

Respondent selection

For the interviews, several respondents were selected to gain information on the project from different viewpoints, to increase the data collection and therefore increase validity using the triangulation method.

For each case, similar actors were selected to be able to compare the cases, derived from the identified stakeholders in Section 3.4. Most business parks cases have a park manager, who is usually involved with the business park on a day-to-day basis and forms the bridge between the users of the business park and the municipality or network operator. In some cases, the park manager is also part of the 'managing organization' of the business park. Furthermore, the local energy systems organization must consistently coordinate with the network operator, as they seek to establish different agreements for energy usage compared to standard arrangements. Additionally, another important actor are the companies located at the business park, connected to the local energy grid, mostly forming the end-user. In all case studies, the role of the external advisor was mentioned as an important actor in the network, therefore they are included in the interviewee selection as well. Lastly, the municipality (or other public authorities) can also play a crucial role in the development and existence of local energy system projects through their policies of facilitating roles for example. Therefore, the following stakeholders have been selected for the semi-structured interviews.

- Business park organization
- Regional Network Operator
- Municipality
- External Advisor

As the companies on the business park were with too many, a questionnaire was chosen as a more feasible method to retrieve data from

In Table 2.2 an overview of the selected respondents can be seen and whether they have shown interest to the research to contribute to an interview. Unfortunately, not every stakeholder was available for the interview. Furthermore, as mentioned above, the companies did not partake in an interview, but were questioned through a questionnaire.

Table 2.2: Stakeholder selection case study

	Business park organization	**Regional network operator**	**Municipality**	**External advisor**	**Company**
Schiphol Trade Park	STP-1	STP-2	-	STP-4.1 & STP-4.2	STP-5 (5)
Hessenpoort	HES-1	HES-2	HES-3	HES-4.1 & HES-4.2	HES-5 (1)
EcoFactorij	ECO-1	-	ECO-3	ECO-4.1 & ECO-4.2	ECO-5 (1)
Tholen	THO-1	THO-2	THO-3	THO-4	-

The "-" in Table 2.2 indicate that the stakeholder has been approached, but was not able to take part in an interview.

Semi-structured interview, questionnaire and desk research

The interview and questionnaire will be used as a method to retrieve data from the interviewees and respondents. The full interview questions and questionnaire questions, can be found in Appendix A and Appendix B Both the interview and questionnaire will be built up as the following parts:

1. General Introduction
2. Network
    - Actors
    - Relations
3. Vision and learning activities
    - Shared vision

    - Learning activities
4. Interactions
    - Barriers and enablers
5. Round off

For the desk research, internal documents (presented by the interviewees during the interview), project websites and new articles were used. Municipal documents were also investigated, however they did not mention any relevant information for this specific research. Upon questioning the municipal actors during the interview, they confirmed that these pilot projects were not discussed in detail during municipal meetings. An overview of the documents used for the case studies can be found in Appendix E.

2.2.3. Data collection

For the data collection of the case studies, semi-structured interviews were used as a method to collect qualitative data. This method is chosen as it provides a direction for the theoretical framework to be applied, but also leaves room for the interviewee to delve into topics they feel are very important for the projects. This follows the choice of exploratory research as it leaves room to discover new insights. Furthermore, according to Adams (2015), semi-structured interviews can be valuable if interviewees do not feel comfortable talking about certain topics if their peers are involved as well. As this research focuses on the actor-network and therefore the relations between different actors, it could be that certain actors are more uncomfortable as tensions could be present. Additionally, a survey will be distributed to the companies situated within the business parks of the case studies. Due to the large number of companies, a questionnaire format will be utilized, as conducting individual interviews with each company would be impractical.

The interviews are conducted on Microsoft Teams, and were also be recorded with this software. Before the interview begins, the interviewee signs an informed consent form. This form informs the interviewee of the background and goal of the research, how the data will be treated, the potential risks, the storage and access of the data, etc. The questionnaire will be made in Google Forms and will be sent to the general email addresses of the located companies. Before starting the questionnaire, a introduction text will be shown involving the consent when participating in the questionnaire.

As human research subjects as involved in the research to obtain data, it is important to ensure their privacy and to protect the data provided by the human research subject. Personal information will be securely stored on the TU Delft WebDrive. Only the research team will have access to this drive. The transcripts of the interviews will be anonymized, and the personal information will be deleted at the finalization of this research.

2.2.4. Data processing and analysis

The recordings of the interviews were transcribed by the software of Microsoft Teams. After this, the recordings were played next to the transcribed text, and corrected if necessary. This is an essential step, as the software makes mistakes easily and does not recognize 'jargon' or abbreviations. The recordings and transcribed texts are stored on the WebDrive of the TU Delft during the research. After completion, the data on the TU Delft WebDrive will be deleted, and the thesis with the results from the interviews will be stored on the TU Delft Repository. After the research, the answers of the questionnaire will be deleted.

The transcribed texts of the interviews was used to retrieve data by using coding to interpret the findings. Another software was used for this process; AtlasTI. This software can help to organize codes and see inter-dependencies between codes. For this research, both deductive and inductive code methods were used, both codes can be seen in Appendix F. The deductive approach, also known as closed coding, uses the theoretical framework as a structure to analyze the data and determines predefined codes, before the actual interview. This way, the theory is imposed on the data and can be used to analyze the transcript (Burnard et al., 2008). This method works well with (semi-)structured interviews as they follow the predetermined framework. However, deductive coding also has its limitations, as they are inflexible, you run the risk of forcing the data on the framework and it limits new theme development (Burnard et al., 2008). As this research has an exploratory nature, these risks should be mitigated. Therefore, a second method was be used as well. This is the inductive approach, also known as open coding. This method does not use a predefined framework but uses the data from the interviews to discover themes or theories (Burnard et al., 2008). It allows the researcher to discover important themes that were thought of beforehand. This hybrid form of using both deductive and inductive coding at the same time allows for a framework to guide the interviewee to stay focused on the topic, while at the same time allowing the interviewee to elaborate on themes that they think are important to consider.

2.2.5. Synthesis

The findings from the previous two parts are used in the synthesis part. The findings of the individual cases as well as the comparison between the cases were used to formulate the first results. The first preliminary version of the general actor network was developed, to give insights into the collaboration of stakeholders on business parks in the contact of local energy systems. Following this, to validate the findings from the outcomes of the research, a focus group is organized.

Focus Group

The focus group consists of three experts working in the context of local energy systems. These experts are employees of the internship company; Fakton Energy. The session took 1,5 hours and was composed of first brainstroming on a general actor network and barriers and enablers, following by a review of the proposed actor network as a result of this study. Neither the experts nor the company were involved in the case studies, and therefore has no bias to the results of the case study. During this session, the experts were asked to come up with a general actor network, and engage in a collaborative brainstorming session to identify the barriers and enablers that actors may encounter when working in collaboration with other stakeholders. Afterwards, the case study findings were presented, and the experts will discus if these findings align with their practical experiences in the field. The results of the focus group, can be found in Appendix C.

2.2.6. Validation

Next to the recording and playing back the recordings of the interviews to ensure the validity of the data, the transcripts were emailed to the participant to check if the content is correct. This way, any information interpreted incorrectly can be adjusted to improve the results of this research. However, it is good to keep in mind that the interviews were conducted with individuals who are all involved in the project, and therefore will be biased. To mitigate these biases, multiple stakeholders from different organizations of the same case study were interviewed to gather information from multiple sources. Furthermore, desk study was also be performed to retrieve relevant data from the case study from internet sources. This method is called triangulation (Saunders et al., 2019) and is used to collect data from different sources to increase the validity of the data. Next to the case studies, will the findings also be discussed in a focus group with energy consultants working on local energy system projects.

2.2.7. Ethical considerations

Ethical considerations should be at the core of every research. Especially when conducting research with human research subjects, their safety should be guarded. To ensure the ethical standards of the TU Delft, an ethical plan will be submitted to the Human Research Ethics Committee (HREC) of the TU Delft, to ensure these standards. Before the interviews and case studies will be performed, approval of the committee is necessary. This approval serves as confirmation that the study meets ethical guidelines and respects the rights and privacy of participants.

Before the interviews will take place, a Data Management Plan, the informed consent form and the risk assessment will be submitted to the Human Research Ethics Committee of the TU Delft, to ensure the privacy and safety of the human research subject.

Theoretical Research

3
Literature Review

In this chapter, first the background of the concepts of the local energy system will be discussed to gain a better understanding of the topic. Afterwards, the existing literature will be reviewed, and the research gap will be uncovered.

3.1. Possible solutions for Net Congestion

As described in the introduction of this thesis, frequent overloads in the main energy grid lead to net congestion. This congestion is primarily attributed to the growing share of renewable energy sources, and their variable character, and the increasing energy demand, which is partly being driven by the rising adoption of technologies like heat pumps and electric vehicles. Several solutions have already been described in the current literature, and the key concepts will be further explored in this paragraph.

3.1.1. Expansion of the current grid

One of the most logical solutions to the overloaded grid would be to expand the current grid to ensure sufficient capacity throughout the day. However, this seems to be a much more complex task than just expanding the grid. At the moment, more than $1 trillion is invested annually in the energy sector infrastructure and technologies. To reach net-zero emissions by 2050, those investments will need to increase to around $4 trillion according to the International Energy Agency (Energy Agency, 2050). Furthermore, the research of Seltzer (2020) predicts that the electricity transmission system will need to expand by 60% in 2030. *"Achieving this objective would require a mind-boggling acceleration of the typical ten-year capital project timeline. It is, arguably, a century of work to do in less than a decade"* (Brown et al., 2022). This means that next to the long period this kind of project already takes up, other hurdles like financing also need to be tackled before even beginning the expansion. Although the expansion of the energy grid might seem like the logical next step, it acts more as a long-term solution due to the complexity of the energy grid. In summary, the expansion of the grid takes too long to keep up with the increase in electricity supply and demand. Furthermore, considering the high costs of grid expansion, it makes sense to explore solutions for managing electricity more efficiently. As the problems of net congestion already exists, more efficient solutions focused on the short-term are needed.

3.1.2. Peak shaving

For these more efficient, short-term solutions, the aim is to utilize the 'free space' present, as described in Section 1.1.1. The goal is to flatten the peak moments (moments where electricity demand is high) by distributing them over the rest of the day. In doing so, the excessive contracted capacity, which often exceeds demand for the majority of hours, can be reduced, thus creating available space on the grid. One way to create this flexibility, is by congestion management. Within congestion management, the main aim is to flatten the peak, by creating a financial incentive for the end user, also referred to as 'peak shaving' or 'load shifting; in literature. It makes use of the flexible load to spread out the peak demands and therefore makes sure the net does not get congested (Hennig et al., 2023). During peak hours, electricity is more expensive than during low demand. This type of management system is reliant of several factors, such as their predictability. The prices for energy need to be clearly communicated. Some enery providers use day-ahead prices (the prices are published one day before using it), while others use real-time flexibility to be more accurate. However, this does mean that users lose grip on the planning of their consumption. Furthermore, localization (as congestion can be local), discrimination, and social inclusion are important factors to keep in mind when operating a congestion management system (Hennig et al., 2023). Congestion Management is mainly a system to control peak shaving, by laying the responsibility for it by its users. It creates financial incentives for the users to plan their energy demands in less overloaded times. This is a good solution to change the behavior of users and make them more aware of their consumption, but it is not a solution for overall grid management. Furthermore, it stimulates discomfort for the less wealthy people as it becomes more expensive for users the use energy at the more efficient hours, therefore contributing to energy poverty.

Cable pooling as a solution comes from the Renewable Energy Sources level. Generally, Renewable Energy Sources have their own connection to the energy grid, in the form of a cable. However, it rarely ever happens that RES is generating power 24/7, as it is subjective to the climate. For example, solar panels generate energy during sunlight hours, while wind turbines produce electricity when there is sufficient wind. This means, that the infrastructure of the cables and the grid is not optimally used. By connecting these different RES sources to a joined cable, energy generated from wind turbines can compensate for the lack of energy generated by solar panels in the nighttime. As a result, it provides a more stable power supply for the energy grid (Y. Li et al., 2023). However, cable pooling does not directly help solve net congestion. Instead, it can be a strategy used by net operators to efficiently manage and optimize their resources, which indirectly contributes to alleviating net congestion.

3.1.3. The need for a decentralized solution

Due to the unpredictable nature of RES, imbalance occurs more often and is more significant than before. Restoring imbalance re-actively is expensive and inefficient. Furthermore, as micro-generators (such as solar panels or mini wind turbines on roofs) are becoming more common in residential settings, it is necessary to allow homes to contribute their excess energy to the grid, or store it locally with the use of batteries for example. This ensures that surplus energy is not wasted or replaced by fossil electricity plants when a particular household is not using it at that exact moment. Already in 2010, the power industry has changed to accommodate the implementation of new technologies, to make the grid more efficient in generating, transmitting, and distributing electricity (Moreno Escobar et al., 2021). In most countries, the electricity systems are managed through centralized procedures. However, there is a trend in the electrical industry to shift decision-making authority away from centralized control and towards distribution companies (Hussain et al., 2020). Furthermore, the need to modernize the electricity systems and make them more efficient, calls for the need to establish deregulation in the power industry (Alotaibi et al., 2020), especially with the rise of renewable energy sources that have a variable character. The old, centralized energy system is not suitable for the shift towards RES, given the localized and variable nature of these sources (TKI Urban Energy, 2022). Efficient utilization of such sources occurs at the local level, eliminating the need for energy transportation and easing the burden on the energy grid. However, achieving decentralization is crucial for realizing these benefits. As a solution to these issues, local energy systems use advanced information technologies (IT) to bridge the gaps mentioned above (and many more). Because of the way a local energy system takes a different approach to the energy grid, it is considered to be the most promising alternative at the moment (Alotaibi et al., 2020), (Tuballa & Abundo, 2016), providing that local solution to net congestion.

3.2. Local energy system

The local energy system (LES) is an electricity network combining all actions from users, generators, those that do both, and storage facilities. With intelligent IT and services, it can efficiently distribute or store energy within the grid (Ardito et al., 2013). It is important to note that local energy systems differ from energy-saving household technologies such as smart metering or home energy management systems (HEMS). However, these household-scale technologies are important aspects of a successful local energy system implementation (Milchram et al., 2020). Simply put, this means that if a household produces more electricity, such as from solar panels, than it consumes, the surplus of electricity is either sent to the local grid for others to use, or stored for later use when the demand exceeds the generation. This means that unlike the traditional electricity grid where everything moves in one direction: from generator to consumer (see left side of Figure 3.1), the transportation of energy is bidirectional (see right side of Figure 3.1). Users become prosumers, by not only getting energy from the grid but also producing and delivering energy to the grid.

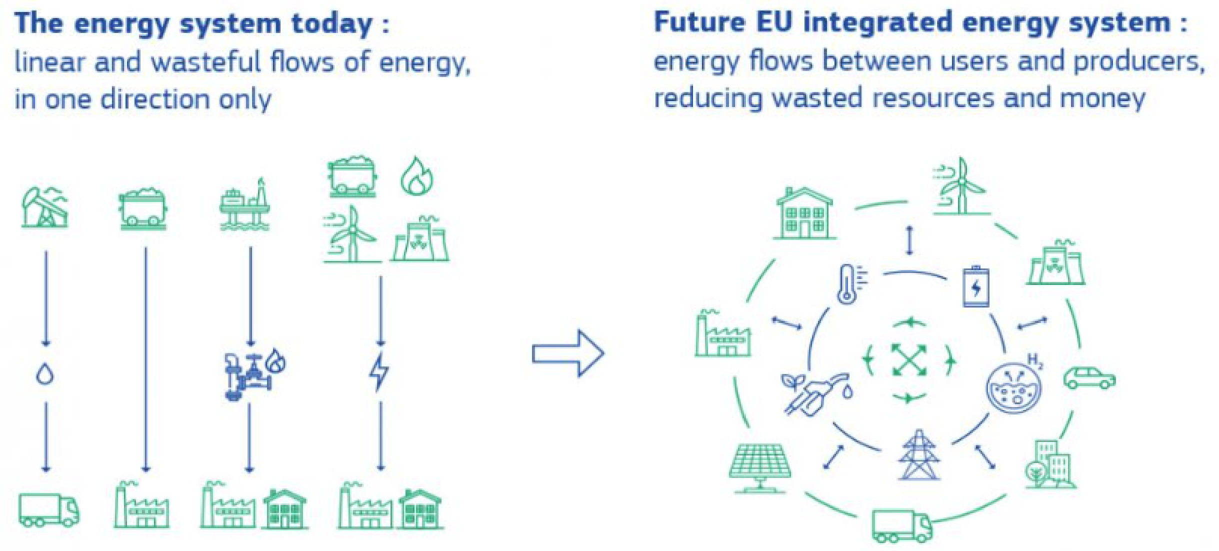

Figure 3.1: Change of energy system (European Commission, n.d.-b)

Next to the technical aspects of the local energy system, it is important to note that environmental impact, regulatory framework, standardization usage, ICT and migration strategy, and societal and governmental requirements are important aspects (Ardito et al., 2013), to ensure a successful and widespread adaptation of local energy systems. Currently, local energy systems in the Netherlands are mainly implemented in pilot projects, due to restrictions in legislation (see Section 3.3) (Milchram et al., 2020).

3.2.1. Definition

First of all, the 'local energy system' does not have a single definition that is universally accepted. The term is sometimes subdued for 'energy hub', 'smart grid', 'virtual net' etc. A definition given to the smart grid by the National Institute of Standards and Technologies (NIST) is a modern grid with, unlike the traditional grid, a bi-directional flow of energy, data, and communication, integrating digital computing and technologies (Gopstein et al., 2021). A smart grid goes beyond applications like smart meters for homes and businesses. The Strategic Deployment Document for Europe's Electricity Networks of the Future describes the smart grid as an electricity network that can intelligently integrate the actions of all users connected to it – generators, consumers, and those that do both – in order to deliver sustainable, economical, and secure electricity supplies efficiently (European Commission Directorate-General for Research and Innovation, 2006). In the traditional grid, energy is generated by generation companies, transmitted through high-voltage lines by transmission companies, and goes through the distribution companies eventually to the consumer who uses the energy in a one-way street. In a smart grid, the energy flows both ways. Consumers not only receive electricity but can also produce their own energy, send surplus energy back to the grid, or even store energy for later use. This bidirectional flow of energy, facilitated by smart technology on a local scale, enhances the efficiency of the entire energy system.

Since terms like "local energy grid," "smart grid," and "energy hub" all broadly refer to similar concepts, this thesis will primarily use the term "local energy grid" to encompass all relevant aspects. Furthermore, as there is no uniform definition for the local energy system, the following definition based on the authors mentioned above will be used: the local energy system is an energy system in which consumers can use, generate, and store sustainable energy by using smart tools. Energy, data, and communication flows in both ways, in order to deliver sustainable, economical, and secure electricity supplies efficiently. This means, that the local energy system encompasses four aspects: demand, supply, storage and control. This has been abstractly visualized in Figure 3.2. In this thesis, the energy mentioned in the local energy system, refers solely to electricity. However, in the future, other media of energy can be added to the local energy system. Therefore, energy here refers to electricity, data to the measuring of the supply and demand, and communication to the addressing is there is a need for more or less electricity.

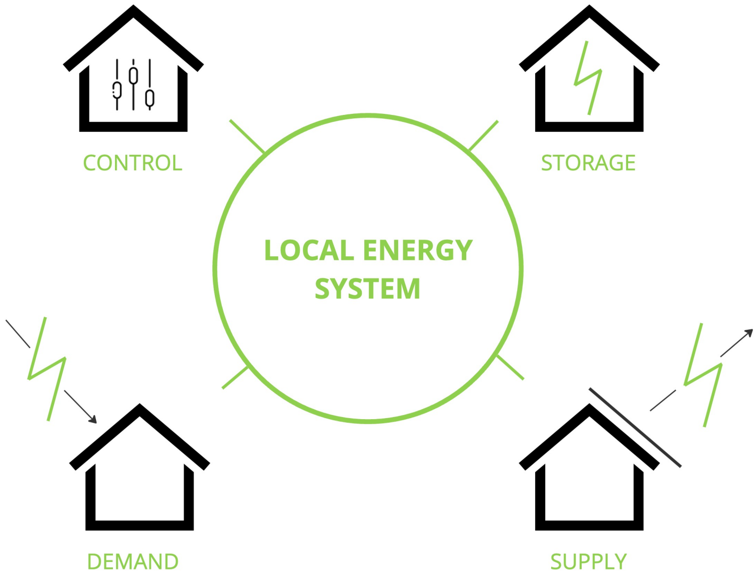

Figure 3.2: Visualization four components local energy system (image by author)

3.3. Relevant legislation

In this part, the current policies, and therefore regulatory possibilities or limitations, on local energy systems will be discussed.

3.3.1. Dutch Electricity Act 1998

The current law regulating the energy systems in the Netherlands is the Electricity Act 1998 ("Elektriciteitswet 1998", 1998). This Act liberalized the market. Generation, transmission, and distribution were separated, allowing multiple companies to operate in those segments creating competition and making it possible for customers to choose their own energy supplier. Under this Act it is not possible for individuals/organizations/companies to control or manage the grids, a regulatory authority needs to oversee and regulate the energy market. Only DSOs, which don't have a profit incentive, can control the grid.

3.3.2. The Experiments Electricity Act 2015-2018

From 2015 to 2018, an exception was made to the Electricity Act 1998 called the Experiments Electricity Act 2015-2018 (Experimenten Elektriciteitswet 2015-2018, 2015). This act was temporarily implemented to stimulate a sustainable approach to the energy supply in the country. Local initiatives got the chance to experiment with innovative solutions that were not in line with the existing Electricity Act. New technologies, (grid) structures, and business models could be applied to projects to make the energy systems more flexible and sustainable. The projects that wanted to apply were scored for: Application of renewable energy or co-generation in local initiatives; Efficiency of energy infrastructure; and Cooperation with end users in energy supply. In total 15 projects got the exemption permitted.

This Experiment Act was initially set up for four years (2015-2018) but with the possibility of an extension of another four years. However, the Council of State did not approve the extension of the exception in the evaluation. One of the objections was that the Act could be conflicting with the EU energy law (Swens & Diestelmeier, 2022).

3.3.3. EU legal framework

In 2019, a renewal of the legal framework 'Clean Energy for all Europeans Package' (CEP) , governing the energy sector in the EU, was passed (Electricity Directive, 2019). Within this renewal, the focus on citizens as part of the solution for an acceleration of the energy transition was discussed for the first time (Swens & Diestelmeier, 2022). This shift of focus opens up the way for new organizational structures, meaning that there is room for the energy system to change in favor of the transition. Such an example of a new organizational structure is the concept of 'Energy Communities' that is adopted in the new CEP (Swens & Diestelmeier, 2022). An energy community is a local part of the energy grid where the members connected to the grid control the system ensuring to provide environmental, economic, or social benefits to the community (Reijnders et al., 2020). As this is a EU law, the member states have room to determine for their own interpretation how an energy community could operate. It is described as: "Energy Communities have to provide environmental, economic, or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits ("Renewable Energy Directive", 2018). At this moment, the option of an energy community is not yet integrated into the Dutch Law. However, they are working on reforming the entire energy sector legislation. In the Draft Bill of 2021, the option for an energy community to manage and control their own grid system has not been described. It argues that grid operation should be kept to professional organizations like DSO's for several reasons like grid safety (Swens & Diestelmeier, 2022).

3.3.4. Group Contract

On the 18th of October 2023, the Ministry of Economic Affairs and Climate sent out a letter to the Speaker of the House of Representatives (Voorziter van de Tweede Kamer) to announce new measures that will be taken to tackle the problems on the Dutch energy grid at the moment (Ministerie van Economische Zaken en Klimaat, 2023). One of the measurements mentioned was the option for a group contract (in Dutch: Groeps-TO groeps-transportovereenkomst) for business parks. A group contract entails a set of agreements between the grid operator and the connected parties for the technical connection capacity of a customer and the allocated capacity for the group as a whole and, instead of an individual allocated capacity. The advantage for the individual is that participation in the group allows him to use more transport capacity (GTV) than his original GTV, as long as the group as a whole remains within the group's capacity. Within the group, arrangements must be made to ensure the group GTV and the division of electricity use (Netbeheer Nederland, 2023). In Figure 3.3 a visualization of the Group Contract can be seen. On the left three user profiles of their electricity use have been displayed, and the corresponding GTV. When you combine their electricity use and GTV (the picture on the right), it becomes clear how much capacity is not used to its potential.

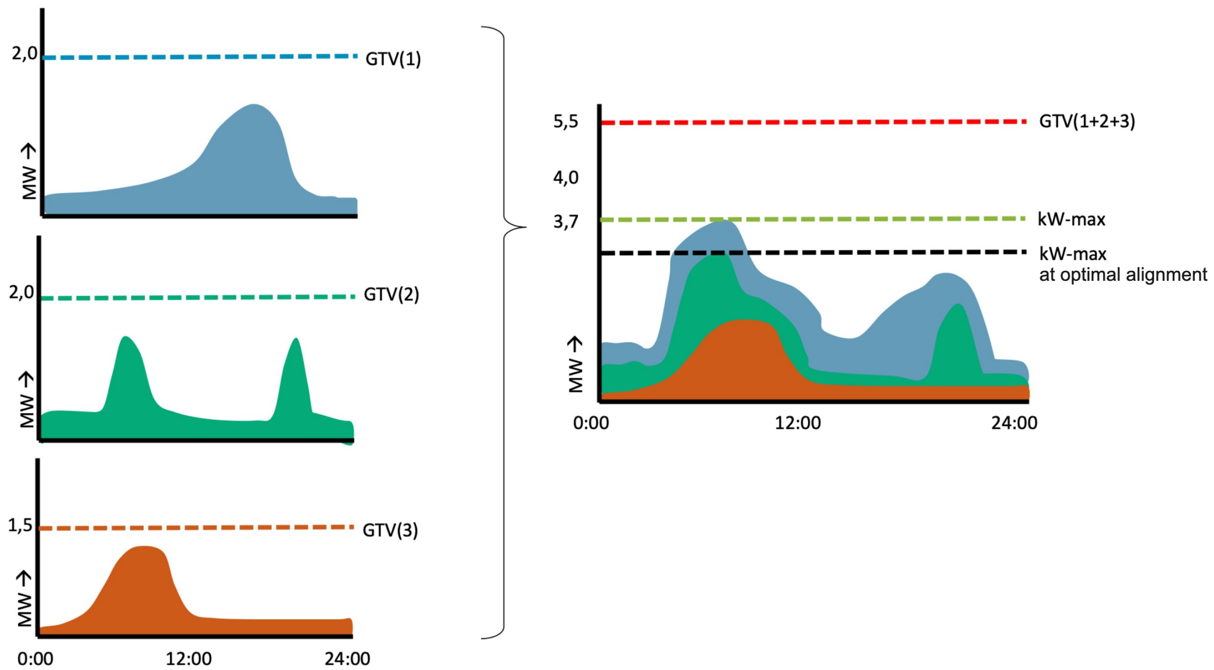

Figure 3.3: Visualization Group Contract (Netbeheer Nederland, 2023)

For the grid operator, the group contract provides more security. Instead of uncoordinated and individual grid use, the group contract encourages non-similarity between connected parties and thereby creates optimal utilization of grid capacity. The plan is for the group contract to take effect next year (Ministerie van Economische Zaken en Klimaat, 2023). With the arrival of this group contract, the way to share electricity between different parties locally has been opened. This means that the connected parties will need to manage their energy flows. As mentioned before, local energy systems seem to be the most promising alternative for this, to manage and distribute the electricity within the group contract efficiently.

3.4. Stakeholders

The stakeholders involved in local energy systems projects range from governmental organizations to the energy distribution to the consumer. A stakeholder interacts with the local energy system through an interest or concern (Reinders et al., 2018). Although these stakeholders are always involved, the interests and focus of each stakeholder are on a different scale. In the literature review from Reinders et al. (2018) the following stakeholders have been identified as stakeholders that are involved in residential local energy system projects. Furthermore, a description of their role has been given, see Table 3.1.

Table 3.1: Stakeholders in local energy system environments and descriptions of their roles (Reinders et al., 2018)

Stakeholder	Description
Residential customer /prosumer	A residential customer or utility business that produces electricity. Roof top PV installations and energy storage battery systems are examples of homeowner investments that allow people to do both consume and produce energy for use locally or to export during certain parts of the day or year.
Aggregator	A person or company combining two or more customers into a single purchasing unit in order to negotiate the purchase of electricity from retail electric providers, or the sale of electricity to these entities. Aggregators also combine smaller participants (as providers or customers or curtailment) to enable distributed resources to play in the larger markets.
Balancing responsible party (BRP)	A legal entity that manages a portfolio involving the demand and supply of electricity, and has a commitment to the system operator in a European Network of Transmission System Operators for Electricity (ENTSO-E) control zone to balance supply and demand in the managed portfolio on a Program Time Unit (PTU) basis according to energy programs.
Balancing service provider (BSP)	In the EU Internal Electricity Market, this is a market participant providing balancing services to its connecting transmission system operator (TSO), or in case of the TSO-BSP model, to its contracting TSO.
Supplier	A supplier provides energy to end customers, based on a contract. The energy can be from the supplier's own power plants or traded in relevant markets.
Distribution system operator (DSO)	The DSO is responsible for the safe and secure operation and management of the distribution system. DSOs are also responsible for the planning and development of the distribution system
Transmission system operator (TSO)	A legal entity responsible for operating, developing, and maintaining the transmission system for a specific zone and, where apposite, its interconnections with other systems, and for guaranteeing the long-term ability of the system to meet reasonable demands for the transmission of electricity.
Government/Regulator	The regulator must strengthen competition and ensure that this does not compromise security of supply and sustainability. To act even-handedly in the interests of all market participants, regulators must be politically and financially independent.

The literature review of Reinders et al. (2018) elaborates on the role of the residential customer/prosumer, as they are described in the literature with multiple terms and the corresponding behavior. Customers, consumers, prosumers, and end users are the terms that are used. Customers are seen as the stakeholders who are supposed to instantly adapt to the new energy system, while the prosumer is seen as a proactive stakeholder who generates and uses energy within the grid. The consumer is seen as a passive stakeholder, while the prosumer actively takes part in the local energy system. The difference in this behavior is also seen in the acceptance of the new energy system, where the ‘end-users’ with knowledge of local energy systems can either stimulate the acceptance or create confusion (Reinders et al., 2018). This kind of information about stakeholders is relevant for understanding which stakeholders are involved and their roles. Important to note is that the literature review of Reinders et al. (2018) covers the stakeholders based upon residential local energy system projects. Given that the focus of this thesis is on industrial business parks, the residential customer/prosumer as an end-user should be substituted with the end-users of business parks, specifically the companies. The description can remain about the same, as companies also can produce energy and have storage options. Next to the production of energy, the end-user also consumes the energy, an (obvious) aspect that is missing in the description. The report of (Ma et al., 2019), discusses the role of each stakeholder in even more detail.

Within the extensive report of (Ma et al., 2019), an analysis of stakeholders involved in ’Energy flexible buildings’, such as local energy systems, has been done. Although there is much overlap with the stakeholders identified by (Reinders et al., 2018), a few more specific stakeholders regarding business parks are useful to include in this overview. In Table 3.2 these additional stakeholders are described.

Table 3.2: Stakeholders in local energy system environments and descriptions of their roles (Ma et al., 2019)

Stakeholder	Description
Energy managers in x buildings	The role of an Energy Manager (EM) involves facilitating energy conservation by identifying and implementing various options for saving energy, leading awareness programs, and monitoring energy consumption.
Industrial consumer	The single largest electricity consumer. Industrial consumers have heavy energy use and have already begun to implement smart grid technologies for production purposes.
Energy consultant	Consultancy services, including energy analytics and conducting innovative projects with illumination and documentation.
The National Regulatory Authority	Responsible for creating a fair market for all stakeholders. They aim to make the market transparent for the customers and ensure that the methods which are used for the settlement of energy prices are consistent with the laws in force.

In the additional overview of Ma et al. (2019), we see that more specific stakeholders are discovered, and their roles. This specifies more detailed stakeholders’ roles. Where the residential customer/prosumer is described by Reinders et al. (2018), we see that the industrial consumer indeed has the same role, but with a much higher electricity demand (Ma et al., 2019), which has an impact on the local energy system. Furthermore, more supportive stakeholders like an Energy consultant stakeholder are involved, as they can have an influence on the project.

For the successful integration of flexible energy buildings, like local energy system, there is a need to understand stakeholder needs and behavior, and their position in the network Ma et al. (2019). The overview and categorization of Reinders et al. (2018) and Ma et al. (2019) gives a clear overview of the involved stakeholders on multiple levels and their roles in a local energy system project. However, not much has been described in literature regarding their position in the network and the relation between the stakeholders. By collaboration between stakeholders, the interests of different stakeholders can be aligned better, ensuring a stronger network. The stronger network has a higher potential to realize the shared goal (Ma et al., 2019), and therefore operating a local energy system among the stakeholders. Therefore, more insights on how to promote collaboration between stakeholders is important for the further integration of local energy systems.

3.5. LES in the socio-technical context/LES as a niche-innovation

With a clear understanding of the background of the local energy system, it becomes crucial to examine its interactions within the socio-technical environment. This will help us understand how this concepts operates within its surroundings.

3.5.1. Multi Level Perspective

The Multi-Level Perspective (MLP) (Geels, 2011) is a conceptual framework that provides a valuable lens for understanding such socio-technological transitions. It proposes three levels to understand the dynamic patterns in socio-technical transitions; the socio-technical landscape, the socio-technical regime, and the niche-innovations. The socio-technical landscape resembles the wider context, incorporating factors such as economic, financial, societal, or technical aspects, etc. This landscape can put pressure on the other levels, as values, policies or economic conditions in the landscape can change. This level is also known as the macro level and is relatively slow to change. The middle level is the socio-technical regime. This meso level represents the established system or set of technologies, practices, and institutions that characterize the ’way of doing things’. The regime is supported by rules that may be formalized in laws or regulations, as well as informal norms and standards that guide the practices of involved actors. There is some sort of stability to this regime, but pressure from the landscape and/or niches can cause a shift in the standard way of doing this, creating a redirection. This also also defined as ”the window of opportunity”, for niches to enter the regime (Geels, 2011). The niche level, also known as the micro level, is the more experimental part of the MLP framework. Actors such as entrepreneurs or start-ups are present at this level, as they are challenging the other levels with innovations. Niches need to break through to the regime for their innovation to settle in the standard practices. The landscape can put pressure on the regime, and niches may challenge the existing regime by offering alternative technologies and practices. Geels (2011) argues that the MLP framework can help explain why certain sustainable innovations are able to settle into the regime, and why others fail to do so. Furthermore, the framework seems to successfully be applied to future transition studies such as electricity systems (Geels, 2011).

As there are currently only a limited number of local energy systems projects in the Netherlands, which are still in the pilot phase, they can be regarded as the niches within the framework. The existing net congestion in certain regions of the Netherlands can be viewed as a landscape change, exerting pressure on the established regime. This pressure enacts on the regime, by the upcoming implementation of the Group Contract. This could potentially create the window of opportunity for local energy system to settle into the regime. Therefore, the framework can help us understand how local energy systems will enter into the regime and be incorporated into the standard systems. This can be seen in Figure 3.4

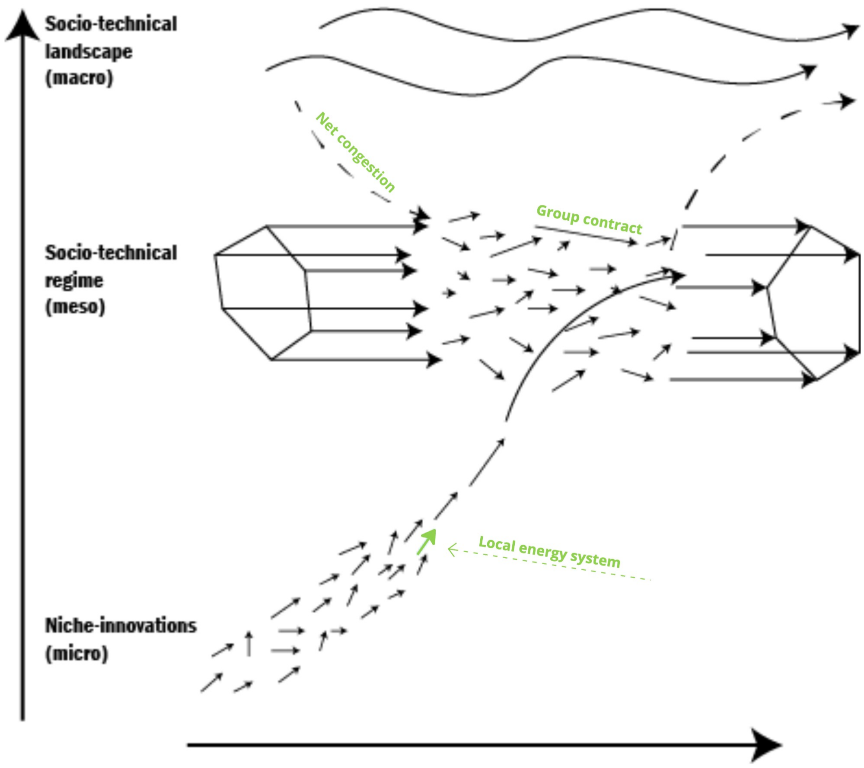

Figure 3.4: Multi Level Perspective Framework, adjusted for the context of the research, based on Geels (2011)

3.5.2. Strategic Niche Management

For the niche-innovation to enter into the socio-technical regime, processes have been described in Strategic Niche Management (SNM) literature to analyze their successful integration into the regime or their failure. Strategic Niche Management is an analytical tool to investigate the diffusion of new sustainable technologies through experiments. Three core processes have been described (Schot & Geels, 2008):

- **Articulation of expectations and vision:** the motivations of stakeholders to identify their expectations and vision.
- **Building of social networks:** interaction between stakeholders
- **Learning activities:** to sustain the impact of niche experiments and learn from failure and success.

These three core processes work together to stimulate the integration of the niche-innovation in the socio-technical regime, and form the answer to the first sub research question.

Expectations and vision

The articulation of expectations and vision of the niche innovation is important to get actors involved in the project. As local energy systems are inter-firm networks (with actors from all different organizations), they all have their own goals and interests. However, for a niche innovation to be successful, the expectations and vision should be aligned (Schot & Geels, 2008). Therefore, it is essential to understand the motivations and goals for all actors in the project, in order to understand their position in the project and align them to the other actors. Described in theory, expectations and visions contribute the most to successful niche management if they are:

- Robust (shared among more actors)
- Specific (can give guidance, it is clear which steps are necessary to realize the expectations)
- Quality (experiments support the expectation)

It is argued that these three characteristics increase the shared expectations and vision (Schot & Geels, 2008) and therefore it is more likely for the niche innovation to integrate into the regime.

Network

According to SNM, the network among actors is a crucial aspect of the diffusion of niche innovation. The network of niche innovations is made up of the actors involved in the innovation. Next to the visions of these actors, the composition of this network plays a role in niche management. A network is strong when it is broad and deep (Schot & Geels, 2008). A broad network means that multiple stakeholders are included and therefore different viewpoints are taken into account and the project will be supported by a larger stakeholder group. A deep network means that the actors can mobilize their resources and have influence in their organizations. As also mentioned by Ma et al. (2019), interest alignment of stakeholders ensures a stronger actor-network. A strong actor-network has a higher chance of realizing the shared goals, that is the local energy system.

Learning activities

As niche innovations are mostly experimental projects, learning activities are key to improving the niche-innovation. Therefore, regular 'learning moments' should be built into the process. Furthermore, there should not only be a focus on first-order learning, facts and data, but also on second-order learning, underlying values (Schot & Geels, 2008). First-order learning focuses on adaptive learning. By gathering facts and data about the ongoing project, the aim is to optimize the current performance of the project within the existing frameworks and routines. Learning processes are focused on improving the current methods. Within second-order learning, the focus is on challenging the existing frameworks and routines, and implementing new ideas to shift the current methods.

Schot and Geels (2008) describe that networks have a tendency to be narrow and focus on first-order learning. By including external stakeholders, and therefore broadening the network, second-order learning gets stimulated. However, both first-order and second-order learning should be implemented in the niche-innovation project to contribute to niche development, and therefore integration into the socio-technical regime.

By focusing on the three core processes of niche innovation, niches have a higher chance of successful implementation. Furthermore, the three core processes provide a framework to analyze the development of niches. As the literature indicated, there is a need to focus on the position of actors in networks and how they collaborate. The network aspects, which describe the position of the stakeholder and their relations in the projects, is one of the key processes to successful niche integration, and therefore the focus of this research. However, as the processes are reinforcing, the other two core processes will need to be taken into account as well.

3.5.3. Multi Actor Network Analysis

To analyze and visualize the network of a project, Gerding et al. (2021) combined the Actor analysis with the Network analysis, creating the Multi-Actor Network analysis framework.

In the actor analysis presented by Enserink et al. (2023), an investigation of all involved actors and their interests is conducted, acknowledging that, more often than not, the interests of these actors differ on certain aspects or, in some cases, are even in conflict. Being aware of this, and gaining an insight into these interests and motivations, provides valuable insights. *"An actor analysis can mobilize knowledge, clarify values, help generate new ideas map areas of potential conflict or mobilize support"* (Enserink et al., 2023). Stakeholders involved with local energy systems have already been discovered in Section 3.4, however, there is a slight difference between a stakeholder and an actor. As described by (Reinders et al., 2018), a stakeholder is an entity (organization or individual) that interacts with the local energy system through an interest or concern. *"An actor is a social entity, a person or an organization, able to act on or exert influence on a decision"* Enserink et al. (2023). A stakeholder is an entity with an interest in the project, whereas the actor actually can act on decisions or has an influence on them. Therefore, an actor is also always a stakeholder, but a stakeholder is not always an actor. For the actor analysis, the list of stakeholders derived by the literature can therefore be used as a starting point, but not all stakeholders will need to be included. For the actor analysis, Enserink et al. (2023) proposed six steps to undertake:

- 1. Formulation of a problem and associated decision arena as a point of departure.

- 2. Identification of the actors involved.
- 3. Mapping the formal institutional playing field: Chart the formal institutions and relations of actors.
- 4. Identifying actor characteristics: Determining the interests, objectives, perceptions and resources of actors.
- 5. Summarizing the interdependencies between actors using overview tables or diagrams.
- 6. Determining the consequences of these findings with regard to the problem formulation.

However, the downside of this actor analysis is that it displays a static representation of the analyzed situation. Therefore, Gerding et al. (2021) proposes to combine the actor analysis with relations, or ties, proposed by Ruijven and et al. (2015) to create a Multi Actor-Network Analysis, see Figure 3.5. This framework is a useful tool in understanding multi-actor environments, as is the case in local energy system projects. The framework helps identify the key actors, the roles, and the influence they have on the project. Furthermore, by incorporating knowledge on local energy systems, the position of key players, their influence, and their role give valuable insight into a project.

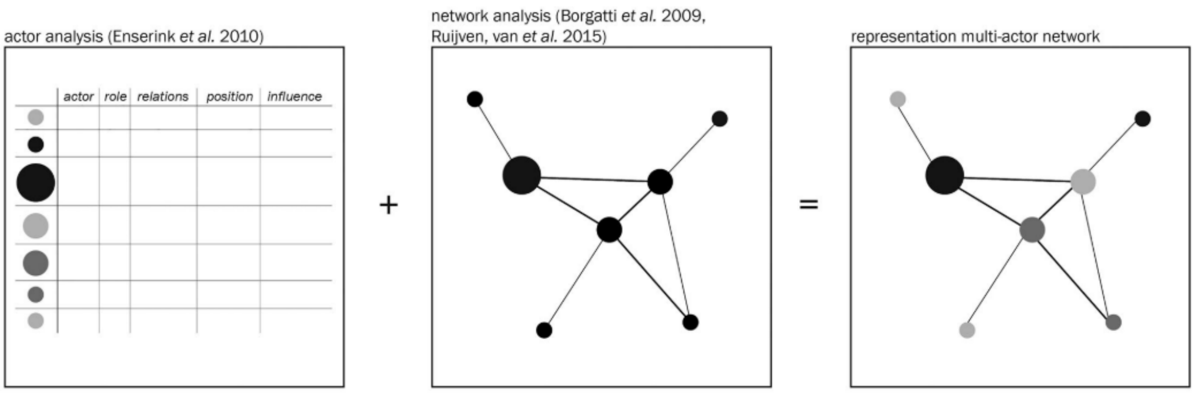

Figure 3.5: Multi-Actor Network Analysis (Gerding et al., 2021)

As made visible in Figure 3.5, the actor network is made up of different aspects; the actor and their role, the relation, the position and the influence. Furthermore, Gerding et al. (2021) has implemented the knowledge of the actor as well in the network, to gain even more insights into the dynamics of the actor network. These aspects will be discussed briefly.

Actors

As described above, an actor differs slightly from a stakeholder. An actor is s a social entity, a person or an organization, able to act on or exert influence on a decision Enserink et al. (2023), and can act on their interests.

Relations

The relations in the actor network visualize a connection between two actors. *”A relation indicates exchange of information or coordination between actors’* (Gerding et al., 2021; Ruijven & et al., 2015). Within the actor network, there are two different types of relations analysed. The formal or informal relation, and the frequency of the relation. A formal relation between two actors indicates that formal documents or procedures have been established between the actors, like a contract. Informal relations display a connection between two actors, without there being a official document to imply the connection. The frequency of the relation days something about how often the actors interacted with each other. A frequent relations implies that the actors interacted with each other weekly or biweekly, whereas infrequent relationships occur less frequently.

Position

The position of the actor in the network indicates the centrality of the actor, and how involved the actor is. The centrality of the actor is determined by *”the number of connections between a node and other nodes”* (Ruijven & et al., 2015). The distance between the actors is insignificant.

Influence

The influence is one of the aspect to measure, as it is not based on precise data. Therefore, they are assumptions based on the case studies. For example: If the actor was mentioned numerous times in the interview, this was interpreted as an actor with a lot of influence. Furthermore, in the interview various actors mentioned several anecdotes indicating the influence of an actor, like: ”because actor x did not want to cooperate, the project came to a pause, as this had to be solved first”. This shows the high influence of actor x. Next to that, in the questionnaire to the companies, the respondents could indicate which actor posses the most knowledge in the project.

Knowledge

The second aspect harder to measure is the knowledge of the actor. Again, this aspect is based on the information of the case studies. In the questionnaire to the companies, the respondents could indicate which actor has the most influence on the project. Within the interviews, different anecdotes gave insight into the knowledge of an actor, like: *”but I am not an expert on local energy systems, for those answers you should ask actor x”*.

In projects like local energy systems where multiple actors from different organizations are involved, an inter-firm network is created de Bondt et al. (1993). This network is made up of actors and their relationships with other actors in the network. The collaboration of actors in an inter-firm multi-actor organization is called a network of actors Heijer and Van Der Voordt (2004). However, the term ’network’ can mean different things in different contexts, especially in the world of energy systems. Therefore in this thesis, we refer to the network made up of actors and their relations as the actor-network.

The construction of the actor network can be seen in Appendix G

3.5.4. The frameworks combined

The MLP framework of Geels (2011) analyses the bigger picture, how the niche-innovation of local energy systems can integrate into the socio-technical regime. The SNM framework supports this theory by connecting three core processes for the niche-innovation to analyze their successful integration into the regime. As the research gap of the literature review focuses on a need to understand actors and their interdependent relations, to gain insight into how these networks work. As a focus on this aspect, the multi actor network of Gerding et al. (2021) will be used to analyze the networks of local energy system project. How these frameworks align with each other, has been made visible in Figure 3.6

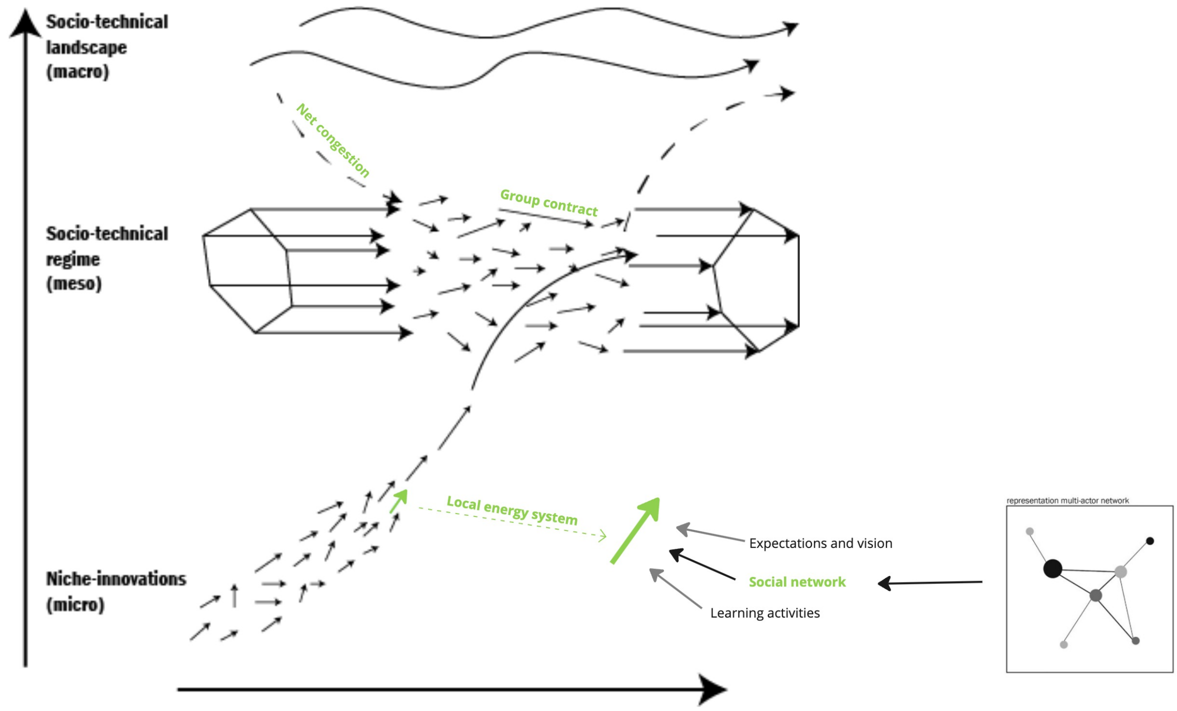

Figure 3.6: Theoretical framework combined, based on Geels (2011), Gerding et al. (2021), and Schot and Geels (2008)

3.6. Collaboration barriers and enablers of stakeholders

As the main barrier to further deployment of local energy systems on business park is the complex stakeholder processes, and this overlaps with one of the core processes for stimulating the niche innovation to settle into the regime, it is valuable to gain a better understanding of the collaboration between these stakeholders. No extensive literature has been found on specifically the collaboration between stakeholders in the context of local energy systems. Most of the literature is focused on the role of the stakeholder and their individual drivers and barriers. This may be attributed to the fact that local energy systems initiatives are still in their experimental stages, and regulatory adjustments are necessary to enable collaborative, multi-actor local energy system projects. However, Papenhuijzen (2024) researched barriers and enablers of stakeholder collaboration in similar contexts, risk-sensitive urban planning (Ganeshu et al., 2023) and urban renewal (L. Li et al., 2022), and tested them in the field of net congestion. Therefore, these discovered drivers and enablers will be used to research stakeholder collaboration for stakeholders on business parks, with a local energy system.

The systematized literature review of Ganeshu et al. (2023), aims to address the lack of comprehensive understanding of stakeholder collaboration issues in risk-sensitive urban planning in a global context. After a careful and transparent selection process, described in the article, 53 articles were selected for in-depth analysis. Barriers to stakeholder collaboration within risk-sensitive urban planning were derived in the literature review, as well as enablers in stakeholder collaboration. In the analysis of L. Li et al. (2022), 10 expert interviews and 295 expert questionnaires were conducted to research the experienced barriers of stakeholder collaboration in the context of urban renewal in China. These two studies form the basis of the research done by Papenhuijzen (2024). The discovered barriers and enablers by Ganeshu et al. (2023) and L. Li et al. (2022) were tested through 4 expert interview and two questionnaire rounds with 80 participants. The questionnaire provided specific stakeholder groups with possible barriers to test if they were experienced by them. This resulted in a revised list of barriers experienced in stakeholder collaboration in the context of net congestion and new urban area development projects.

Because the initial study of L. Li et al. (2022) and Papenhuijzen (2024) did not take enablers of stakeholder collaboration into account, the enablers proposed by Ganeshu et al. (2023) will be used as a starting point to research the enablers in stakeholder collaboration in the context of local energy systems.

In the study of Papenhuijzen (2024), 34 barriers were identified. In the study of Ganeshu et al. (2023) 45 enablers were identified. These barriers and enablers have been classified under 13 themes and 4 categories. The four main categories are:

- External aspects
- Inter-Organizational aspects
- Intra-Organizational aspects
- Personal aspects

Important to note is that these barriers and enablers are from the stakeholder viewpoint, although there exist barriers and enablers on other levels of local energy system projects, like technical or economic barriers and enablers. Because the focus of this thesis is on the collaboration between stakeholders, only the barriers and enablers to stakeholder collaboration are taken into account.

External aspects

Policies and legislation, governance, and politics are the three themes of the category 'external'. For policies and legislation, this includes the lack of policies that promote collaboration, the lack of coherence in government policies and legal instruments, the lack of legislation support and authority to delegate the stakeholder's responsibilities and duties, and the lack of defined financial plans and its implementation in policies due to the lack of funds. This means, there is a need for clear policies and legislation to pave the way for stakeholders in different sectors to come together efficiently. However, with the implementation of the group contract for business parks, these barriers on policies and legislation have lifted a bit. The enablers therefore are focused on introducing and strengthening law and regulations for stakeholder collaboration, providing guidance, and policy development.
For governance, the barriers are the lack of clear responsibilities and therefore overlapping responsibilities of stakeholders, rigid formal governance structures, and a lack of a coordination mechanism in governance arrangements. The current governance structures do not provide clarity for involved stakeholders resulting in vagueness, uncertainty, and sometimes even a project standstill. For the enablers, governance structures towards a more flexible approach without traditional power-based relationship should be promoted. Furthermore a decentralized organizational arrangement with formal and informal ways of collaboration could be implemented.
For politics, four barriers were identified; lack of political support, political interference, competing interests among politicians, and thematically structured political committees. These political barriers result in a non-holistic approach, which negatively impacts stakeholder collaboration. Therefore, the enablers described are bridging different political interests and values, and seeking the support and commitment of dedicated politicians. See Table 3.3 and Table 3.4 for an overview.

Table 3.3: External Barriers (Papenhuijzen, 2024)

External Barriers	
Theme	**Barriers**
Policies and legislation	Absence or lack of policies that promote collaboration
	Lack of coherence in government policies and legal instruments
	Lack of legislation support, legislative authority to delegate stakeholders' responsibilities and duties
	Lack of defined financial plans and implementation roles
Governance	Lack of clear-cut responsibilities and overlapping responsibilities among stakeholders making the system ineffective and less accountable
	Rigid formal governance structures
	Lack of coordination mechanism in governance arrangements
Politics	Lack of political guidance/support/leadership/willpower for planning and implementation
	Political interference
	Competing interests and visions among politicians
	Thematically structured political committees

Table 3.4: External Enablers (Ganeshu et al., 2023)

External Enablers	
Theme	**Barriers**
Policies and legislation	Harmonize and strengthen the laws and policies that can support collaboration
	Introduce policies and legislation to mainstream collaboration
	Ensure policies provide space for setting up informal structures that promote collaboration
	Provide guidance and support that assists policymakers' awareness
	Policy development with stakeholder involvement
	Develop and implement adaptive policy
Governance	Create collaborative governance structures that remove traditional power-based relationships
	Adopt accountable governance mechanisms
	Shift towards flexible and self-organized network governance
	Establish decentralized organizational arrangements linked with the centralized system
	Establish reporting mechanisms and assessments of progress
	Incorporate formal and informal ways of inter-organizational arrangement in collaborative governance
Politics	Bridge different political interests and values
	Secure political will and commitment
	Seek support and approval of dedicated politicians
	Introduce and encourage an apolitical approach

Inter-Organizational aspects

The four themes under this category are; leadership, organizational interests, communication and coordination, and collaboration processes. Within the theme of leadership and organizational interests, the

barriers uncovered are disagreements on which leading organization should take the lead and competing interests and objectives lead to conflicting opinions and priorities, which negatively affect the collaboration. Therefore, establishing a dedicated coordination organization with neutral partners to facilitate the processes acts as an enabler. Next to that, creating a joint vision among organizations will result in synergies and therefore more collaboration.
The barriers to communication and coordination focus on limited coordination and communication among fragmented sectors at different levels, skepticism, jargon, and different official languages. Furthermore, information is asymmetric among stakeholders. As these form the barriers, formal agreements for information sharing to establish regular and transparent information flows will work as enablers. Furthermore, when improving the understanding of information needs, will also enable communication between stakeholders.
The last theme, collaboration processes, identifies barriers such as the involvement of large numbers of stakeholders in complex urban planning as there are a lot of aspects to be thought of in the process, and the lack of trust between these stakeholders. Moreover, the long-term commitment of these stakeholders in such projects and the need to be flexible is what organizations are reluctant to. Therefore, ensuring trust in the relations between stakeholders and selecting appropriate stakeholders will enhance the collaboration. See Table 3.5 and Table 3.6 for an overview.

Table 3.5: Inter-Organizational Barriers (Papenhuijzen, 2024)

Inter-Organizational Barriers	
Theme	**Barriers**
Leadership	Lack of leadership among stakeholders
	Disagreement in the selection of key leading organisations for collaboration
Organizational Interests	Competing interests
	Different sectoral needs, interests, and issues
	Unrecognised common interests
Communication and coordination	Limited coordination and breakdown in communication among many fragmented actors at different levels
	Information is asymmetric among stakeholders
	Lack of information-sharing between stakeholders
	Communication breakdowns due to skepticism, use of jargon, and different official languages
Collaboration process	Involvement of a large number of organisations
	Lack of trust between stakeholders
	Long-term and inelastic collaborative process

Table 3.6: Inter-Organizational Enablers (Ganeshu et al., 2023)

Inter-Organizational Enablers	
Theme	**Barriers**
Leadership	Establish a dedicated coordination organization
	Engage neutral partners to facilitate multi-stakeholder collaboration processes
Organizational Interests	Establish synergies by creating a joint vision among organizations
	Harmonize and strengthen policies and laws that support collaboration
Communication and coordination	Establish formal agreements for information-sharing
	Improve understanding of the information needs and requirements of organizations
	Establish regular and transparent information flows and communication among organizations
Collaboration process	Nurture trust-based relationships
	Select appropriate stakeholders and maintain continuous engagement
	Anticipate and manage conflicts

Intra-Organizational aspects

Organizational structure, culture, and resource capacities form the themes within this category. For structure, the lack of supportive organizational structures which do not prioritize collaboration forms a key barrier, due to the routine of existing roles and responsibilities which do not support collaboration. Therefore, new structures with clear rules and boundaries are necessary to enable collaboration.
This routine is also present in the culture, leading back to the old way of working individually, also described in this paper as silo-based working. As enablers, top management approaches are described, as well as incorporating collaborative tasks with the 'regular' work of stakeholders.
Furthermore, organizational resources are also the cause of barriers to collaboration. This could be financial resources, staff, or even technical capacity to share knowledge on the topic. Therefore, a focus on gaining more resources by either recruiting additional staff with that knowledge or allocating these resources within the organization itself. See Table 3.7 and Table 3.8 for an overview.

Table 3.7: Intra-Organizational Barriers (Papenhuijzen, 2024)

Intra-Organizational Barriers	
Theme	**Barriers**
Organizational structure	Unsupportive organisational structure for collaboration
	Existing roles and responsibilities which do not allow or support collaboration activities
Organizational culture	Traditional silo-based organisational capabilities and thinking
	Following old routine practices
Organizational resource capacity	Lack of financial and human resources
	Inadequate technical capacity to collaborate
	Mitigating the impacts on the livability of the environment during an intervention to reinforce the power grid

Table 3.8: Intra-Organizational Enablers (Ganeshu et al., 2023)

Intra-Organizational Enablers	
Theme	**Barriers**
Organizational structure	Re-organize or set up new structures with clear rules and responsibilities for promoting collaborative working
Organizational culture	Establish collaborative practices as regular routines
	Encourage top management to influence the change in culture
	Incorporate responsibilities for collaborative tasks along with their official job description
Organizational resource capacity	Identify and provide essential technical and financial resources to build organizational capacity for collaboration
	Better financial planning to optimize the available funds to support collaboration requirements
	Recruit additional skilled staff to strengthen collaboration capacity
	Introduce digital technology to improve efficiency
	Allocate funding for building collaboration capacity through policies

Personal aspects

The personal barriers and enablers are more individual-based than organizational-based like the barriers and enablers before. The three themes include intrinsic barriers, profession-related barriers, and knowledge-related barriers. Intrinsic barriers come from the person working on the project, lacking enthusiasm or commitment to the collaborative project. This could also be due to the lack of understanding of the benefits of the collaboration. To enable this individual, incentives could be created. Next to that adressing personal interest or concerns about the collaboration could provide insights in the reluctance of collaboration, and can then be tackled.
The professional-related barriers include conflicting interests and competition, where stakeholders focus more on their own interests creating conflict between the involved actors. Moreover, the collaborative approach could give the feeling of losing power over your own interest, resulting in a hesitant approach to the stakeholder. To counteract these barriers, raising awareness of the positives and negatives of collaborative ventures can reduce hesitancy in collaborative working
Lastly, the gap of knowledge that exists between stakeholders provokes a barrier, this could result in different views on the project and different understandings. To overcome this barrier, knowledge-sharing can be encouraged, and implementing measures to address the gap could enable collaboration. See Table 3.9 and Table 3.10 for an overview.

Table 3.9: Personal Barriers (Papenhuijzen, 2024)

Personal Barriers	
Theme	**Barriers**
Intrinsic barriers	Lack of enthusiasm and commitment to collaborative initiatives
Profession-related barriers	Conflicting interest and competition
	Fear of losing power
Knowledge-related barriers	Lack of knowledge of stakeholders
	Stakeholders’ reluctance for exploratory learning

Table 3.10: Personal Enablers (Ganeshu et al., 2023)

Personal Enablers	
Theme	**Barriers**
Intrinsic barriers	Establish indicators to monitor the progress and ensure participation
	Offer incentives and rewards for their collaborative performance
	Address personal interests and concerns for collaboration
Profession-related barriers	Acknowledge and enable power-sharing, shared responsibility, and accountability towards other stakeholders which are important in multilevel governance
	Raise awareness of the positives and negatives of collaborative ventures to reduce hesitancy in collaborative working
Knowledge-related barriers	Build capacity through knowledge development and training programs
	Encourage knowledge-sharing
	Collaborative knowledge-brokering with the help of an expert
	Implement measures to address the knowledge gap, build trust, clarify uncertainties, and bridge values
	Facilitate knowledge co-production through formal and informal social relationships

The studies identify barriers and enablers to stakeholder collaboration in urban area development projects, within the context of net congestion. The findings of these studies show that the barriers and enablers occur on different levels. Where personal and organizational aspects are at the micro-level, policies, governance, and political aspects are more on the macro-level. The results of the studies show that micro-level aspects (Inter- and Intra-Organizational, and personal aspects) are linked to each other, and are being driven by the macro-level (External aspects) (Ganeshu et al., 2023). Therefore, a focus on both levels is needed to overcome the barriers and enable the collaboration of stakeholders in the context of urban area development with net congestion.

The categorization of the barriers and enablers described by Papenhuijzen (2024) and Ganeshu et al. (2023) will be used as a framework within the case study interviews, to analyse which stakeholder collaboration stimulates or discourage local energy system development and see how they interact with the underlying factors. With this information, the most dominant barriers and enablers to stakeholder collaboration will be made visible, which provides valuable information for future collaboration between stakeholders in the same context. As the barriers and enablers are quite time specific, they will be divided by the following phases: initiation, research and design, and exploitation. These phases are derived from the blueprint for e-hubs by Eigen (2023).

Empirical Research

4 Case Study

This chapter provides an overview and analysis of the case studies used in this research, and the findings derived from the interviews, internal documents and desk research. The findings are structured in line with the theoretical framework described in Figure 2.1. In this chapter, the four case studies will be introduced, providing an understanding of the context of the case study. Following this, the Actor Network will be analyzed providing an insight in the relationship between the actors of the projects, diving into the main core process of Strategic Niche Management as discussed in Figure 2.1. Additionally, the other two core processes will be described, as they are integral to the theoretical framework. Lastly, the barriers and enablers experienced in the project by the interviewed actors will be made visible to gain understanding of the stakeholder collaboration and how this can contribute to further implementation. In the following chapter, the term 'the project' will be used, referring to the local energy system at the specific case study.

4.1. Schiphol Trade Park

Schiphol Trade Park (STP) is known for its first collective and sustainable energy system: a virtual grid. The end-users in the business park share the capacity available, in order to welcome more organizations to the park than possible with a traditional grid connection. The business park resides next to the national airport of the Netherlands, Schiphol, and is therefore a very well-connected location logistically. The business park aims to be the most sustainable and innovative business park in Europe (SADC, n.d.-a). Companies who want to establish at the location, need to comply with sustainable requirements set by SADC (Schiphol Area Development Company), the developer of the business parks around Schiphol. During the development of Schiphol Trade Park, one of the business parks in the Schiphol area, the network operator was unable to offer maximum capacity contracts to companies already in the process of constructing their offices there. While four companies had secured maximum capacity agreements, the remaining 11 companies, already in the midst of office development at the location, faced electricity supply challenges due to grid congestion arising during the development. This meant that the business park now had 11 future buildings, already being built, without any electricity supply. This lead to the situation where the organizations without capacity, started looking for alternatives to power their processes. A feasible option was making use of generators powered by diesel, however this was not in line with the sustainable vision SADC had for the area. Therefore, SADC decided to explore other alternatives. In Chapter 3 is described how most buildings do not use the full capacity they contracted. Furthermore, especially on business parks, electricity demand peaks occur at varying times due to the diverse operational processes. Additionally, many organizations contract a maximum capacity for their facilities while considering future expansion. Consequently, although the business park may appear to have reached its maximum capacity on paper, in practice, a significant portion of electricity consumption remains not utilized. After a study by an external advisor, sharing the maximum capacity of the four companies with all the buildings on the business park, became a feasible option. The signed maximum capacity of the four buildings who did secure it, in combination with solar panels and batteries, are distributed for the whole business park by a virtual net ensuring electricity supply for all buildings. For a back up option, gas generator are also installed, in case the contracted capacity and the batteries cannot supply enough electricity. Since the implementation of the virtual net, the gas generator has remained unused as it has not been required (BNR, 2023) (Interview STP-1).

Figure 4.1: Location of STP

The buildings

The buildings on the business park vary fairly in function. In total, there are 15 companies located on STP. In the north of the park there is a big hotel with 280 rooms. The hotel mainly gets visited by people on business trips, and therefore have their peak energy demand in the early morning, evenings and sometimes weekends. The hotel secured the maximum capacity with the network operator before the cutoff, however by the outlook of not having any business opportunity around them, they decided to share their capacity. This was one a main motivator for organizations with excess capacity to share it with others, thereby making the business park more attractive to more organizations. Next to the hotel, there are multiple logistic buildings. These buildings take up the most amount of square meters on the business park. Next to transportation of goods, they also have a warehouse for the storage of goods. Their processes mainly happen during the day, in the working hours. However, there are processes which require energy after working hours, such as the powering of the docks. Furthermore there are also a few offices, without any heavy industrial processes. They require energy supply during work hours in the day.

The virtual net

To be able to share contracted capacity by the first few buildings for the entire business park, a virtual net was designed. The name 'virtual net' was chosen as the physical net remains unchanged, but a digital layer monitors real time the demand of the buildings, and distributes the unused capacity to the other buildings. In Chapter 3 is described that terms like 'local energy system', 'energy hub' and 'smart grid' are terms that have no single definition, and are being used interchangeably. The description found on the SADC website features both the term 'virtual grid' and the term 'energy hub' (SADC, n.d.-b), indicating that here also there is no single definition for their local energy system.

According to the regional network operator, Schiphol Trade Park only uses a contracted group capacity of 3,6 MW for the whole business park. If each building would have its individual contract capacity, this would come to 12 MW for the whole business park. By making use of solar panels and batteries, and gas generator as a back up, the 15 companies can operate on the capacity of the four initial maximum capacity contracts. The software behind the virtual net controls the demand and supply by monitoring each company. By measuring each organization's demand, valuable insights are gained into controlling energy use and spreading out peak moments, ensuring that the total consumption remains below 3.6 MW. *"Then they see it's those 20 trolleys that we then all put in the loading docks at five o'clock to load, that's where* *the peak comes from. Then we can put timers between those points so that everyone can just drive into the dock, but that one extra one comes on every hour. Then you can spread that loading out over the whole night instead of having a big peak"* (STP-1). The responsibility of the control of the virtual grid lays in the hands of the energy cooperative. The supply, demand and storage in the hands of the companies. This can be seen in Figure 4.2.

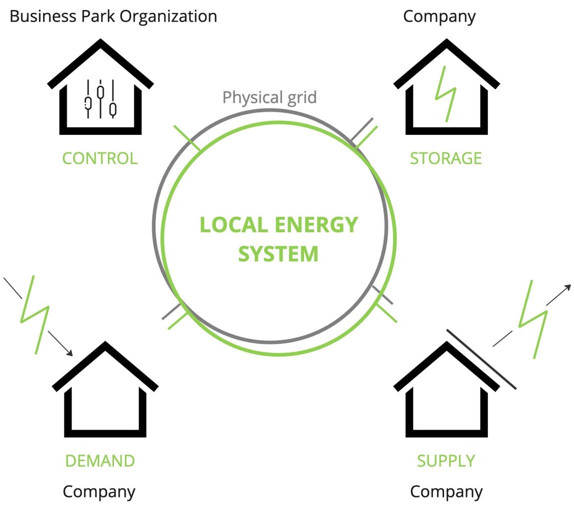

Figure 4.2: Concept LES STP

4.1.1. The Actor Network

The multi-actor network visualized in Figure 4.3 appears chaotic, reflecting the complexity in local energy grid networks. However, this complexity also provides valuable insights into the intricate nature of multi-actor collaborations within these networks. The construction and components of Figure 4.3 are elaborated upon below.

Actors

Indicated on the website of SADC, there is confusion in the actors of the project, and their roles (SADC, n.d.-b). To clear this confusion, they have indicated the four main actors in a document, including a description. According to SADC the four main actors are: SADC, Energy Cooperative Schiphol Trade Park, Liander and Spectral (SADC, n.d.-a). These four actors were also mentioned in the interviews (STP-1,2,4.1,4.1). SADC is the area developer of the business park, and aims to develop and maintain the most sustainable business park of Europe. This is an interesting actor, as their shareholders consist of the municipality of Amsterdam, the municipality of Haarlemmermeer, the province of North Holland, and Schiphol Group (each 25%). This indicated that 100% of the shareholders of SADC are public parties (SADC, n.d.-a), (STP-1, STP-4.2).

Liander is the regional network operator, and although there was not any capacity to give out anymore, Liander did connect the buildings to their cables, making it possible for the virtual net to transfer the unutilized capacity to these buildings (STP-2, STP-4.1). The last main actor described by SADC is Spectral, the software developer of the virtual grid (STP-1, STP-4.1). Spectral in an external actor, designing and maintaining the virtual grid of STP.

The companies at Schiphol Trade Park (STP) are the end users of the local energy system. These companies fall into two groups: those with a maximum capacity agreement with the network operator and those without (STP-4.1). All companies are connected to the virtual net and are part of the energy cooperative Schiphol Trade Park, established to legally unite them and share electricity capacity. The cooperative's board includes delegates from SADC, companies with capacity, and companies without capacity (STP-1). Additionally, a business club was formed to connect all companies informally (Schiphol Trade Park Services, n.d.) (STP-1), organizing meetings and events to foster communication and provide updates on projects like the virtual grid (SADC, n.d.-a).

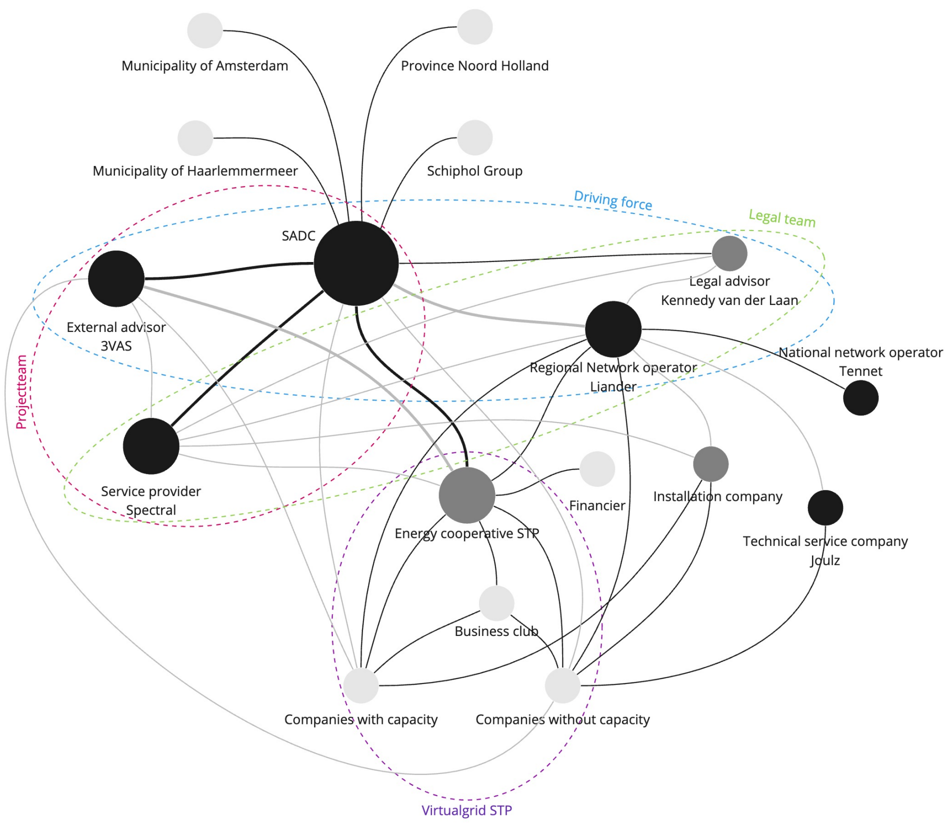

Figure 4.3: Actor Network Schiphol Trade Park

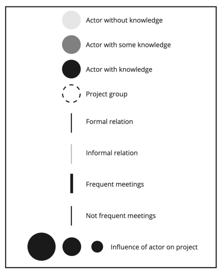

Figure 4.4: Legend actor network

Another external advisor, next to Spectral, is 3VAS (STP-1, STP-4.1). This actor was mainly involved to stimulate the development by motivating the located companies, both with and without a contracted capacity. 3VAS also can be seen as one of the projectleader of this project. *”I see 3VAS a bit the same as our internal team, as project management”* (STP-1).

A legal advisor, Kennedy van der Laan, is involved due to the need for new contract forms, as the project is a pilot and current legislation does not yet accommodate it (see Section 3.3) (STP-2, STP-4.1). Two technical companies are crucial for the physical implementation of the virtual grid, including measuring devices. Companies without capacity had already been working with a technical service company to address congestion issues individually. Another technical company ensures the grid’s implementation for all companies. Additionally, a financier is involved to invest in the virtual solution, and the national grid operator participates indirectly (STP-1, STP-4.2).

In addition to individual actors, certain teams also play roles at Schiphol Trade Park. The companies on the virtual net, both with and without capacity, the energy cooperative and the business club form the team of the local energy system. SADC, 3VAS, and Spectral form the project team for the virtual grid’s development (STP-2, STP-4.1), while Kennedy van der Laan, Liander, and Spectral handle the contractual aspects (STP-4.1). Lastly, SADC, 3VAS, Kennedy van der Laan and Liander were mentioned as a team who were the driving force of the project in the early stages, motivating other actors by showing possibilities. *Kennedy van der Laan, SADC and 3VAS were the triangle that were very powerful in the preliminary exploration phase* (STP-2).

Relations

The relations between actors are indicated by a line. The actor with the strongest relations is SADC, as it has the most bold lines and therefore indicating frequent interactions and formal relations(Interviews STP-2, STP-4.1, STP-4.2 and STP-5). As SADC is the developer of the business park and the initiator of the project, this is as expected. This also shows the role of the energy cooperative. The energy cooperative is mainly set up as a legal entity, than as a collaborative actor, as most collaborations go through SADC. Another noteworthy aspect is the relations between actors and the external advisors/service provider 3VAS and Spectral. Both 3VAS and Spectral are providing a service to the project, and have a formal and frequent relation with the developer, but are also engaged in multiple informal relations with other actors in the network (Interview STP-1, STP-4.1 and STP-4.2). This shows their formal relation with SADC, but also their informal relations with actors to contribute to the project. Furthermore, the shareholders of SADC, which are mostly public entities including both municipalities and the province, are only connected to the project through SADC, but have no other relation with the project. The same principle goes for the national grid operator, who is only indirectly involved by the regional net operator.

Positions

The position of the actors in the actor network indicates the centrality of the actor in the network. This gets determined by the amount of lines connected to a node. SADC is in this network the actor with the most relations connected to it, and therefore making it the central actor. Next to the amount of relations connected to the actor, most of the relations are also formal one, and quite a few meet frequently. Next to SADC there are four other actors which have a relatively high number of connections. These are Liander, energy cooperative STP, Spectral and 3VAS, indicating their central position of the actors in the network. Liander and the energy cooperative are relatively involved in many formal relations, where Spectral and 3VAS are more involved in informal relations.

Influence

The influence of an actor is hard to measure, but is derived through qualitative analysis of interview data and the sentiments expressed by the interviewees. As SADC is the initiator of the project, partly the financier, and allocated most of the risks, SADC has the most influence on the project. Next to SADC, again Liander, energy cooperative, Spectral and 3VAS have the most influence. As the regional network operator, Liander has to set boundaries of what is possible and not when it comes to sharing electricity, and therefore having significant influence on the project. *”The regional network operator had a very solid role in the project, as the major agreements had to be made with them”* (STP-4.2). Furthermore, as the legal entity of the virtual grid, the energy cooperative influences the project’s direction by deciding its continuation. With all companies on STP equally represented, the energy cooperative holds more significant influence than individual companies do. Spectral has influence on the project by designing the virtual grid, and 3VAS by its ability to motivate companies to participate in the virtual grid. *"He understands very well the issues of the grid operator because he comes from there. He can convey the story well, he can bring confidence to all parties who are still a bit hesitant. That's why they joined in"* (STP-2).

Knowledge

The knowledge of the virtual grid mainly lies outside of the actors directly connected to the local energy system. SADC has educated themselves about this topic to come to a solution for STP, and hopefully extend this to the other business parks in development of SADC. *"SADC is the central conscience of the project; they have the overview of everything"* (STP-1). Furthermore, the national and regional network operator posses a lot of knowledge, as they are the developers and operators of the national and regional grids. Next to that, 3VAS and Spectral have knowledge on local energy systems (Interview STP-1 and STP-5). *"And they had brought a company that could just technically tie that together and measure it and monitor it. That was Spectral"* (STP-2) and *"Spectral and 3VAS, of course, they are just 'knowledge eaters' (NL: kennis vreters) and they know everything it comes to meter control systems, software and technical specifications"* (STP1). This does mean that the knowledge lies more in the external actors, than the actors within the virtual grid.

4.1.2. Vision and learning activities

Vision

Almost every actor interviewed stated that although net congestion might be the reason why the virtual net was implemented at STP, the business park will operate a local energy system even without net congestion (Interview STP-1, STP-2, STP-4.2 and questionnaire STP-5), and share the vision of making the virtual grid even more efficient. This indicates the robustness of the vision. The specificity lacks a bit in this project, as not every actor indicates exactly knowing which steps to take to achieve the shared vision. *"Our whole system needs to look different, and STP can serve as an example of that, but it probably won't be the same"* (Interview STP-2). This indicates that the steps needed to be taken are not clear yet, and need more research to become specific (Interview STP-1 and questionnaire STP-5). The quality of the project thus far scores high, as the expectations of the actors for the project have supported the outcomes, and maybe even exceeded them. The implementation of the gas generators as back up was needed to take away the risk that the buildings would have too little electricity at certain times. However, the gas generator has remained unused, as the capacity provided by the network operator, in combination with the battery, has consistently met the energy demands of the companies (Interview STP-1 and STP-4.2). This has increased the trust of not only the companies, but also other actors in the project.

The vision of STP is aligned among actors and therefore contributes to the success of the project. The robustness and quality of the vision score high, while the specificity of the project could be improved to achieve an even clearer vision.

Learning activities

During the business park's development phase, when the network operator stopped allocating capacity to companies, those without capacity began exploring solutions within the existing framework, such as integrating gas generators as energy suppliers (STP-4.2). This can be seen as a learning process within first-order learning. The companies as an individual, which can be seen as the narrow network, collected the available facts and data to come to a solution. However, by including external actors such as Spectral and 3VAS through SADC (STP-1. STP-2), innovation and new boundaries were researched and implemented, creating a more optimal solution for all stakeholders. By integrating these external stakeholders, and therefore implementing second-order learning, the project contribute to the further development of the niche-innovation.

Because at Schiphol Trade Park, the project needed to be implemented quite suddenly, to prevent the installation of gas generators, no specific learning moments were implemented in the process. *"It was mainly learning by doing"* (Interview STP-4.2). *The project was a pressure cooker because it all had to be done quickly to avoid installing gas generators, and thus little to no learning moments were built into the process* (Interview STP-4.1). Interviewee STP-2 also mentions that the knowledge acquired for this project isn't documented or applied to other processes explicitly. Instead, it is primarily retained and reused in other projects through the collective expertise of the employees involved. However, since Schiphol Trade Park was one of the first business parks to share their electricity among more buildings on the location, other interested organizations visit Schiphol Trade Park to gain insights from their project, and therefore the knowledge is transferred nowadays (Interview STP-1). Furthermore, for knowledge sharing within their own network, the business club organizes meetings and workshops for the companies to share the knowledge gained in the project (Interview STP-5).

4.1.3. Barriers and enablers in stakeholder collaboration

The enablers and barriers in the development and exploitation of the local energy system on Schiphol Trade Park have been divided in the three phases: initiation, research and design and exploitation, as actors have different responsibilities and motivations in these phases. Dividing these phases gives more insights into the understanding of the stakeholders collaboration.

Initiation

In the initiation phase of the virtual grid, a lot of enablers towards the developer of STP were mentioned by the interviewees, however a lot of barriers were discussed in regard to the energy cooperation. This demarcation is made visible in Figure 4.5. This shows that actors are willing to work with the developer of the local energy system (SADC), but are not yet organized in a appropriate manner to do so, or have their processes organized to facilitate this. Furthermore, we see that the companies with contracted capacity, also experienced a lack of collaboration in the initiation phase. This is due to the fact that at first, they did not have a problem. The sentiment of the companies with capacity is described by interviewee STP-4.2: *"Why should I help my neighbor, who is my biggest competitor*", and *"One of the main question in the starting phase of the companies with a contracted capacity was: if I would share my capacity, will there be enough for me left?"* (Interview STP-1).

Table 4.1: Barriers in initiation phase STP

Code	Barrier
A1	Absence or lack of policies that promote collaboration
E2	Different needs, interests, and issues
E3	Unrecognized common interests
I2	Following old routine practices
M2	Stakeholders' reluctance to exploratory learning

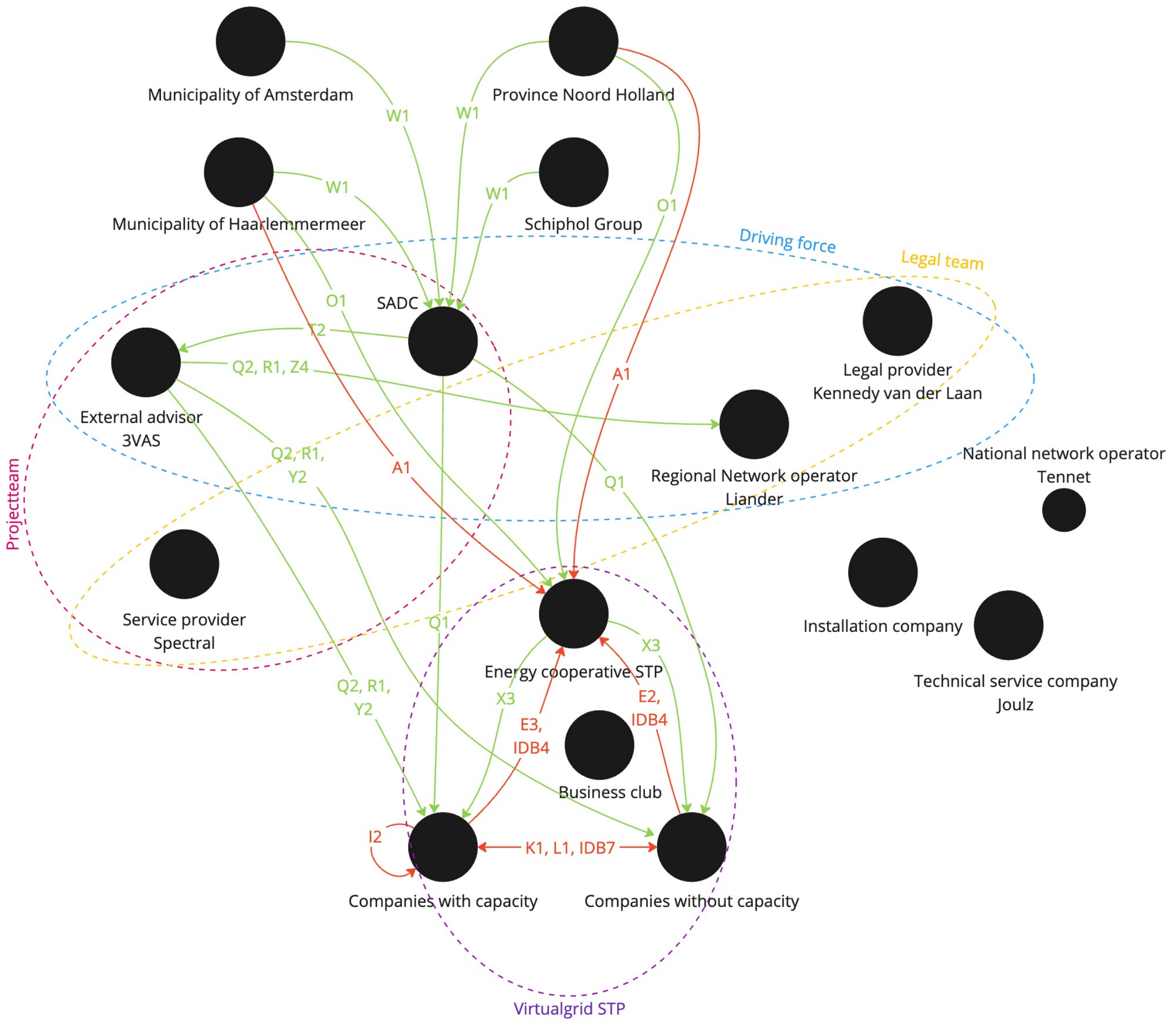

Figure 4.5: Barriers and enablers STP initation phase

Research and design

During the research and design phase, a lot of the barriers arisen from the companies have been tackled. This is mainly due to the enablers coming from 3VAS, motivating the companies to participate in the project. *"He can convey the story well, he can bring confidence to all parties who are still a little nervous"* (STP-2). This even resulted in that the companies with capacity were the first ones to join the energy cooperative (STP-1). Therefore, the companies decided to unite in a legal entity, the energy cooperative and made it

Table 4.2: Enablers in initiation phase STP

Code	Enabler
Q1	Establish a dedicated coordination organization
Q2	Engage partners to facilitate multi-stakeholder collaboration processes
R1	Establish synergies by creating a joint vision among organizations
T2	Select appropriate stakeholders and maintain continuous engagement
W1	Identify and provide essential technical and financial resources to build organizational capacity for collaboration

possible for the project to continue. Next to the enablers from 3VAS to the companies, more enablers from 3VAS to other actors can be witnessed. The barriers from the municipality and province, with an absence of policies that promote collaboration, and the reluctance of the financier to exploratory learning remain. *"The financier does not have the documentation. What are you actually going to do with a cooperative, and power, and capabilities. And what does the funding guarantee look like?"* (Interview STP4.2). For the financier this was also a new project, but was reluctant to find new ways of working.

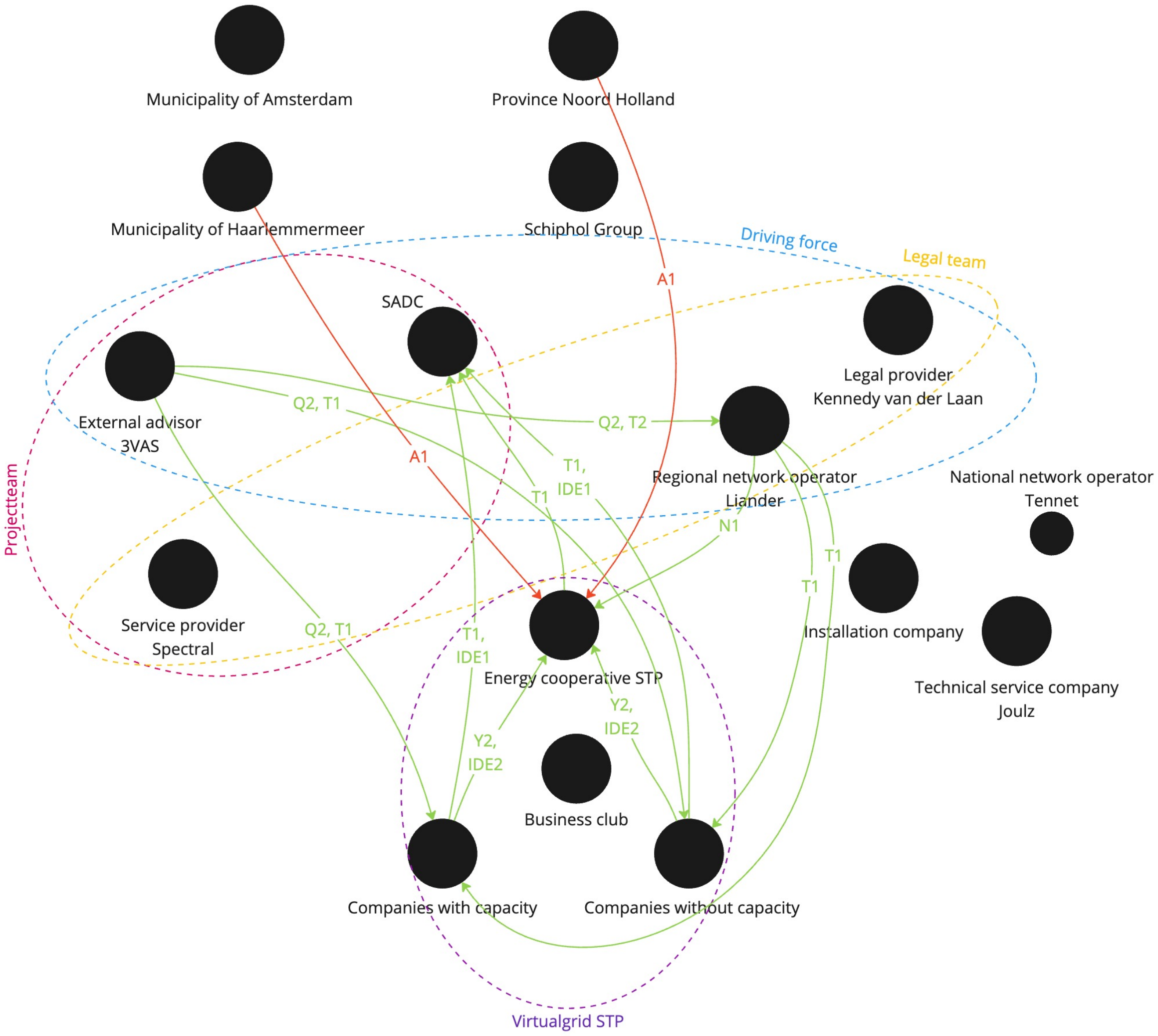

Figure 4.6: Barriers and enablers STP research and design phase

Table 4.3: Barriers in research and design phase STP

Code	Barrier
A1	Absence or lack of policies that promote collaboration
M2	Stakeholders' reluctance to exploratory learning

Table 4.4: Enablers in research and design phase STP

Code	Enabler
Q1	Establish a dedicated coordination organization
Q2	Engage partners to facilitate multi-stakeholder collaboration processes
S2	Improve understanding of the information needs and requirements of organizations
T1	Nurture trust-based relationships
T2	Select appropriate stakeholders and maintain continuous engagement
W1	Identify and provide essential technical and financial resources to build organizational capacity for collaboration
Y1	Acknowledge and enable power-sharing, shared responsibility, and accountability towards other stakeholders which are important in multilevel governance
Y2	Raise awareness of the positives and negatives of collaborative ventures to reduce hesitancy in collaborative working

Exploitation

For the exploitation phase, most barriers have been resolved, and a few enablers have been formed. The implementation of the business club plays an important role in engaging companies, ensuring their active involvement, and fostering their contributions to the energy cooperative. Additionally, the business club facilitates informal communication between the cooperative and the companies. The enablers introduced by 3VAS remain influential, as they continue to engage with companies and the regional network operator, ensuring ongoing support for the project and facilitating its continuous improvement. The barriers formed by the national grid operator do not influence the local energy system of STP directly, but have been mentioned as a barrier to local energy systems as a whole and therefore indirectly for STP. The national network operator has announced that the peak occurring at a regional level are not in line with the peaks occurring at a national level, and therefore local energy systems operating on the free space left in the contracted capacity can cause difficulties at the national grid.

Table 4.5: Barriers in exploitation phase STP

Code	Barrier
E2	Different needs, interests, and issues

Table 4.6: Enablers in exploitation phase STP

Code	Enabler
Q2	Engage partners to facilitate multi-stakeholder collaboration processes
T1	Nurture trust-based relationships

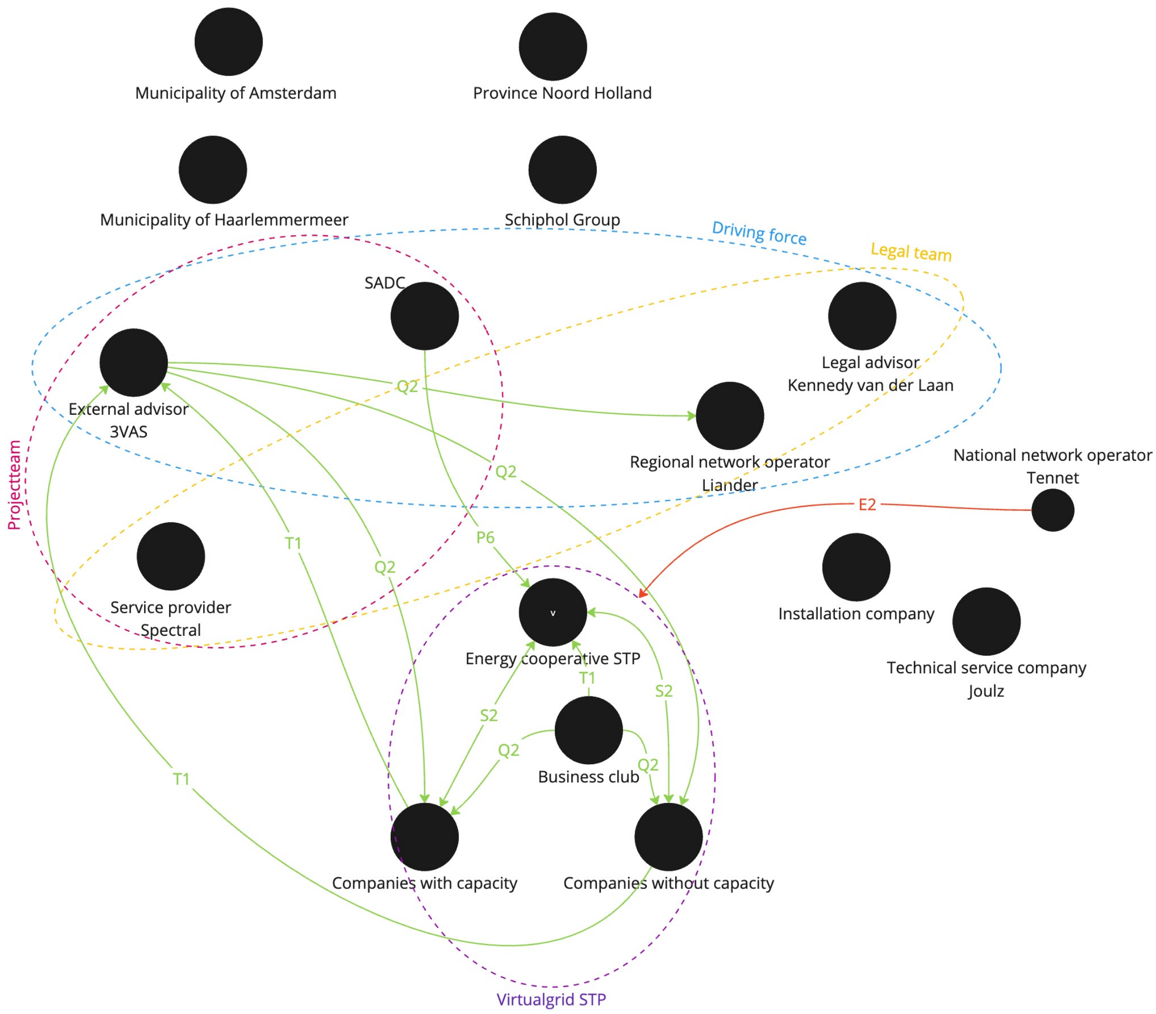

Figure 4.7: Barriers and enablers STP exploitation phase

Lastly, the barrier 'Involvement of a large number of organizations' was mentioned by several interviewees (STP-2, STP-4.1) as a more general barrier to the whole project, not being attributed to a single actor.

4.1.4. Findings

Within the actor network of Schiphol Trade Park, one clear key actor has been discovered. This actor, SADC, is part of a the project team and driving force, but also holds formal and frequent relations with the actors in the other teams. Furthermore, SADC has a central position, posses a lot of knowledge and has high influence on the project. Another notable aspect of the actor network is that the actors with knowledge are involved in multiple teams and hold strong relations with actors of other teams. This indicates that there is a lot over overlap between the actors. Next to that, the end-users of the project, the companies, do not posses a lot of knowledge or influence, but do have a relatively central position in the actor network due to its many relations with other actors.

The vision of the actors of Schiphol Trade Park is robust and qualitative, but can improve of its specificity, as the steps further are not clear for every actor. The learning activities are lacking in the project, as there was a time pressure to develop the local energy system as quickly as possible. Therefore, no specific learning activities were build into the process. Interestingly, the project did give a practical insight into the theory of Geels (2011), showing the companies were looking for a solution within the existing frameworks (first-order learning), but with the involvement of an external advisor, new frameworks were researched (second-order learning). The project took off, and had a focus on the second-order learning. However, as there were no actual learning moments build in to the process, first-order learning was less prevalent.

The barriers and enablers between the actors were mostly present in the initiation and research and design phase. Interestingly, there were almost no barriers in the exploitation phase, and a few enablers. This shows something about the successful implementation, as actors experience no barriers in the project anymore. The barriers in the initiation phase are mainly from the companies, and public parties. In the research and design phase, the barriers from the companies have been resolved, mainly by the efforts of the external advisor by establishing a synergy and creating a joint vision among actors. The barriers of the public parties are still prevalent however, as there is an absence or lack of policy that promotes collaboration. Noticeably, there is also no collaboration or relation between the public bodies and the local energy system of STP. There are only involved as stakeholders. Derived from the interviews, this relation is only formally, and the public parties are no much involved with the projects of SADC. This could explain the experienced barrier, and why it has remained after initiation. On the other side, the barriers first experienced by the companies in the initiation, have transformed to enablers in the exploitation. The business club has a positive effect on the collaboration, as stimulates the collaboration between the companies and builds on the trust in the energy cooperative. Finally, two barriers occurred, the first barrier involved the financier's uncertainty about how to secure their investment, as their knowledge on the project was missing, or did not fit in the existing frameworks of the actor. The second barrier referred to the national network operator's distinct needs compared to those of the energy hub or the regional network operator, given that congestion occurrences based on peak demand or supply do not align simultaneously in the national and regional grids.

4.2. Hessenpoort

The business park is located in a central position of the Netherlands, near Zwolle. From early on, Hessenpoort had the ambition to make their business park more sustainable. However, during the transition phase, challenges arose as the feed-in option of the grid became congested due to the development of solar panels and other sustainable initiatives. Consequently, further progress toward sustainability had to be put on hold. In response, inspired by the example set by Schiphol Trade Park, the idea emerged to optimize energy usage on the business park. Notably, the large production halls feature extensive solar panel installations, resulting in energy production exceeding the buildings' demand at times. In this situation, moments occur where the surplus energy generated sustainably cannot be utilized effectively due to feed-in net congestion. Ideally, this excess energy could benefit neighboring companies on the business park, contributing to their energy needs and furthering sustainability goals. However, as it is not possible to transport this surplus energy to the grid, it remains unused and potentially wasted. Therefore, solutions to optimize the energy usage and supply on the business park were looked into. In fact, the municipality was the actor who initiated a feasibility study for the business park, showcasing the possibilities of the buildings. After this, the business park organization (ondernemersvereniging) together with the external advisors and the province, implemented the local energy system. This local energy system is much like the virtual net of Schiphol Trade Park, a virtual data layer above the physical net, to allocate the capacity among the buildings. At Hessenpoort, they refer to the local energy system as an 'Energy Hub'.

Figure 4.8: Location of HES

The buildings

In April 2024, only three buildings are connected to the local energy system of Hessenpoort; Euroma (a spice producer), Transferro (hardware purchasing company) and Carema (distributor for mobile hardware and label printing solutions). Euroma and Transferro have a big production/logistics hall, and Carema is a smaller office buildings. Because of the successful implementation of the pilot project in this first stage, the aim is to connect 50 more buildings to the local energy system (HES-1). The distribution centre of Wehkamp, a large online retailer, is also located on the business park, with a hall around 8 times as big as the one from Euroma. Furthermore, there are more distribution centres and office like buildings on the business park, all with the assumption of a main energy demand during the day. The majority of buildings are have extensive amounts of solar panels on their roofs, generating electricity throughout the day. Effectively managing the input and output of the energy would alleviate pressure on the regional grid and offer Hessenpoort opportunities to further advance its sustainable initiatives.

All the companies combined can produce up to 400 MW, but due to grid congestion on the feed-in scenario, they can only deliver 90 MW back to the grid. To prevent the sustainably produced electricity from going to waste, it is now used locally within the local energy system. This allows companies to utilize their own produced electricity and reduce their demand from the grid, while. This happens because of monitoring the demand and supply constantly, and anticipating on that data. At Hessenpoort, solar panels are owned by individual companies, while the battery is owned by the business park organization. Companies can lease a battery from the business park organization, minimizing their risks by not investing themselves. This can be seen in Figure 4.9.

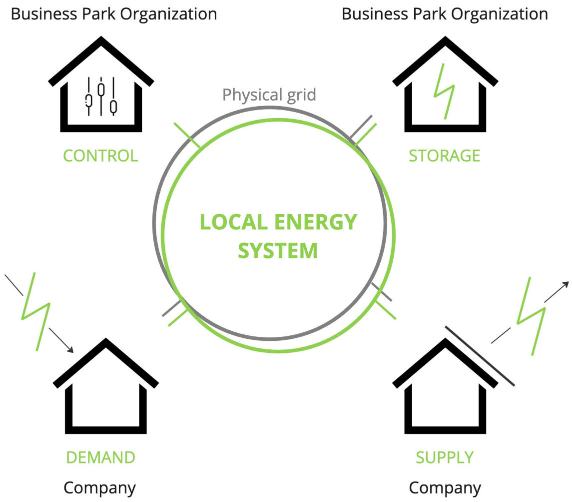

Figure 4.9: Concept LES HES

4.2.1. The Actor Network

The multi-actor network observed in Hessenpoort, see Figure 4.10, appears to exhibit slightly less chaos in comparison to that of STP. This difference may stem from the fact that the development of the network at STP occurred relatively abruptly, whereas at Hessenpoort, it was a more deliberate and conscious decision-making process. In the actor network, two actors stand out immediately; the business park organization the regional network operator. Both have a central position in the network due to their relations with other actors, and have the most influence on the project. Furthermore, they posses medium to high knowledge of the local energy grid.

Actors

As mentioned in the introduction of Hessenpoort, only three companies are currently (april 2024) connected to the energy hub. These companies are united in the energy cooperative, a legal entity created for the deployment of the energy hub. Next to the energy cooperative, there is also a business park organization. This organization is for the whole business park of Hessenpoort, so including the not connected companies (HES-1).

The municipality was one of the initiators of the energy hub, and is still involved in the exploitation and further development of the energy hub (HES-1, HES-2). Furthermore, the province is also greatly involved, and even part of two teams ensuring the development of the energy hub (HES-1, HES-3). The waterboard is also involved in the project, but only minimally. The regional network operator also plays a role in this project, as the energy hub is a pilot project of the regional network operator. These four actors are all public bodies, and form the 'steeringgroup' (regiegroep) (HES-3), regulating the innovation from a public point of view.

Three external advisor actors who are involved in the Schiphol Trade Park project are also engaged in Hessenpoort. As previously noted, Hessenpoort has taken STP as an exemplary project, which is why these actors are involved in a similar way (HES-4.1). These three are 3VAS as an external project manager, Spectral as a service provider for designing and exploiting the local energy system and legal

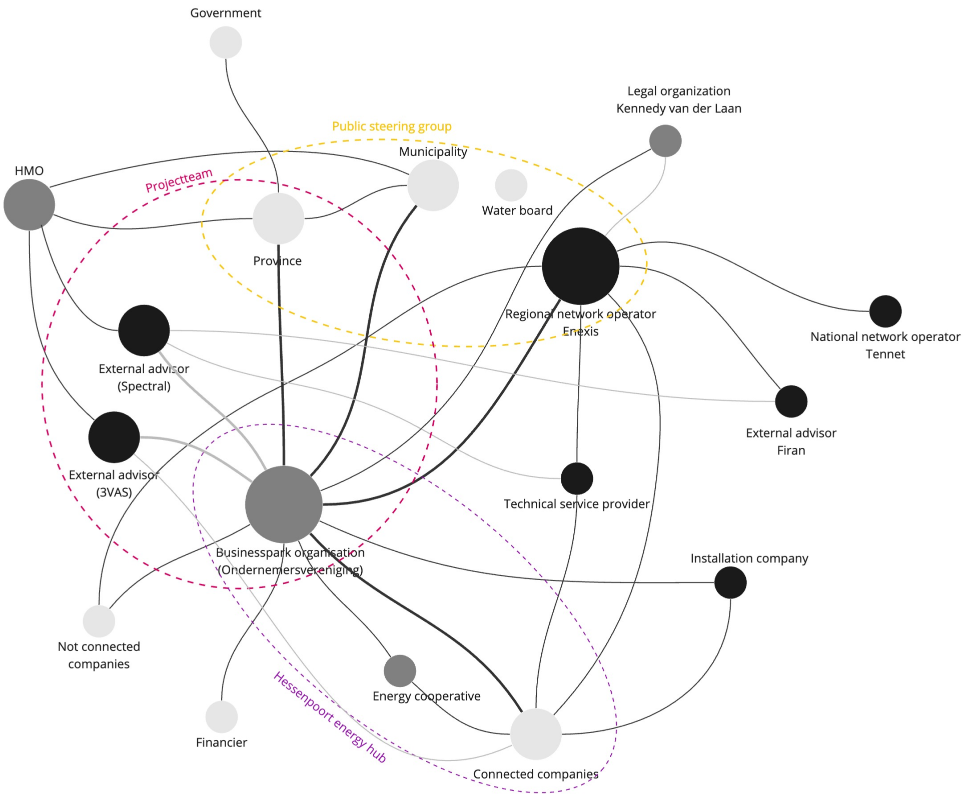

Figure 4.10: Actor Network Hessenpoort

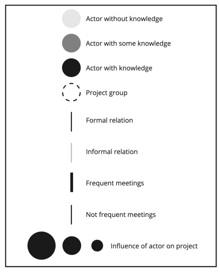

Figure 4.11: Legend actor network

advisor Kennedy van der Laan, for the new contractual arrangements. The projectteam working closely on the project consist of the business park organization, 3VAS, Spectral and the province (HES-1, HES-4.1). Another external advisor is involved in the project, Firan. They are mainly involved for the regional network operator to advise on the project, and therefore not as closely related to the project as the other external advisors (HES-1).

The last actors are HMO, a governmental party supporting the project mainly financially, the government by regulations, and Tennet as the national network operator. Lastly, a financier for project investors and technical service providers and installation companies are involved, for the physical and technical adjustment to the connections of the companies. Most actors are represented in a 'team', while others have a more external and distance relation to the energy hub.

Relations

The only formal and frequent relation are between the business park organization and other actors. The business park has frequent and formal connections with the province, the municipality, the regional network provider and the connected companies. All other actors have less frequent or informal relations. Due to the overlap in all teams and the establishment of formal and frequent relations among the actors within these teams, a significant level of close collaboration between them is noticeable. Furthermore the relations also display the role of the energy cooperative in comparison to the business park organization. *"We created a separate energy cooperative, because of course we can't force everybody to join that service platform, I hope of course, but I can't force everybody to join there. So we had to make that a separate entity"* (HES-1). Other than the formal relation between the energy cooperative and the connected companies, and the energy cooperative and the business park organization, no other actor has a relation with the energy cooperative. All relations are either with the companies itself, or the business park organization.

The relation between the external advisors and the business park organization are not formal, and are only informally connected. This is because there is no actor who can take on the risks of the project. Therefore, the external advisors are financed by the HMO, but collaborate with the business park organization.

According to interviewee HES-1, this informal relation is also where the power lies sometimes: *”External advisors tend to bring everything very formal, whereas the strength lies in the informal”*.

Positions

The centre position in this network is taken by the business park organization, as it undergoes the most relations with the other actors. Next to that, the connected companies and the regional network operator also immerse in quite a few relations, giving some centrality to those actors. *”The regional network operator takes a strong position in the collaboration, partly because there are really interested in the project”* (HES-4.1) and *”During meeting on the division of electricity, the connected companies also take part to stay closely involved”* (HES-5).

Furthermore, the municipality, province and external advisors 3VAS and Spectral also have quite a central position. Especially the municipality and province have quite a few relations in this case study, and therefore take a more central position in this case study.

Influence

The actors with the most influence are in line with the actors with a central position. It could be argued that this centrality, and its influence are interconnected. In this case, the business park organization and the regional network operator have the most influence on the project. This also shows the involvement of the regional network operator. As it is their first pilot project for a local energy system, they want to be involved and have influence on the project (HES-2).

Furthermore, the influence the companies have is noticeable. They have more influence then the energy cooperative. This is because in this case, the energy cooperative is only a legal entity. The three connected companies all have a place in the business park organization, and therefore more influence on the project. Next to that, because of the close involvement of the municipality and province, their influence is relatively high as well (HES-1, HES-5).

Knowledge

Noticeable is that the knowledge mainly lies with external parties to the local energy system. The external advisors, the national and regional network operator, and the installation company all posses the most knowledge. Remarkably, only half of these actors have a direct relation with the business park organization. The knowledge of the projects therefore mainly lies away from the project, than it is directly in involved. Furthermore, the municipality and the province have little to no knowledge, but are the initiators of the project and collaborate closely with the business park organization.

4.2.2. Vision and learning activities

Vision

The vision for the local energy system on Hessenpoort can be seen on three different levels; 1) Societal goal for further sustainability transition (interview HES-2, HES-3), 2) Attractive business environment (interview HES-2, HES-3), and 3) Companies want to grow further but can’t due to grid congestion (interview HES-2, HES-5). This also indicated that the vision or driver for actors differs slightly. The business park organization want to mainly expand their local energy system, by connecting more companies but also adding more assets like batteries or an electrolyzer. Furthermore they want to deploy their system for not only electricity, but also other energy mediums. This vision of including other energy mediums is shared by the municipality. The companies are content with the local energy system now, but are mainly focuses in keeping their processes going then in investing in the energy system of the whole business park (interview HES-2, HES-5). This information indicated that there is no one shared vision for the actors involved, meaning that the vision lacks robustness.

For the specificity, the next steps to take are quite clear. The business organization, regional network operator, external advisors and some companies have frequent meetings already to discuss the next steps for the local energy system. The municipality is also involved in these next steps, but less regularly. Also, there is a clear pathway of becoming more financial independent. *”this is really the tipping point year to start doing it independently. So we really have a whole membership agreement ready and we’re going to hook companies up, we’re going to charge them a development fee to connect to that platform, but also just to cover our hours”* (Interview HES-1).

As Hessenpoort started on a smaller scale, with three companies connected in the first pilot, there was a focus on the quality of the project. If the expectations matched the experiment, the project could expand and convince the other companies to joint the project as well. The experiment has met the expectations, as now there is a waiting list of 50-60 companies willing to join the local energy system (Interview HES-1).

Learning activities

As Hessenpoort got inspired by Schiphol Trade Park, and two external advisors were both involved in the projects, Hessenpoort had the opportunity to learn first-hand from Schiphol Trade Park. However, there were still a lot of uncertainties in this project as well. After every phase, a evaluation moment was planned with every key stakeholder, to discuss the progress of the project (HES-4.1). This can be seen as first-order learning, as the existing framework gets evaluated by the existing information.

For the regional network operator however, this was the first time participating in such a project. As they see potential in this new innovative solution, the regional network operator has build in clear evaluation moments with a go/no go gate (HES-2, HES-3). By involving the regional network operator so closely in the project, the social network as more potential to become broader. This can be seen by the actors connected to the project via the regional network operator, who posses a lot of knowledge (HES-1). This stimulates the second-order learning.

4.2.3. Barriers and enablers in stakeholder collaboration

Initiation

A noticeable barrier that has been shared among multiple actors is the communication breakdowns due to the use of jargon. This barriers arose between the municipality, the regional network operator, the connected companies and the business park organization. This created a lot of delay in the project as agreements were not fully understood by the actors: *"Certainly now we have had a number of contract talks for our first phase of Hessenpoort and then it's pretty hard on paper what our terms are and then all at once everyone is shocked, oh what is that? Yes I've been saying that for a year. Every time but you guys haven't understood it either when I say there's a hard limit somewhere then you switch off. That means that we're actually going to turn off say somebody. Oh yes, we thought that switching off means that you're going to gently ask us if you would please cut back."* (HES-2). Furthermore, the unrecognized interest and different needs also created a barrier from the companies to the energy hub. On the other side, a lot of enablers were witnessed coming from the public steering group to the business park organization, as well as from the later on connected companies.

Table 4.7: Barriers in initiation phase Hessenpoort

Code	Barrier
E2	Different needs, interests, and issues
E3	Unrecognized common interests
F1	Limited coordination and breakdown in communication among many fragmented actors at different levels
F3	Communication breakdowns due to skepticism, use of jargon, and different official languages
G2	Lack of trust between stakeholders
J1	Lack of financial and human resources
M1	Lack of knowledge of stakeholders

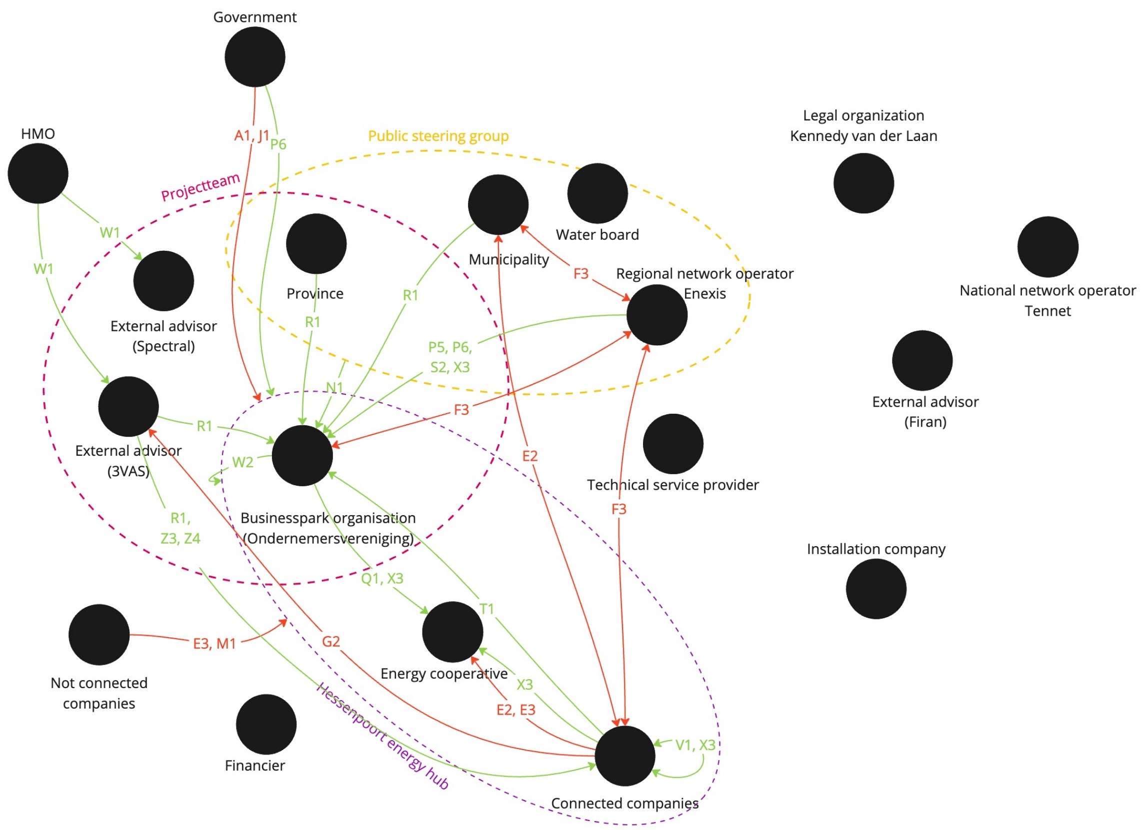

Figure 4.12: Barriers and enablers initiation phase Hessenpoort

Research and Design

Many barriers to the energy hub have been dissolved, however the barrier caused by jargon still exists between municipality, the regional network operator and the connected companies. Furthermore, the different needs and unrecognized common interest of the companies still forms a barrier to the energy cooperative. Lastly, the financier lacks knowledge of a energy hub to be able to easily invest in it. *"Investors do not have a product that can properly assess the risks of an energy hub"* (Interview HES-2).

Table 4.8: Enablers in initiation phase Hessenpoort

Code	Enabler
P1 P6	Create collaborative governance structures that remove traditional power-based relationships Incorporate formal and informal ways of inter-organizational arrangement in collaborative governance
Q1	Establish a dedicated coordination organization
S2	Improve understanding of the information needs and requirements of organizations
T1	Nurture trust-based relationships
T2	Select appropriate stakeholders and maintain continuous engagement
V1	Establish collaborative practices as regular routines
W1	Identify and provide essential technical and financial resources to build organizational capacity for collaboration
X3	Address personal interests and concerns for collaboration
Y1	Acknowledge and enable power-sharing, shared responsibility, and accountability towards other stakeholders which are important in multilevel governance
Y2	Raise awareness of the positives and negatives of collaborative ventures to reduce hesitancy in collaborative working
Z1	Build capacity through knowledge development and training programs
Z3	Collaborative knowledge-brokering with the help of an expert
Z4	Implement measures to address the knowledge gap, build trust, clarify uncertainties, and bridge values
Z5	Facilitate knowledge co-production through formal and informal social relationships

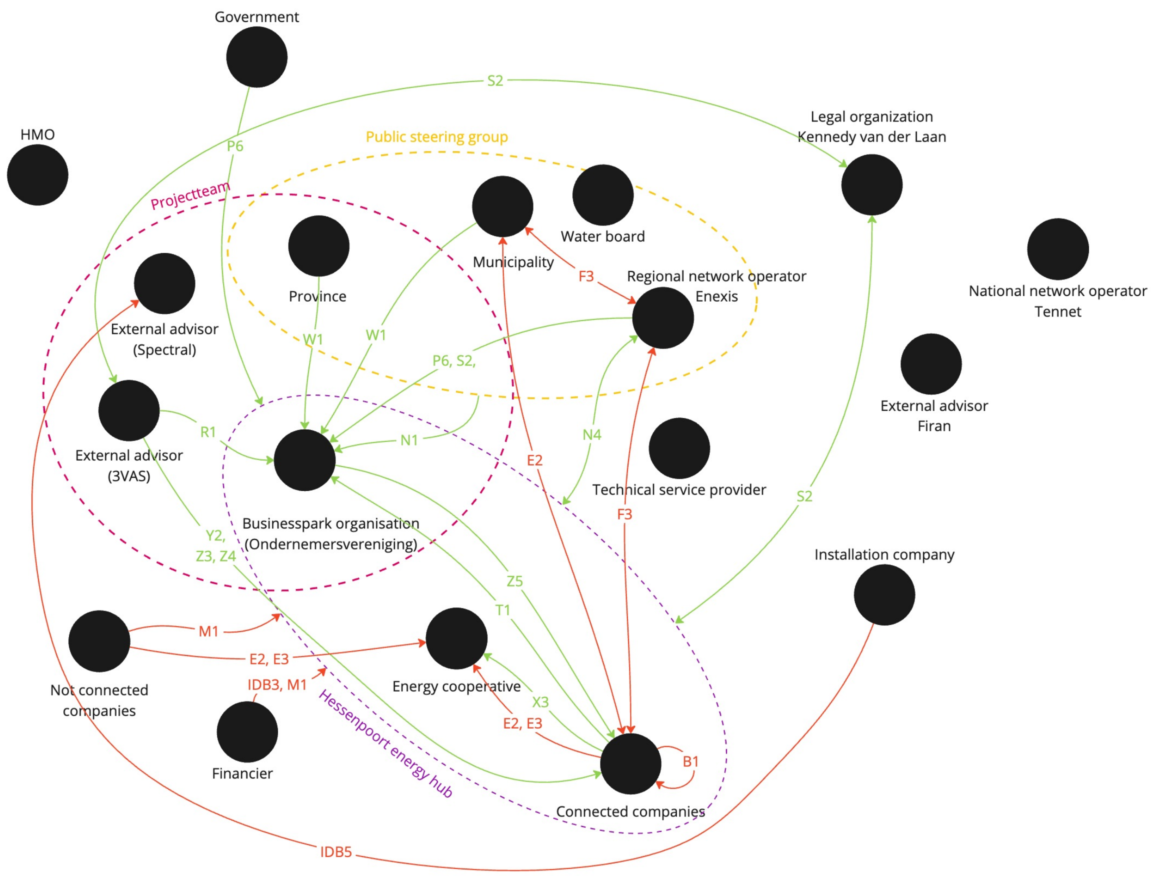

Figure 4.13: Barriers and enablers research and design phase Hessenpoort

Table 4.9: Barriers in research and design phase Hessenpoort

Code	Barrier
E2	Different needs, interests, and issues
E3	Unrecognized common interests
F3	Communication breakdowns due to skepticism, use of jargon, and different official languages
I2	Following old routine practices
M1	Lack of knowledge of stakeholders

Table 4.10: Enablers in research and design phase Hessenpoort

Code	Enabler
P1	Create collaborative governance structures that remove traditional power-based relationships
P6	Incorporate formal and informal ways of inter-organizational arrangement in collaborative governance
Q1	Establish a dedicated coordination organization
S2	Improve understanding of the information needs and requirements of organizations
T1	Nurture trust-based relationships
T2	Select appropriate stakeholders and maintain continuous engagement
W1	Identify and provide essential technical and financial resources to build organizational capacity for collaboration
X3	Address personal interests and concerns for collaboration
Z1	Build capacity through knowledge development and training programs
Z3	Collaborative knowledge-brokering with the help of an expert
Z5	Facilitate knowledge co-production through formal and informal social relationships

Exploitation

In the exploitation phase of the project, most barriers have been solved. However, not understanding each other fully due to jargon still remains a challenge. On the other hand, trust is being gained by some actors due to the collaboration. *"You need familiar faces doing some preliminary work so they can easily connect others later. A business association can be just that"* (HES-1). 3VAS and the connected companies, as well as the business organization enable each other by building trust. The regional network operator again shows it eager involvement by the many enablers it has to the business organization. The national network operator presents a barrier to the overall development of local energy systems. The discrepancy arises because congestion on the regional grid does not align with congestion on the national grid. Therefore, the implementation of local energy systems is not feasible everywhere, and standardization is currently not possible. This situation leads to demotivation among the involved actors (Interview HES-4.2).

Table 4.11: Barriers in exploitation phase Hessenpoort

Code	Barrier
E1	Competing interests
E2	Different needs, interests, and issues
F2	Lack of information-sharing between stakeholders
F4	Lack of knowledge-sharing
M1	Lack of knowledge of stakeholders

Table 4.12: Enablers in exploitation phase Hessenpoort

Code	Enabler
P1	Create collaborative governance structures that remove traditional power-based relationships
S2	Improve understanding of the information needs and requirements of organizations
T1	Nurture trust-based relationships
Z1	Build capacity through knowledge development and training programs
Z2	Encourage knowledge-sharing
Z5	Facilitate knowledge co-production through formal and informal social relationships

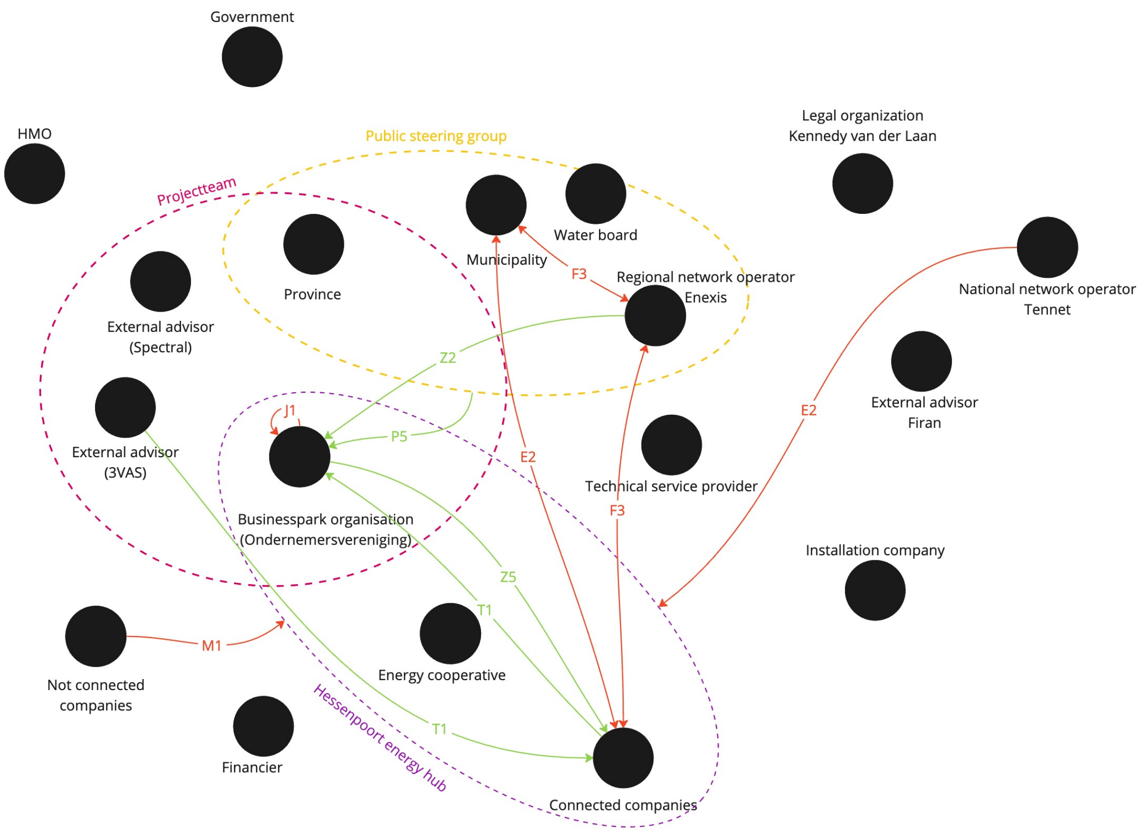

Figure 4.14: Barriers and enablers exploitation phase Hessenpoort

More generally, certain barriers have also been discovered in the analysis, that are not appointed to specific actors. The involvement of many stakeholders was mentioned in this case study as well; *"I noticed that everyone was very eager to say something about it, which resulted in many meetings"* (HES-1). Furthermore, barriers were mentioned that were not described by the literature. The uncertainty, the time it takes to convince a stakeholder and the complex processes involved; *"What destimulates it is just that unfamiliarity"* (HES-2).

4.2.4. Findings

The key actor in the project of Hessenpoort is the business park organization, as it undergoes the most relations, hold a lot of influence and also possesses some knowledge. Furthermore, the relations are mostly frequent and formal relations. The business park organization is involved in two teams, the project team and the energy hub. It is not involved in the public steering group, but does hold close relations with the actors of the public steering group. Looking at the teams, we see a lot of overlap, positioning the province and the business organization as the overlapping actors, each being part of two teams.

The vision shared by the actors involved in Hessenpoort is widely embraced, although the companies demonstrate varying motivations for pursuing that vision. The main driver for the companies is more individually based, as they want to achieve the best energy system that accommodates with their wishes. This means that they are not fully aligned with the vision of the other actors, pursuing a more efficient local energy system, but there is mainly a shared vision. The specificity of the vision however, is clear. Actors know which steps are necessary to take to reach the vision. The learning activities in the project are present in the processes, as both first-order learning and second-order learning based activities are organized. This stems from the conditions of the subsidy of the public steering group, the subsidy of RVO and therefore the involvement of the research group, and the internal motivation of the actors.

For the barriers and enablers, a focus of barriers can be witnessed in the initiation phase, while the enablers are more apparent in the research and design phase. In the exploitation phase, both barriers and enablers are prevalent. One of the main barriers in the initiation phase, was the use of jargon. Each actor uses it own vocabulary, and therefore misunderstandings can happen in the collaboration of the actors. Furthermore, the barriers coming from the companies are observed again. These barriers portray the unrecognized common interest. These obstacles last throughout the research and design phase, despite the external advisor's endeavors to overcome them. However, these efforts are being answered in the exploitation phase. Next to that, enablers in the initiation phase can be observed coming from the public steering group. Furthermore, trust acts as an enabler in the exploitation phase. Again, the barriers of the financier and national network operator were observed.

4.3. Ecofactorij

The Ecofactorij is situated near Apeldoorn, in the east of the Netherlands. The Ecofactorij is the only business park in the Netherlands that operates on a closed distribution system (GDS). Where most local energy systems are only virtual layers, like STP and Hessenpoort, the local energy system of the Ecofactorij is a physical one. The local energy system at Ecofactorij was already implemented 20 years ago, long before net congestion occurred. However, during the last few years the attention to Ecofactorij grew, as they efficiently manage their energy demand and supply, and therefore form an interesting solution to lower the burden on the electricity grid. The initiation of the local energy system came from the first company to be located at the business park, Grolleman. Grolleman is a coldstore specialized in packaging, cooling, freezing and storing meat, among other things. As they are a cold store, electricity is a primary process for them. Therefore, they wanted a specially stable network, and saw the GDS as the perfect solution (Cobouw, 2024) (ECO-1). Over the years, multiple companies joined the business park, and automatically join the closed distribution system. Nowadays, 25 companies are connected to the local energy system, and the plan is to expend ever further in the future. The map of the Ecofactorij can be seen in Figure 4.15.

Figure 4.15: Location of ECO

The buildings

The first building on Ecofactorij, as mentioned before, was a big cold store. Cold storage buildings hold particular significance in the context of local energy systems. The optimal temperature for freezers within these buildings can vary within a certain range. This variability offers flexibility in energy demand for cooling installations, particularly when the building's insulation is effectively designed (ECO-4.1). As a result, cold storage buildings contribute to the flexibility of local energy systems by enabling adaptable energy consumption patterns. The other companies mainly have buildings with the function of logistics halls, distribution centres and production halls. These processes mainly happen during the day, however, these processes also require the charging of their machinery which happens outside of working hours. By steering this, it introduces flexibility into the local energy system. Next to Grolleman, two other companies have special role in the development of the local energy system. VDL is one of the companies located at Ecofactorij, and thus part of the closed distribution system, but they are also the supplier of the battery. Additionally, the office of the company Sparkling Projects is also located at the Ecofactorij, but also utilizes its services to the energy system. Furthermore, the companies at the Ecofactorij are relatively large buildings, with large production halls. This aligns with Grolleman's initiative, as these structures have a substantial electricity demand, and therefore adding impact when used flexibly to the local energy system.

The closed distribution system

As mentioned, the local energy system at the Ecofactorij is a closed distribution system. This means that the grid on the Ecofactorij is not in the hands of a regional network operator, but is privately owned. The private grid has one main connection to the regional grid, with a contracted capacity. Everything after this main connection, is in owned by the cooperative Ecofactorij. The design and operation of the private grid is done by a group of technical external advisors, ensuring the electricity demand and supply from every connected company, with their systems based on real time monitoring every second. They are hired by the business park organization, who are responsible for the local energy system. To be able operate a private grid, Ecofactorij needed permission from the ACM. Furthermore, the business park organization also owns and manages the storage of the electricity. The companies are in charge of the demand and supply. This can be seen in Figure 4.16. The local energy system uses a contracted capacity of 20 MVA, whereas the business park would have needed 65 MVA if they would have a traditional connection. In addition, the highest peak on the Ecofactorij only reached 12,3 MVA. Therefore, the regional network operator decided to lower the maximum capacity for the local energy system (Ecofactorij, 2024).

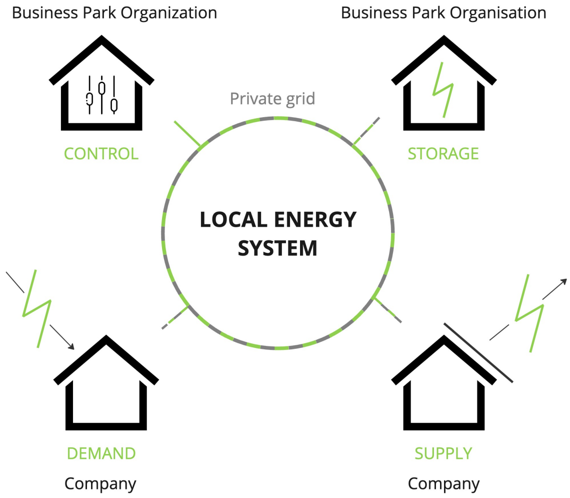

Figure 4.16: Concept LES ECO

4.3.1. The Actor Network

As the Ecofactorij has a technical/physical different system, certain actors have different roles and positions in the collaboration between involved parties. The difference in the energy system has an effect on the relations, positions, influence and knowledge of the actors involved. The actors are more or less the same. The actor network of the Ecofactorij can be seen in Figure 4.17.

Actors

The companies located on the Ecofactorij are automatically a member of the cooperation, called the 'Cooperatief Parkmanagement Ecofactorij U.A.'. At the moment (April 2024), there are 25 companies located in the business park, mostly logistics companies. As mentioned in the paragraph above, three companies are not only located on the Ecofactorij, but are also involved in the initiation and exploitation: Grolleman, VDL and Sparkling Projects (ECO-1, ECO-4.2). All directors of the companies are also on the board of the cooperative. As these actors are also 'professionally' involved, this increases the knowledge of the cooperation with regard to the local energy system.

As the regional network operator does not manage the grid on this business park, the involvement of the grid operator is reduced to a minimum. The network operator is only involved when it comes to the main connection of the GDS, everything after this point is the responsibility of the cooperative and is managed by the private grid operator: Managed Grid (ECO-1, ECO-4.1). Furthermore, the national network operator also checks the regional operator and therefore has an indirect relation with the Ecofactorij, as they also deal with net congestion on their grid and are therefore interested in solutions like these.

For future development of the private grid, several batteries will be connected to the grid. As mentioned by the interviewees, the business case of a battery is not yet positive financially speaking (ECO-4.1). Therefore, the project got a subsidy from RVO (ECO-3). A condition of this subsidy is that the project

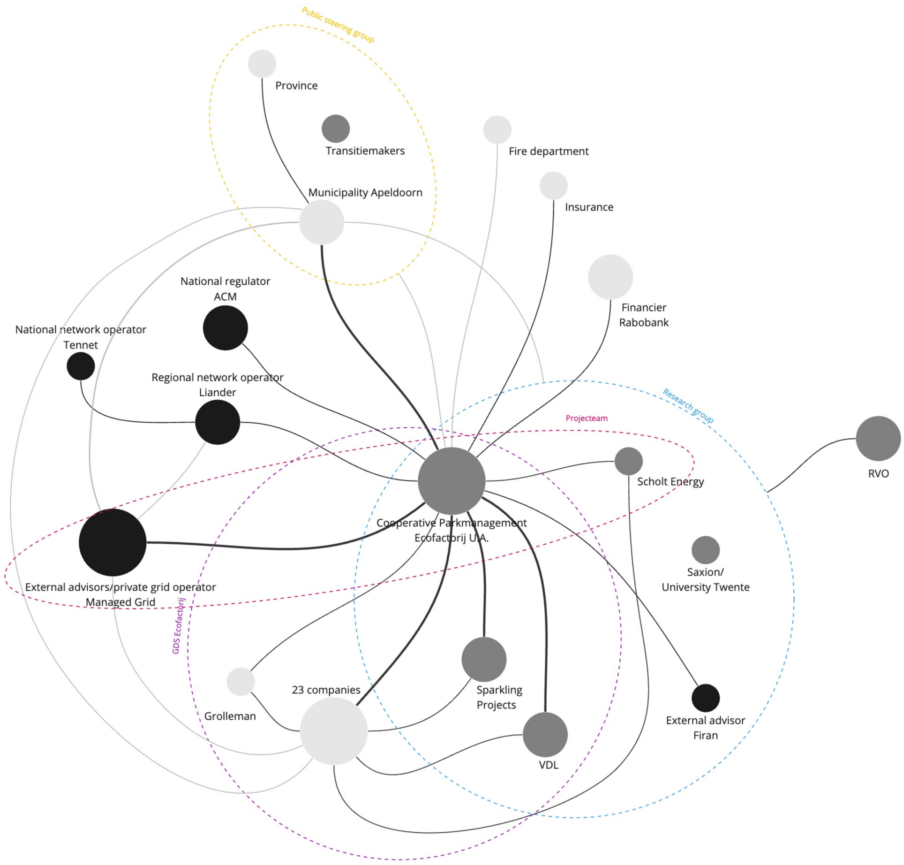

Figure 4.17: Actor Network Ecofactorij

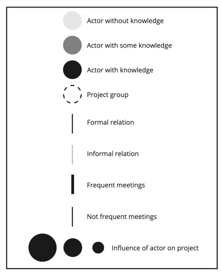

Figure 4.18: Legend actor network

would be open to research, and share the information an knowledge gained in the project. Therefore, Saxion and TU Twente are involved in Ecofactorij as well, to perform research on the project.

The municipality of Apeldoorn has a direct link with the Ecofactorij, as one of the board members is a representative of the municipality (ECO-3). Furthermore, the municipality, province and an advisory organization, transitiemakers, also set up a 'regiodeal', regional deal, supporting initiatives like these (ECO-1).

Lastly, actors like the fire department, insurance companies and investors, Rabobank in this case, are involved as well.

Relations

From the Figure 4.17 can be seen that in the case of Ecofactorij, all frequent and formal relations are with the cooperative. They are the organization that is responsible for the local energy system and therefore sign formal contracts with involved actors. Furthermore, we see several informal relations, for example between the regional network operator and Managed Grid. Both actors have a formal relationship with the cooperative, but also have meetings with each other, as one manages the private grid and the other the regional grid (ECO-1). The municipality also has a strong connection with the cooperative; *"Ecofactorij (GDS) is made possible in part by the Municipality of Apeldoorn. The municipality of Apeldoorn is very committed and involved in everything that happens"* (ECO-5).

For the research group, no relations are visible between the actors in the research group, other than their team. However, there is a lot of overlap between the projectteam, the local energy system and the research team. This implies that these actors do have a relation with each other, but this wasn't explicitly mentioned by the interviewees.

Positions

In the case of the Ecofactorij, a clear central position is taken by the cooperative of the business park. Almost every actor has a relation with the cooperative. This is logical, as the cooperative is the legal entity that is responsible for the local energy system. Furthermore, the companies on the business park also have a central position as they undergo multiple relations with other actors. This is partly due to the knowledge and services of the local energy system, that come from within the business park.

The municipality and Managed Grid take a central position next to the companies and the cooperative. These two actors are external to the local energy system, still central to the project. This is due to their participation in the project and as they are part of a team.

Influence

The cooperative Ecofactorij and Managed Grid have the most influence on the project, as the owner and operator of the local energy system. Furthermore, as the companies are involved in the project, and the cooperative Ecofactorij is equally made up of the companies, they automatically have a lot of influence as well. Actors like RVO and Rabobank exert moderate influence, mainly affecting the financial aspect of the project, which is a critical area of impact. The regional network operator however, has less influence in this case study compared to the others because of the physical aspects of the grid. Therefore, the regional network operator only has an influence on the capacity of the main connection, but not on the management of the private grid (ECO-1). The municipality shares some influence as well as they are part of the cooperative; *"Of course the municipality does have a role there, because they have to take care of security. So the whole permitting process lies with the municipality"* (ECO-3).

Knowledge

In this case study, we can see that the knowledge of actors is relatively closely involved in the local energy system. Because the companies who are located in the business park are also involved in the local energy system, the knowledge remains within the project (ECO-4.2). However, the actors with the most knowledge are there not directly located at the Ecofactorij. Managed Grid is very closely related to the local energy systems and posses a lot of knowledge as they design the whole system (ECO-1), but is an external advisor to the local energy system. The network operators and the national regulator are quite distant to the grid, but posses a lot of knowledge (ECO-1). Other actors more distant to the grid, like the province and the fire department, do not posses a lot of knowledge.

4.3.2. Vision and learning activities

Vision

Almost every actor at the Ecofactorij shares the vision of an expansion of the business park (ECO-1, ECO-3, ECO-4.1, ECO-4.2). However, there are some companies who are not as willing to cooperate, and would rather have their own connection and capacity contract with the regional network operator (ECO-5). The private grid operator also sees this: *"But there are people on the other side who are incredibly suspicious. So let me say of the 25 companies at the EcoFactorij, 85% are very helpful and they listen. But there's always the other side of the pie of people who actually want to torpedo it"* (ECO-4.1).

Next to the couple of companies who don't share the vision of the local energy system, it seems that the regional network operator is also hesitant. The network operator always takes a margin into account, for reactive current. However, due to the efficient design of the Ecofactorij, they want to get rid of the margin to increase their capacity (ECO-1, ECO-4.1, ECO-4.2). This is however not possible, and therefore indicates that the vision of the regional network operator does not align with the other actors. Therefore, although the vision of the actors directly involved with the Ecofactorij is mostly aligned, the vision of the regional network operator differs. The robustness of the vision is therefore lacking somewhat.

The specificity of the project is very clear. For the expansion of the private grid, the cooperative, private grid operator and the municipality are already organizing sessions with stakeholders, to discuss the following steps: *"And there we also had a session with stakeholders. These were mainly business owners and business associations. And they all did insist that a local energy system could be a solution for the future. Yes, a future energy system"* (ECO-3).

The quality of the project has also proven itself. As the project was already implemented 20 years ago, the expectations of the actors have already been met (ECO-1, ECO-3).

Learning activities

Learning activities are included in most processes of the stakeholders. This is due to subsidies given to the project, with the condition that information needs to be shared (ECO-3). Next to that, the collaboration with Saxion and the university of Twente stimulates learning activities as students research the project on several aspects. These learning activities being brought in from external stakeholders, stimlutas second-order learning, by exploring new innovative solutions,

Furthermore, because they want to expand, lessons learned are immediately incorporated into the process (ECO-1). This is an example of first-order learning, as the newly implemented frameworks and processes can be optimized. Therefore, both orders of learning are Incorporated well into the project.

4.3.3. Barriers and enablers in stakeholder collaboration

Initiation

In the initiation phase, barriers and enablers can be seen from the actors on the left side of the figure. This is because the research group and the other companies were not yet involved in the initiation phase of the project. As the initiator, enablers are coming from Grolleman to Managed Grid and the cooperative. Managed Grid experienced the barrier of jargon in the first phases of the project, as they are a group of 12 participant, with each their own expertise of the operation of the grid. This jargon barrier also existed with Grolleman. Furthermore, a lot of barriers are coming from the regional network operator. Good to keep in mind that the initiation of the project was long before net congestion, and the regional network operator saw no reason for the Ecofactorij to operate its own grid. The municipality however, thought differently and supported the project, hence the enablers coming from the municipality to the cooperative.

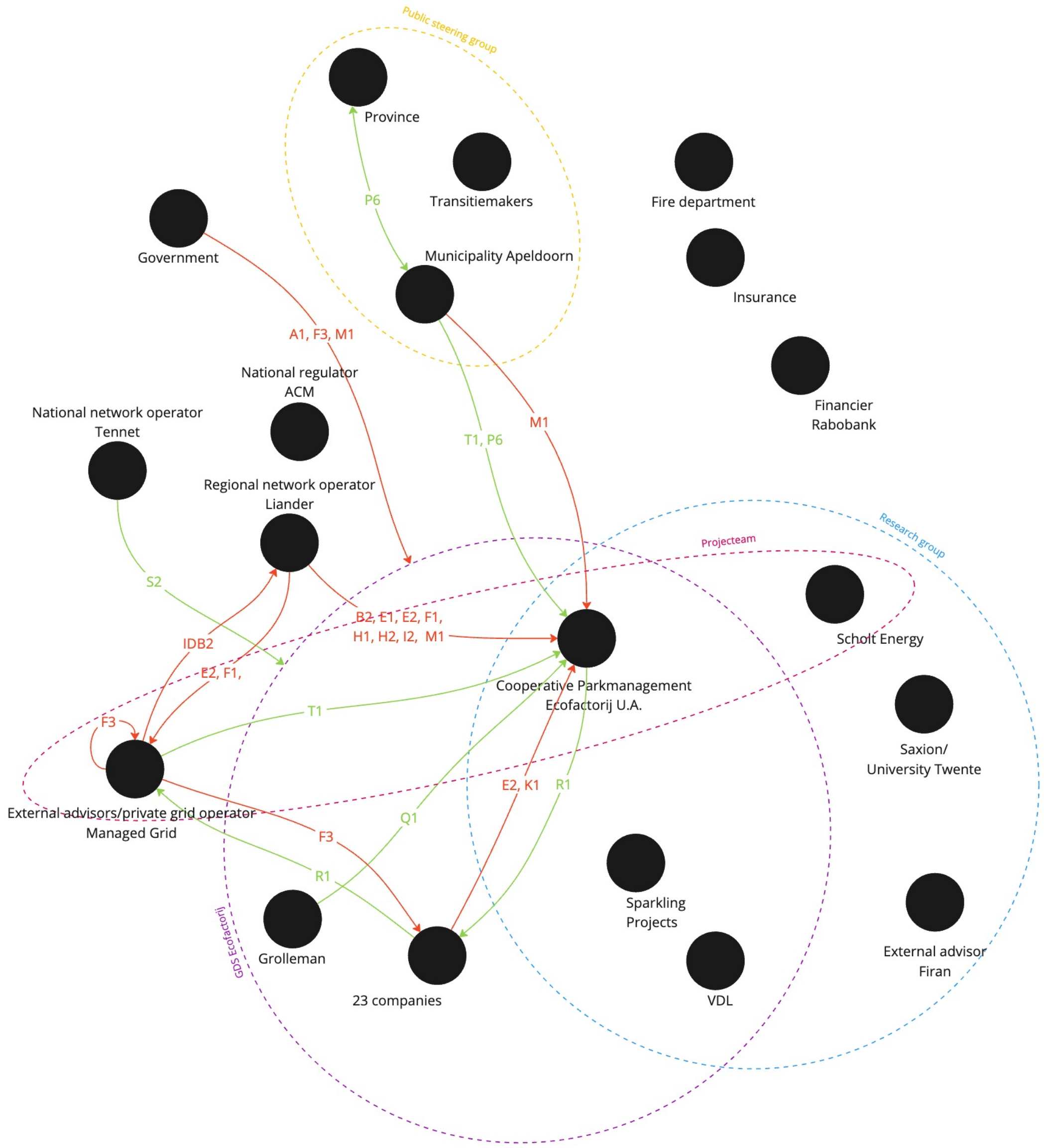

Figure 4.19: Barriers and enablers initiation phase Ecofactorij

Research and Design

During the research and design phase, more barriers were encountered by the cooperative Ecofactorij. The insurance company and the financier got involved, and showed barriers due to the uncertainty there was for them, as they had not done this before. For them, it was about missing knowledge and not knowing how to guarantee the project, as it was not a building or a product (ECO-1. ECO-4.1). Other than small changes, the rest of the barriers and enablers remained similar. This could be due to the perception of the interviewees, as the initiation phase and research and design phase both happened a longer time ago.

Table 4.13: Barriers in initiation phase Ecofactorij

Code	Barrier
E1	Competing interests
E2	Different needs, interests, and issues
F1	Limited coordination and breakdown in communication among many fragmented actors at different levels
F4	Lack of knowledge-sharing
G2	Lack of trust between stakeholders
I1	Traditional silo-based organizational capabilities and thinking
I2	Following old routine practices
K1	Lack of enthusiasm and commitment to collaborative initiatives
M1	Lack of knowledge of stakeholders
M2	Stakeholders' reluctance to exploratory learning

Table 4.14: Enablers in initiation phase Ecofactorij

Code	Enabler
P6	Incorporate formal and informal ways of inter-organizational arrangement in collaborative governance
Q1	Establish a dedicated coordination organization
R1	Establish synergies by creating a joint vision among organizations
S3	Establish regular and transparent information flows and communication among organizations
T1	Nurture trust-based relationships
T3	Anticipate and manage conflicts

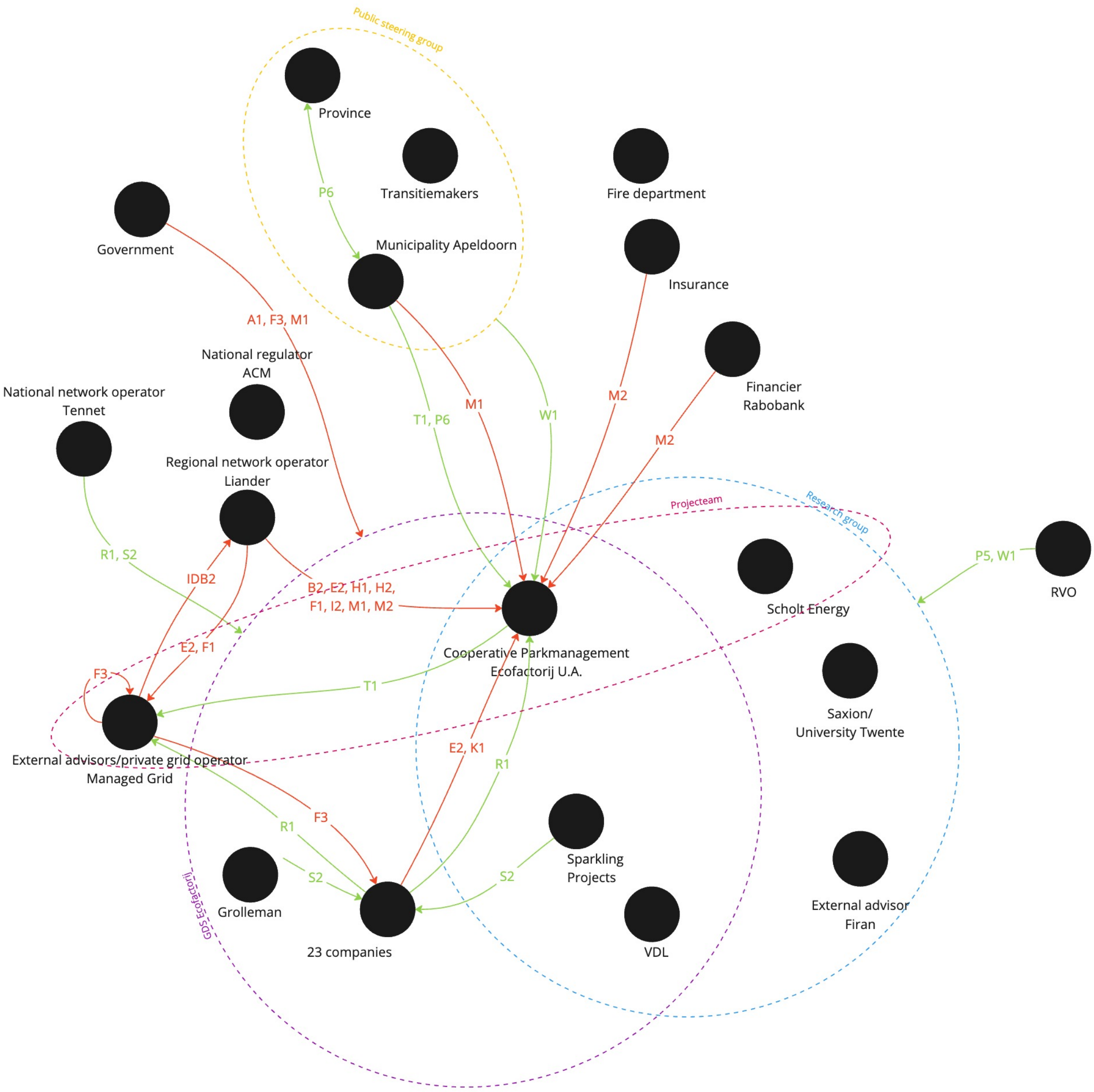

Figure 4.20: Barriers and enablers research and design phase Ecofactorij

Exploitation

During the exploitation phase, more companies were located at the Ecofactorij. By locating at the Ecofactorij, businesses automatically become integrated into the closed distribution system. Consequently, certain barriers and enablers emerge from the companies, reflecting differing perspectives among them regarding this integration. This might stem from a lack of clarity regarding the implications of establishing their company at the Ecofactorij: *"I do think that there are parties who bought his land and didn't realize at all that much at the time that they were thereby joining a cooperative"* (ECO-1).

Also the research group joined the project during the exploitation phase, acting as a enabler to the project as they encourage knowledge sharing.

Table 4.15: Barriers in research and design phase Ecofactorij

Code	Barrier
E1	Competing interests
E2	Different needs, interests, and issues
F1	Limited coordination and breakdown in communication among many fragmented actors at different levels
F4	Lack of knowledge-sharing
G2	Lack of trust between stakeholders
I1	Traditional silo-based organizational capabilities and thinking
I2	Following old routine practices
K1	Lack of enthusiasm and commitment to collaborative initiatives
M1	Lack of knowledge of stakeholders
M2	Stakeholders' reluctance to exploratory learning

Table 4.16: Enablers in research and design phase Ecofactorij

P5	Establish reporting mechanisms and assessments of progress
P6	Incorporate formal and informal ways of inter-organizational arrangement in collaborative governance
R1	Establish synergies by creating a joint vision among organizations
S2	Improve understanding of the information needs and requirements of organizations
S3	Establish regular and transparent information flows and communication among organizations
T1	Nurture trust-based relationships
W1	Identify and provide essential technical and financial resources to build organizational capacity for collaboration

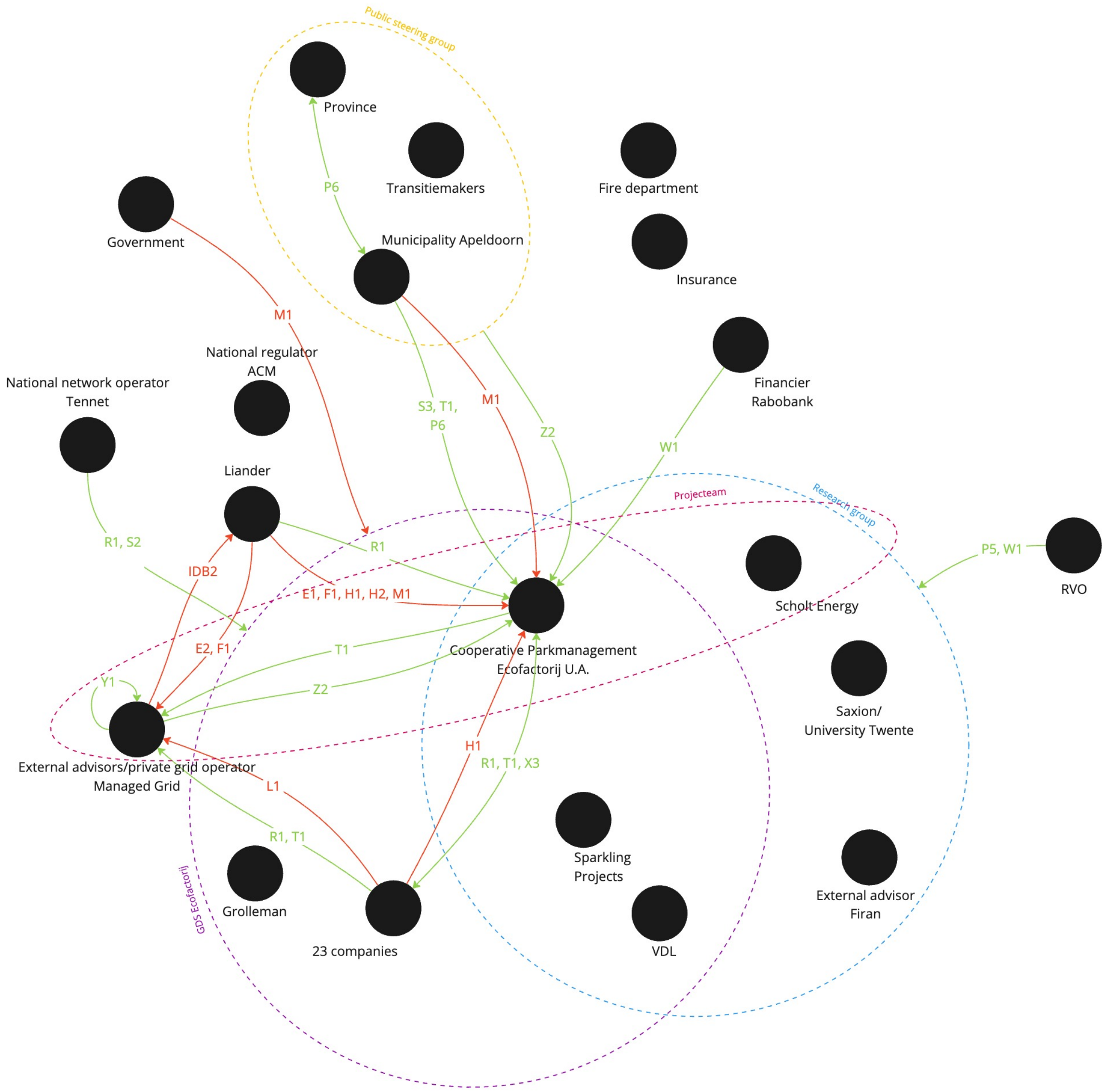

Figure 4.21: Barriers and enablers exploitation phase Ecofactorij

More generally, the barrier of the many involved stakeholders was mentioned by the interviewees, *"This is the solution to a congested grid that is better than going to spend 100 million euros on copper and aluminum for that accounts for 15 minutes a year of congestion time. But before people are here that is just an impossibility with all the interests that are everywhere and all the opinions, you will never get through that"* (ECO-4.1).

4.3.4. Findings

Once more, the key actor derived from the actor network analysis in the case of Ecofactorij is the cooperative of the business park. This actor has the most relations compared to other actors, has a lot of influence on the project and posses some knowledge. Furthermore, it is involved within three teams; the projectteam, the local energy system and the research group. These three teams have overlapping actors and are therefore relatively good connected. The fourth team, the public steering group, has no overlapping actors and is therefore more distant to the other teams. The key actor, the cooperative, does have a frequent and formal relation with the municipality, and thus linking the two teams to some extent. Next to that, the companies also have quite a central position. This is probably due to the involvement of some companies not only as being located at the business park, but also delivering their service to the project. This positions

Table 4.17: Barriers in exploitation phase Ecofactorij

Code	Barrier
E1	Competing interests
E2	Different needs, interests, and issues
F1	Limited coordination and breakdown in communication among many fragmented actors at different levels
F3	Communication breakdowns due to skepticism, use of jargon, and different official languages
G2	Lack of trust between stakeholders
G3	Long-term and inelastic collaborative process
I1	Traditional silo-based organizational capabilities and thinking
K1	Lack of enthusiasm and commitment to collaborative initiatives
M1	Lack of knowledge of stakeholders

Table 4.18: Enablers in exploitation phase Ecofactorij

P5	Establish reporting mechanisms and assessments of progress
P6	Incorporate formal and informal ways of inter-organizational arrangement in collaborative governance
R1	Establish synergies by creating a joint vision among organizations
S2	Improve understanding of the information needs and requirements of organizations
S3	Establish regular and transparent information flows and communication among organizations
T1	Nurture trust-based relationships
W1	Identify and provide essential technical and financial resources to build organizational capacity for collaboration
Y1	Acknowledge and enable power-sharing, shared responsibility, and accountability towards other stakeholders which are important in multilevel governance
Z2	Encourage knowledge-sharing

the end users more, and reflects into their influence. Another notable aspect of the actor network, is the knowledge of the actors. The main knowledge is mainly from external actors, although there are companies who are involved professionally with the project. Again, the public organizations have little to no knowledge in the project.

At the Ecofactorij, there is a clear division in vision of the project. Most actors share the vision of expanding the energy system of Ecofactorij, and attracting new companies to the business park. However, the regional network operator does not share this vision. This results in a lot of barriers throughout all the phases. Because of this, the vision lacks robustness. On the other hand, the specificity and quality of the vision score very well. The steps on how to achieve this expansion of the GDS are very clear, and the first steps are already taken. The learning activities in the project are also well safeguarded. For the learning processes, because of the involvement of companies who are also located at the business park, first-order learning structures get stimulated. Furthermore, by involving a research group to the project, second-order learning processes are involved as well. Next to that, by incorporating a subsidy with conditions towards learning activities and knowledge sharing, contributes to both these processes.

As mentioned before, the main barriers in this project throughout all the phases, are between the private grid operator and the regional network operator. This could be due to the harsh line, in collaboration as well as physically in the grid, between the these two actors. Furthermore, there is a difference in needs and interest, as the main connection between the two actors is the main topic of the private grid operator, while it is only a minor aspect of the regional network operator. From the municipality, mainly enablers were observed, as they were very involved, stimulating the project. Among the companies, in addition to enablers, barriers were also identified. These were partly due to companies not always knowing upfront what they were getting into, and that Ecofactorij has a different energy system than most business parks. Furthermore, the barriers of jargon, and the uncertainty of the financier were also experienced in this case study.

4.4. Tholen

In 2018, the municipality of Tholen initiated WM3 Energy to research the feasibility of the sustainable transition of business parks in Tholen. A feasibility study was done, and the business park called Slabbecoornpolder en Welgelegen in Tholen, the South-West of the Netherlands, in this thesis referred to as Tholen, showed a lot of possibilities for implementing PV panels. However, this was around the same time net congestion was called out for that area for the feed-in scenario, and therefore further sustainability measures were not possible. However, the wish for being more sustainable remained, and WM3 Energy and the business park organization explored possible solutions. This resulted in a collaboration between the business park organization and the regional network operator, and eventually the first group contract was signed, making it possible for the buildings on the business park to share their contracted capacity. This was the start of the, as they call it, energy hub in Tholen. At the moment (April 2024), four companies are connected to the hub, and they are moving towards connecting 30 more companies.

Figure 4.22: Location of THO

The buildings

The buildings on the business park in Tholen vary quite in size. There are three relatively large buildings, with a lot of square meters of flat roofs. This can be seen in Figure 4.22. However, only a small portion of the roofs is used for PV panels, as there is congestion on the feed-in scenario. With the energy hub implemented, it is expected the amount of solar panels will increase. The big buildings mainly are distribution or logistical halls, and therefore have their processes mostly run during the day. However, the charging of their machinery happens at night, and therefore provides a lot of room of flexibility. The other buildings at the business park on Tholen are mainly offices and shops. The electricity demand of the offices is during working hours, but the shops are also open on Saturdays, again, providing flexibility. The buildings on the business park mostly all have their own assets producing electricity. The business park organization manages this electricity can stores is for later demand. This can be seen in Figure 4.23.

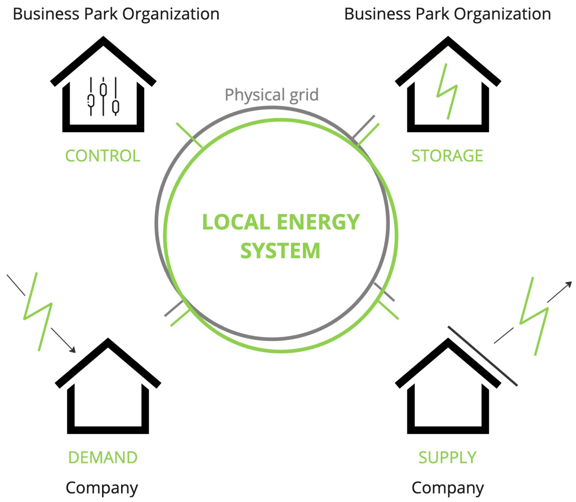

Figure 4.23: Concept LES THO

4.4.1. The Actor Network

For the actor network of Tholen, three layers can be discovered: 1) the companies and the organizations of the business park, 2) the actors with the exact knowledge about the business park and actually make the project happen, and 3) the public parties who are involved, but have no knowledge.

Actors

The initiator of the project was the municipality, by initiating a research on the possibilities for the business park located in Tholen. However, net congestion was not only bound to Tholen, but to most of the province. Therefore, the province became invested as well. The municipality instructed WM3 Energy for the feasibility research. Shortly after, WM3 Energy initiated ON E Target, an knowledge platform and consortium of external advisors in different field (finance, governance, technical design, exploitation). Next to ON E Target as an external advisor, Firan also participated in the project as an external advisor, as designer for the energy hub. Furthermore, the regional network developer is involved.

Next to the advisors and public parties, the companies and the business park organization are involved. In the located companies, there is a difference between connected and not connected parties, as not all companies wanted to connect to the energy hub straight away. Furthermore, the business park organization on Tholen takes on the form of a foundation, with a private company (BV) as legal entity. Additionally, an 'E-team' has been established as an informal platform for companies to collaborate on activities within the energy hub.

The teams formed in the network of Tholen have some overlap, as the regional network operator is both part of the 'projectteam' and 'Foundation Zeeland's Public Interest'. This foundation has been established by the municipality and province for the boost of the sustainability transition, and the business park of Tholen was chosen as a project they would support. The other team are the actors involved in the energy hub.

Relations

Only two relationships between the actors in the network are both frequent and formal: the connection between the REC Tholen foundation and ON E Target, and the connection between the REC Tholen foundation and the municipality. These two relationships also serve as the links connecting the two overlapping teams with the standalone team of the energy hub. As a result, all teams are relatively well interconnected.

Noticeably, the regional network operation has no relation with the foundation, but only with the private company of the energy grid, as it serves as the legal entity. The group contract signed is also between these actors (REC Tholen, 2023).

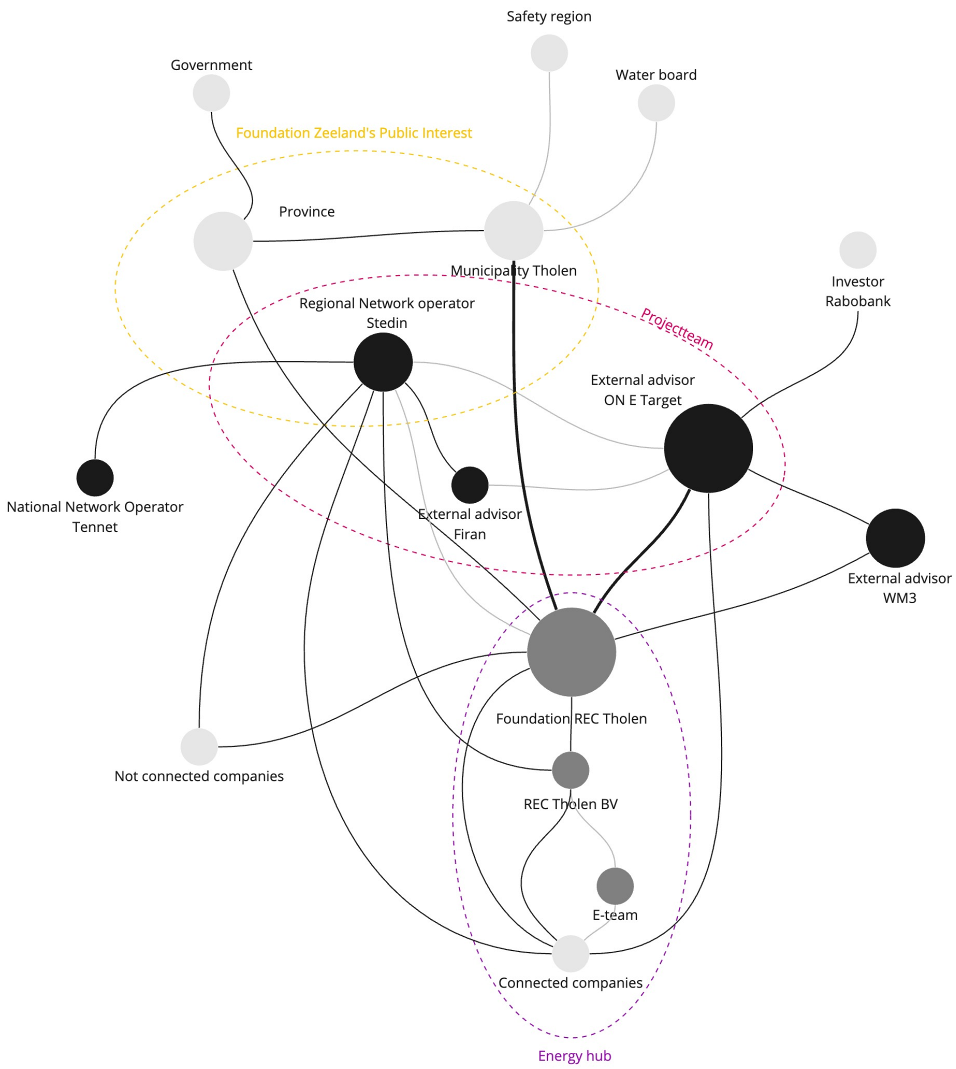

Figure 4.24: Actor Network Tholen

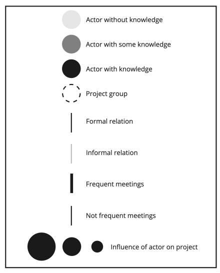

Figure 4.25: Legend actor network

Positions

The central actor of the actor network is the Foundation REC Tholen, as it is engaged in the most relations. However, the regional network operator also has a central position, as it is engaged with a lot of other actors. Furthermore, ON E Target takes a relatively central position.

Influence

The actors with the most influence are the foundation REC Tholen, and the external advisor platform ON E Target, as the responsible and the operator actors (THO-4.1). The municipality, regional network operator and WM3 Energy have some influence. The municipality initiated the project and remained closely engaged throughout its phases, enabling it to actively participate in the projects and exert influence over them (ECO-3). The regional network operator was eager to collaborate with the business park, and seek for solution together. Because of its collaborative and transparent approach, a new contract format was developed, significantly influenced by the regional network operator (THO-2, THO-4.1). Lastly, although WM3 is also part of ON E Target, it still has quite some influence on this project specifically, as it was the first external actor to be engaged in the project.

Knowledge

As mentioned in the introduction of the actor network of Tholen, the three layers in the network are also apparent in the knowledge of the actor. The actors with a lot of knowledge, mainly operate in or are directly linked to the project team. Actors with little to no knowledge are related to public parties, and with some knowledge are integrated into the energy hub, with the companies as an exemption.

4.4.2. Vision and learning activities

Vision

Most actors see a future for the local energy system, even though net congestion might not be an issue any more. However, there is a difference for the actors on how this local energy system should look like. Some argue that this will only be a feasible option for bigger buildings (THO-4.2), while others want to implement it for every business park (THO-3). The interviewees did not elaborate on a specific vision for the business park and its local energy system, other than the energy hub will stay active on the business park, and therefore it misses robustness and specificity.

The quality of the project however, has proven itself. The initial three companies that joined the energy hub appear satisfied with how expectations aligned with reality (THO-1). Moreover, the expectations of companies not yet connected have also been fulfilled, as an additional 30 companies on the business park now express interest in joining the energy hub (THO-1, THO-4.1). Furthermore, as this was the first time the group contract was utilized in the Netherlands, the project drew attention from the government. The Minister of Economic Affairs and Climate called the project a textbook example for other business parks (ON E Target, 2023), highlighting the success of the project.

Learning activities

The learning activities in the project mainly come from two actors: the external advisor ON e Target and the regional network operator, and are mainly second-order learning based. As mentioned, this was the first group contract signed in the Netherlands. For the regional network operator, this meant the existing contract structures and frameworks had to be revised to accommodate for innovation. Furthermore, ON e Target got initiated by this project tot help develop this project.

The Foundation REC Tholen has not mentioned any specific learning activities (THO-1). The municipality has considered the learning activities but indicated that the project's complexity makes it challenging to document the learning lessons in a way that would be applicable to other projects. *"I don't think a blueprint is feasible. There are always so many things depending independently of other things. There is no standard format to make of this is how you can apply it"* (THO-3). However, as a condition to the subsidy retrieved from the Foundation Zeeland's Public Interest, the knowledge of the project should be shared openly for other projects to learn from. How this knowledge is obtained and transferred has not been elaborated on.

This indicates that no specific learning activities are organized in the project, apart from the condition of the subsidy, but some actors do have it embedded internally. Furthermore, the learning activities are based on second-order learning, but first-order learning activities are somewhat missing.

4.4.3. Barriers and enablers in stakeholder collaboration

Initiation

In the initiation phase of the local energy system on Tholen, several barriers were formed. The companies located at the business park showed barriers towards the Foundation REC, but there is a difference between the barriers coming from companies who are going to connect, and the ones who didn't. The companies who didn't connect at the first moment, mostly didn't want to be the front runners in the project. *"There are companies who wanted to see how the wind blows first, before deciding whether to participate"* (THO-1). Companies who did join the energy hub in the first phase, also showed barriers as the existing responsibilities did not align with the group contract signed. *"And one of the things that the business owners did not want to take on as a responsibility was liability for the whole thing."* (THO-4.2). This barrier was also experienced by the regional network operator. Next to these differences in barriers between the companies, all companies also experienced barriers between them en the public team because of the different organisations. *"You do see that the worlds of experience are different. The way of working is different"* (THO-2). This is because they both represent their own interests, and speak a different language. As a result, they do not always fully understand each other, creating a barrier for the deployment of the local energy system.

From a more distant level, the national network operator and the government also form a barrier towards the development of the energy hub. Although, as they are on a more distant level, they do not directly form a barrier specifically to the foundation REC Tholen, but more on the development of an energy hub as a whole. Therefore, the barrier in Figure 4.26 is drawn towards the energy hub, and not to the actor.

Lastly, enablers by the municipality and the province, among other actors, can be witnessed. This is because the project was initiated by the municipality, and therefore provides for the development by providing ground for collaboration, like procuring an external advisor to help the project.

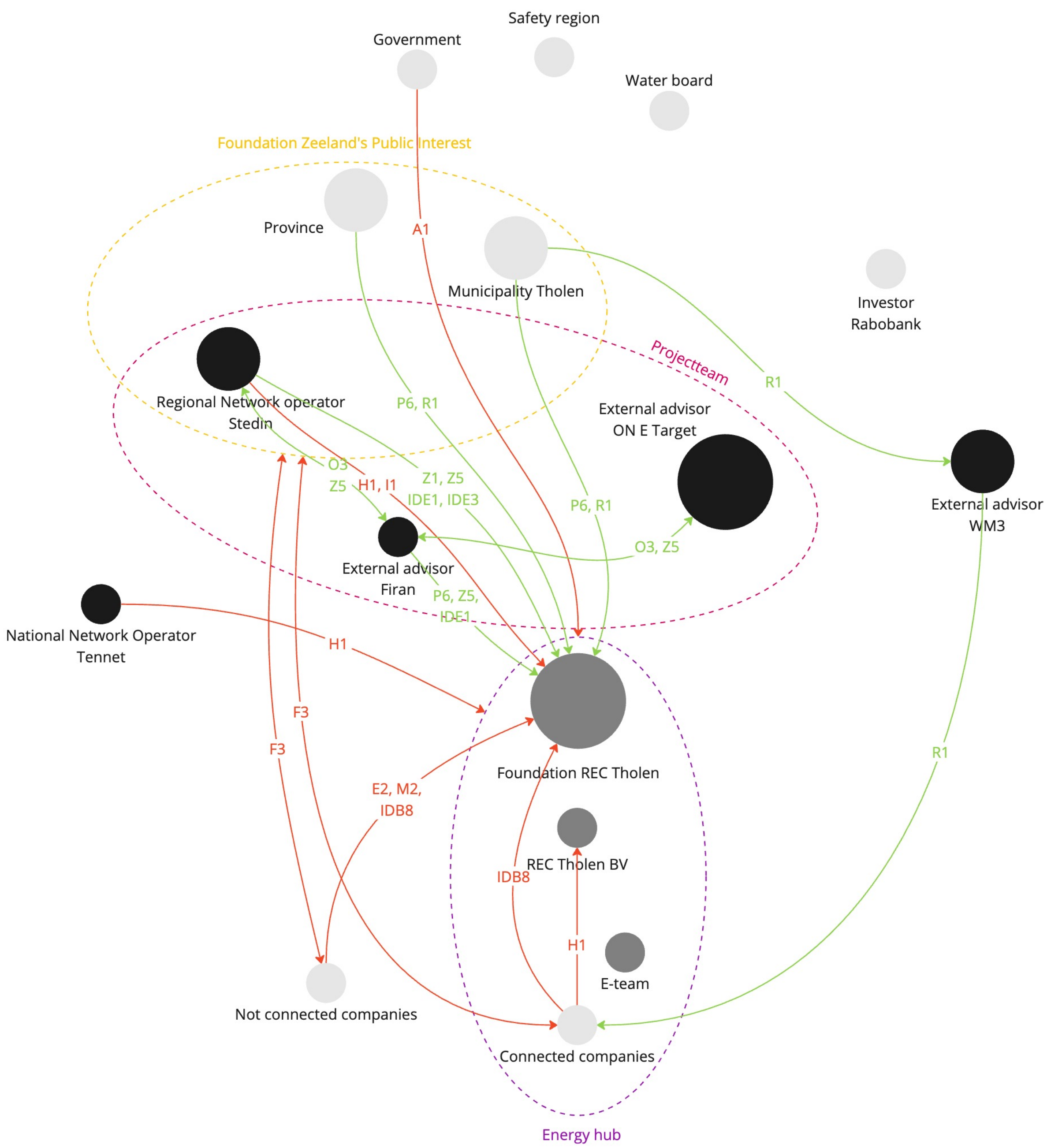

Figure 4.26: Barriers and enablers initiation phase Tholen

Research and Design

In the research and design phase, many enablers were introduced in the project. ON E Target got involved and were not only supported by other actors, but also encouraged the connected companies and reduces the hesitancy to collaborate (THO-4.1). Next to that, a loop of collaboration between the companies, the private company REC and the Foundation REC was sparked, empowering each other. Moreover, the network operators expressed optimism about the project, recognizing potential solutions for their own challenges.

The responsibility barrier remained, but became more active between the companies and the regional network operator, rather than through the REC. *"I don't expect things to go wrong either, quite frankly.*

Table 4.19: Barriers in initiation phase Tholen

Code	Barrier
A1	Absence or lack of policies that promote collaboration
E2	Different needs, interests, and issues
H2	Existing roles and responsibilities which do not allow or support collaboration activities
I1	Traditional silo-based organizational capabilities and thinking
I2	Following old routine practices
M2	Stakeholders' reluctance to exploratory learning

Table 4.20: Enablers in initiation phase Tholen

Code	Enabler
P1	Create collaborative governance structures that remove traditional power-based relationships
P4	Establish decentralized organizational arrangements linked with the centralized system
P6	Incorporate formal and informal ways of inter-organizational arrangement in collaborative governance
R1	Establish synergies by creating a joint vision among organizations
Y2	Raise awareness of the positives and negatives of collaborative ventures to reduce hesitancy in collaborative working
Z1	Build capacity through knowledge development and training programs
Z5	Facilitate knowledge co-production through formal and informal social relationships

Because there are still a lot of marches and safeguards in the grid and all those things. But still, if you cause damage to the grid, you're liable up to 3 million euros. And of course that's something that if a company reads that, then the risk perception goes sky high. And we see on the grid operator side, of course, that that never happens and that the probability is nil. Yeah, that doesn't help a company like that. So this is kind of an interesting one." (THO-2).

Table 4.21: Barriers in research and design phase Tholen

Code	Barrier
A1	Absence or lack of policies that promote collaboration
H2	Existing roles and responsibilities which do not allow or support collaboration activities
I2	Following old routine practices
M2	Stakeholders' reluctance to exploratory learning

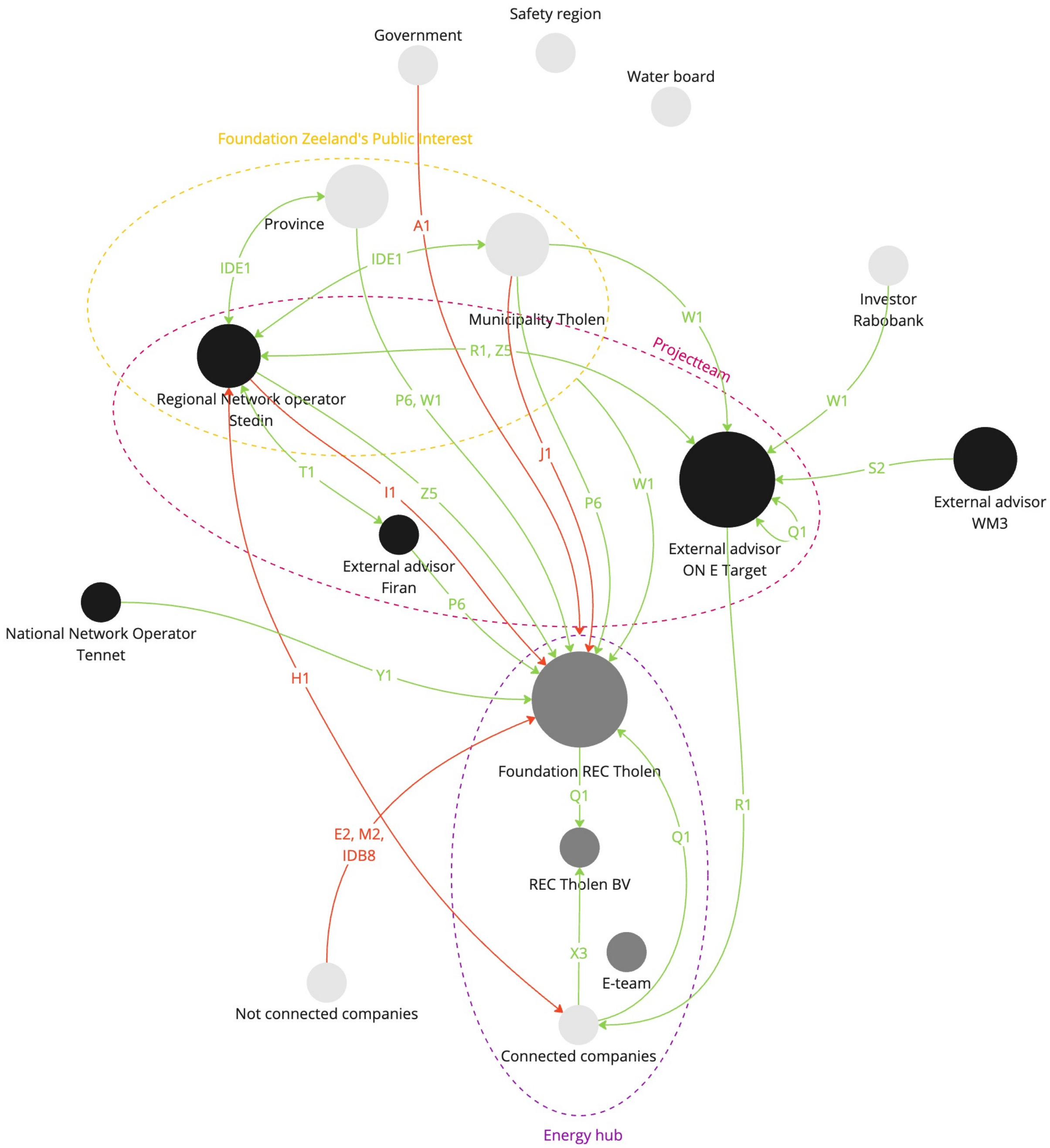

Figure 4.27: Barriers and enablers research and design phase Tholen

Table 4.22: Enablers in research and design phase Tholen

Code	Enabler
P1	Create collaborative governance structures that remove traditional power-based relationships
P4	Establish decentralized organizational arrangements linked with the centralized system
P6	Incorporate formal and informal ways of inter-organizational arrangement in collaborative governance
Q1	Establish a dedicated coordination organization
R1	Establish synergies by creating a joint vision among organizations
S2	Improve understanding of the information needs and requirements of organizations
T1	Nurture trust-based relationships
W1	Identify and provide essential technical and financial resources to build organizational capacity for collaboration
X3	Address personal interests and concerns for collaboration
Y2	Raise awareness of the positives and negatives of collaborative ventures to reduce hesitancy in collaborative working
Z1	Build capacity through knowledge development and training programs
Z2	Encourage knowledge-sharing
Z3	Collaborative knowledge-brokering with the help of an expert

Exploitation

In the exploitation phase, most barriers have been resolved, however the not connected companies still are hesitant to joined the energy hub. The majority of companies primarily focus on their core processes and currently experience no challenges with their electricity demand and supply (ECO-1). However, the Foundation REC Tholen is dedicated to addressing this knowledge gap among the companies because, although they may not encounter issues presently, they are likely to face them in the future.(THO-1. THO-4.1).

Lastly, the loop of empowering has shifted towards the e-team and the companies, by introducing informal relations and sharing knowledge between the active companies about the energy hub. Because of these formal relations, trust can be build among the companies which will improve the collaboration (ECO01. ECO-4.1).

Table 4.23: Barriers in exploitation phase Tholen

Code	Barrier
M2	Stakeholders' reluctance to exploratory learning

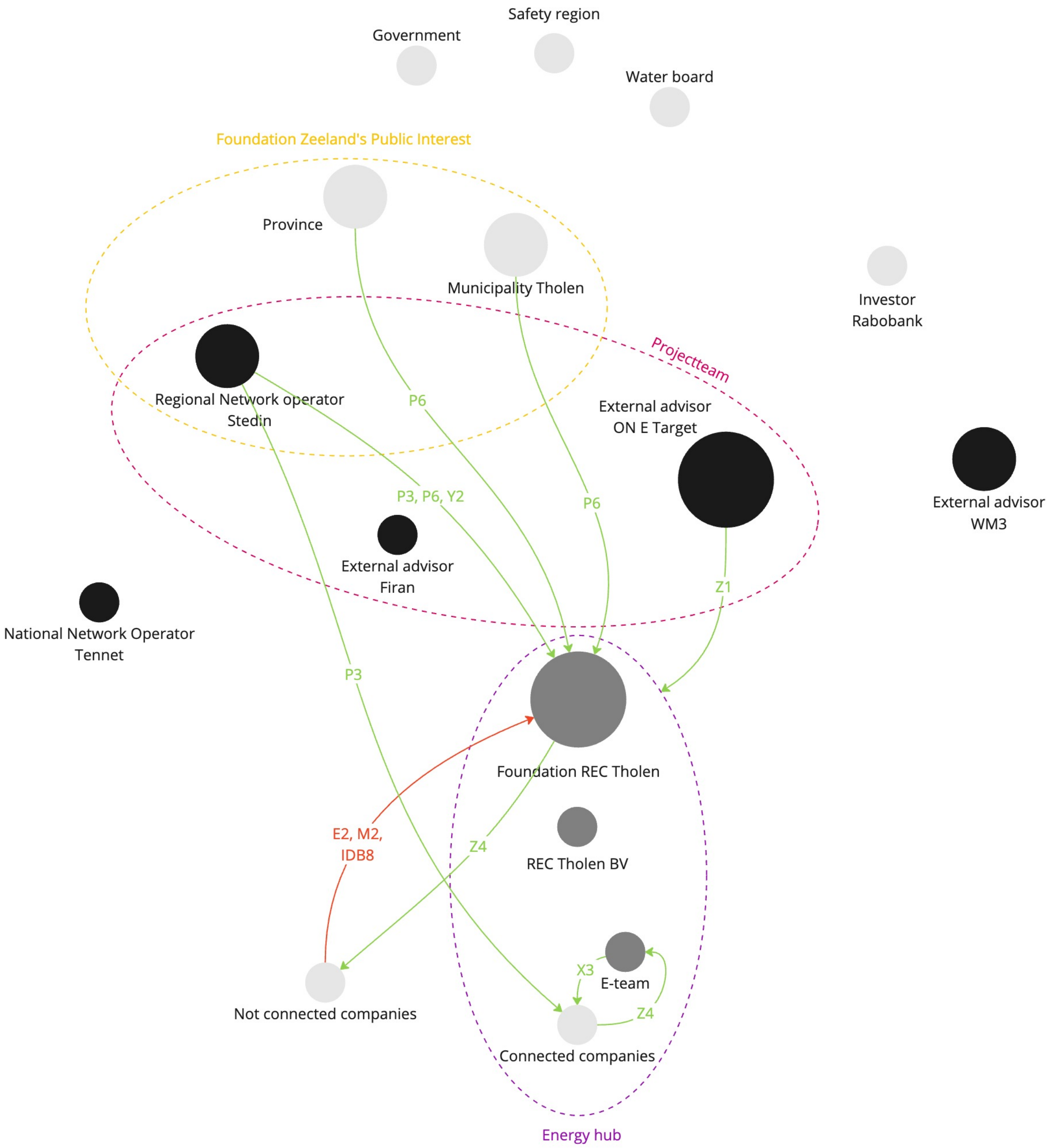

Figure 4.28: Barriers and enablers exploitation phase Tholen

Also in the case of Tholen, the barrier of many involved stakeholders was experienced. Additionally, the inductive enabler of the personal motivation occurred as well *"We are very lucky that there is a lady with a lot of guts at the grid operator"* (THO-3).

Table 4.24: Enablers in exploitation phase Tholen

Code	Enabler
O5	Policy development with stakeholder involvement
P3	Shift towards flexible and self-organized network governance
P4	Establish decentralized organizational arrangements linked with the centralized system
P6	Incorporate formal and informal ways of inter-organizational arrangement in collaborative governance
Y1	Acknowledge and enable power-sharing, shared responsibility, and accountability towards other stakeholders which are important in multilevel governance
Y2	Raise awareness of the positives and negatives of collaborative ventures to reduce hesitancy in collaborative working
Z1	Build capacity through knowledge development and training programs
Z4	Implement measures to address the knowledge gap, build trust, clarify uncertainties, and bridge values

4.4.4. Findings

In the case study of Tholen, the actor network provides quite a clear overview. There is a clear distinction between the energy hub, the external advisors and network operators and the public bodies. The energy hub consists of the companies, and the organizations around them. The Foundation REC Tholen, acting as the business park organization, is once again the main actor in the network, by its centrality, influence and relative knowledge. However, the regional network operator is a close runner up, as it also has a central position, posses knowledge and has some influence. The regional network operator is also part of the Foundation Zeeland's Public Interest, as well as the project team. The whole projectteam is made up of external actors with a lot of knowledge, and influence on some extent. The public bodies however have very little knowledge.

The vision is not as robust, as actors have different perceptions, and there is uncertainty on how the next steps should look like. The expectations of the project have been met however, thus contributing to the quality of the project. For the learning activities, these are mainly coming from one actor, who also partly operates as a knowledge platform. This is an external advisor, and wants to implement these local energy systems at other project as well. The municipality has not implemented specific learning activities, as these kind of processes are too complex to standardize the processes and learn from them. This hinders the learning activities. The focus is therefore more on second-order learning, than it is on first-order learning.

As the project was initiated by the municipality, the public parties showed a lot of enablers in the initiation and research and design phases. Although, again, there were also some barriers of the companies located at the business park. In the research and design phase, the external advisors showed a lot of enablers to the projects, by creating synergies between actors and closing the knowledge gaps. This had an result, as closer collaboration between companies and the business park organizations emerged, creating enablers for the energy hub. This collaboration is also sought in the exploitation phase between the Foundation REC Tholen and the not connected companies, to get them aboard the energy hub. The E-team also stimulates the collaboration of the companies, as it creates informal way to keep the end users involved in the project. Finally, the barriers experienced by the financier are also observed in this case study, along with the identical barrier faced by the insurance company.

5

Cross Case

In the previous chapter the individual case studies were analyzed and the first findings have been derived. In this chapter, these individual findings will be compared to find comparisons and differences between the case studies on the aspects of actor network, vision and learning activities and barriers and enablers.

5.1. Actor network

In all case studies the business park organization emerged as the key actor in the project. This actor holds the most relations with the other actors, and most of these relations are frequent and formal. The actor has a lot of influence in the project, and some knowledge. Furthermore, in the case studies of Schiphol Trade Park, Hessenpoort, and Tholen, the regional network operator also forms on of the main actors in the network. In the case study of Ecofactorij, the regional network operator has a less prominent role. This could be due to the difference in physical aspects of the local energy system. The local energy system in the case studies of Schiphol Trade Park, Hessenpoort and Tholen are a virtual layer, meaning the physical grid remains the responsibility of the regional network operator. In the case study of Ecofactorij, the local energy system is in the form of a closed distribution system, making the physical grid fall in ownership of a private party. Therefore, the regional network operator of Ecofactorij has a smaller part in the actor network as there is a private local network operator for the local energy system.

The regional network operator in the case of Schiphol Trade Park, Hessenpoort and Tholen is also involved in a team, and multiple relations are formed with this actor. This means the regional network operator is involved with the project. In the case of Ecofactorij, the regional network operator is not involved in a team, neither has multiple or frequent relations with the local energy system, indicating the actor is not as involved in the project as other case studies.

Another actor identified as a main actor from the network analyses of all case studies are the companies located at the business park, especially the connected companies. They form the end-users of the project, as they are the actors with an electricity demand. The connected companies have multiple relations with the other actors, and therefore have quite a central position. However, from the case studies it can be seen that the companies do not have a lot of influence and knowledge. All connected companies are represented in an overlapping organization, the business park organization.

Next to the business park organization representing every connected company, in the case study of Schiphol Trade Park and Tholen the companies are also joined together (or can join together) in a more informal organization, such as the Business Club at Schiphol Trade Park or the E-team at Tholen. These groups are formed by employees of the company, and provide informal meetings, workshops, sessions etc. about the project on the business park. This way, the companies get more engaged with the project, and knowledge can be shared more easily.

In the case studies of Hessenpoort, Ecofactorij and Tholen, public organizations, such as the municipality or the province, are directly involved with the local energy system. Especially in the case of Hessenpoort, both the municipality and the province have a strong relation with the business park organization. Furthermore, these two public entities are also grouped into a public steering team, together with the regional network operator. This public steering group is also present at Ecofactorij and Tholen, also involving the public organizations directly with the local energy system and the key actor. At Schiphol Trade Park, the public organizations are not directly involved in the local energy system, but are only connected through another actor, the business park developer. Furthermore, the public organizations are not grouped in a team at STP.

Consistent with the public steering group functioning as a team in most case studies, there are also other teams visible in the case studies such as projectteams, research teams, or a legal team. Furthermore, the actors connected to the local energy systems are also grouped in a 'local energy system team'. The teams in the case studies differ in their degree of overlap. In the case study of Schiphol Trade Park and Tholen, the teams do not overlap with the local energy system. At Hessenpoort and Ecofactorij, the the business organization is part of multiple teams and therefore the local energy system also overlaps with other teams. However, at Schiphol Trade Park and Tholen, the energy cooperative and the foundation REC Tholen do hold very frequent and formal lines with with the other actors. Next to the local energy system teams, in the case studies an overlap in teams can also be observed. In the case studies of Schiphol Trade Park, Hessenpoort, and Tholen, almost every team overlaps with another team. Furthermore, for the teams that do not overlap, have actors in them with a very close relation between them, therefore connecting the teams. In the case study of Ecofactorij, the public steering group does not overlap with other teams, and there is only one strong relation with the other teams. Furthermore, the regional network operator is not included in the teams.

In the case studies, the external advisors have a significant role. They all have multiple relations with other actors, including the main actors, and have a lot of knowledge. The external advisors are also involved in teams, and therefore involved in the project. In the case studies of Ecofactorij and Tholen, the external advisors also have influence over the project. In the cases of Schiphol Trade Park en Hessenpoort this influence is not as big. Interestingly, the external advisors mostly have informal relations with the other actors. This indicates that the external advisors are involved in many processes, and meet with many actors.

Notably in all case studies, the knowledge of the actors mainly comes from external actors to the local energy system. The business park organization has some knowledge, as well as the informal business group, but the connected companies do not posses knowledge about the local energy system. This knowledge mainly comes form the network operators, and the external advisors.

5.2. Vision & Learning activities

In most of the cases, the vision of the project lack robustness, indicating that not all actors share the vision. Most actors do see that the local energy systems benefits their vision, and therefore cooperate, but do not have the local energy systems as their main priority. In the case studies of Schiphol Trade Park en Tholen, the specificity of the project also lacks. Not all stakeholders know which steps to take next in order to achieve the vision. However, in the case studies of Hessenpoort and Ecofactorij, the specificity is clear. The quality of the vision is present in all case studies, indicating that the actors expectations have been met by the experiment. For the case studies of Hessenpoort and Tholen, not connected companies are now on waitinglists to join the local energy systems because of its quality. At Ecofactorij, all located companies have already been connected to the local energy system, but now they want to expand their business park as companies have indicated that they also want to connect to their local energy system and move to the Ecofactorij. This indicates the succesfullnes of the case studies and therefore its quality.

In the case of Hessenpoort, Ecofactorij and Tholen, but also mentioned in the literature by Geels (2011), it is observed that more internal actors promote activities of first-order learning. However, derived from the case study of Schiphol Trade Park, just by having the internal actors, does not guarantee first-order learning. In the case studies of Hessenpoort, Ecofactorij and Tholen the first-order learning structures by internal actors is stimulated by obtaining a subsidy with the condition of learning activities and knowledge sharing. This highlight the importance of the public steering group and the subsidy stimulating the learning activity based on first-order learning.

In all cases can be observed, as well as mentioned in the literature of Geels (2011), that the involvement of external actors improves the learning activities based on second-order learning. In the case of Ecofactorij, a research group got involved in the project, encouraging knowledge transfer and learning activities to perform research on the local energy systems, and specifically its batteries. In the case of Tholen, the external advisor was in the form of a knowledge platform, contributing to draw insights from the project. This concept of involving external actors for promoting second-based learning was especially observed in the case of Schiphol Trade Park, where the external advisors brought in new frameworks for the end user, to optimize their energy system. This highlights the importance of external actors, and even a research group or knowledge platform, to stimulate the learning activity based on second-order learning. Both first-order learning, and second-order learning are important for strategic niche management.

5.3. Barriers and enablers

In all the case studies, the companies experienced barriers towards the local energy system. Most of these barriers are centred about not having the knowledge about the project and therefore not knowing or wanting to get into it, and unrecognized common interest. This is partly due to the enablers coming from external advisors, raising awareness to the positive and negative aspects of collaborating to reduce hesitance, creating a joined vision and closing the knowledge gap. A general barrier mentioned in all case studies was the involvement of a large number of organizations, however this was not attained to a certain actor, but experiences as general barrier in the whole project. The cross-case analysis table can be found in Appendix H.

In more detail, for the initiation phase in the case study of Hessenpoort, Ecofactorij and Tholen, the barrier of communication mainly caused by jargon was one of the most prevalent barrier. In the case study of Tholen, this barrier occurred between the public team and the companies. For Ecofactorij this barrier formed between the companies and the external advisor/local network operator. In Hessenpoort, it was between the companies, the regional network operator and the municipality. Notably, the companies are frequently involved for this barrier. In most case studies this barrier only pertained in the initiation phase, and was solved in the further phases. This could be because they were getting used to working together, and getting used to the differences in language or ways of working.

Additionally, the barrier of different needs, interests and issues is also visible in the initiation phase. Again, this barrier mainly occurred between companies and other actors, and frequently between companies and the dedicated cooperative. As the case studies were all already existing business park, this was mainly base on the reasoning of the companies *”Why would I participate in a shared local energy system, when I have no problem with my current electricity system?”*. This reasoning was mentioned in several case studies. In Ecofactorij this barrier also existed between the local network operator and the regional network operator. In the case studies, this barrier was mitigated in the further phases by raising awareness and sharing knowledge with the companies by external advisors. Especially at Schiphol Trade Park and Hessenpoort, these enablers ensured the mitigation of the barrier. The establishment of synergies by creating a joint vision among organizations was the most common one in the initiation phase, and also somewhat in the research and design phase. This enabler mostly came from the external advisors, and sometimes from the public actors. This was mainly aimed at the companies, to ensure the collaboration for the local energy system, and mitigate uncertainty.

For every case study in the initiation phase, the barrier of absence or lack of policies that promote collaboration coming from the government or other public party were experienced. This implies that the national policies and regulation are not yet suitable for local energy system implementation, and therefore hinder the development. Initially, this was also the case for the case studies, but because most local energy system became pilot projects, an exception was made and therefore it could continue. The barrier was solved in the further stages because of this pilot exception. On the other hand, an enabler coming from public actors in most case studies was providing financial resources. This was either done by subsidies, and sometimes loans. This ensured the collaboration between the actors could take place and not create any delays for the project. Additionally, the relation between the public organizations and the other actors were described as both formal and informal, contributing to the collaboration.

A very important enabler, especially visible in the case study of Schiphol Trade Park, was the enabler of nurturing trust-based relations. Out of all the case studies, Schiphol Trade Park was the case study with the least collaborations barriers overall. This could be incidental, as the interviews with all case studies were not aimed on this aspect, but desk research also implies that Schiphol Trade Park was a very successful project, being mentioned many times by governmental documents (Rijksoverheid, 2024). The nurturing of trust-based relations, could support this ’smooth’ collaboration, and was mostly mentioned in the case study of Schiphol Trade Park. As can be seen in the case study of Schiphol Trade Park, but also in the other case studies, the enabler of trust was mainly mentioned in the later phases; research and design and exploitation. This implies that in collaboration, time is needed to build upon these trust-based relationships.

Lastly, a lot of knowledge-related barriers were experienced in the case studies in more later phases, coming from the external stakeholders or between the companies and the cooperative. For the external stakeholder these were mainly focused on implementing measures to address the knowledge gap for different actors, and facilitation knowledge, while the companies build capacity through knowledge development with the cooperative. This helps to grow the knowledge of the actors, and take away uncertainties.

Synthesis

6

Results and Validation

The goal of the research was to provide more insights into the stakeholder collaboration of local energy systems on business parks. The proposed general actor network, based on the findings of the research, aims to give this insight. In this chapter, the results of the research will be explained, the general actor network will be proposed, and a focus group will validate the findings.

6.1. Results

Based on the findings of the literature review, the individual case studies and the cross case analysis, a generalized actor network was developed to give an insight into the collaboration of stakeholders on business parks with a local energy system. This actor network is build upon the aspects analyzed in the previous chapters, the current actor networks, vision and learning activities and the barriers and enablers of the collaboration. The synthesis of the findings from the case studies can be further seen in Appendix D, and will be discussed in this chapter.

As described in Chapter 5, there is one key actor in all actor networks, which is the organization that represents all companies on the business park, mostly in the entity of a cooperation. This organization is responsible for the management of the local energy system, and sometimes the storage of the electricity. The companies that use, generate and sometimes store the electricity are the end users of the local energy system on the business park. They also have a relative central position in the actor network, but lack influence and knowledge. However, this influence and partly knowledge is housed in the business park organization. This is mainly attributed to the fact that electricity is *”not their core business”* (THO-1, STP-4.2). Furthermore, derived from the questionnaires with the companies, most companies see the problem of net congestion as the main driver to collaborate on a local energy system, as it creates a solution to the problem. Interviewees support this observation (STP-4.2, HES-4.1, THO-4.2), mostly after companies become aware that their ”core business” or further growth of the business could be hampered by not getting a higher contracted capacity or new connection. This can also be seen in the barriers coming from the companies in the initiation phases of the case studies, by barriers concerning jargon, knowledge gaps and different needs coming from the companies. This shows that the companies do not initially have the knowledge to collaborate effectively with each other, and other actors. The frequent barrier of different needs and interest and the knowledge gap, also overlaps with two of the three core processes of SNM for a successful integration of pilot projects, which is a shared vision and learning activities, highlighting the importance of mitigating this barrier. To overcome these initial barriers in the case studies, enablers coming from the external advisors and sometimes public entities were used. By establishing synergies between actors and a focus on knowledge sharing, this resulted in mitigating the barriers in the later phases, and thus contributing to the collaboration.

Related to the companies, are the business groups that have been set up in the case study of Schiphol Trade Park en Tholen. In the exploitation phase of these case studies can be observed that the companies provide more enablers to the local energy system compared to the case studies without such an organization, as it involves the end users more in a informal form as well instead of just a formal form. The business groups organize workshops and knowledge session to inform the companies, and keep them engaged and up to date on the local energy system. These enablers coming from the business groups will also improve the efficiency of collaborating, helping the project move along. This 'business group' could also help with building a robust vision along the actors of the project, given that companies are more involved as a collective entity rather than individually. Next to that, it also helps with knowledge sharing through informal relations and events.

The public steering group holds an important factor in the network. The case studies with a active public steering group (Hessenpoort, Ecofactorij and Tholen) experienced little to no barriers towards the local energy system, whereas the public bodies involved in Schiphol Trade Park did show barriers to the local energy system in the initiation and research and design phase. However, there was a barrier coming from the public parties, which was the lack of policies for promoting collaboration. As explained in Section 3.3, there are already shifts in national legislation which should tackle this barrier in the near future. Next to that, it was mentioned in two interviews, that the trust of the companies increased because the public entities were actively engaged. This ensured them that the project was not being pushed by a single actor, but was really initiated for the collective. This trust than stimulates the collaboration in the project. Next to that, an active public steering group can also stimulate the project financially, by giving out subsidies. However, next to the financial stimulus, the public steering group can than also ensure conditions upon receiving the subsidy, as was done in multiple case studies. Knowledge sharing was one of the conditions of the subsidy handed out. This again aligns with one of the core processes of SNM, as an factor that will benefit the pilot project, and highlights the importance of the active steering group in the network. Furthermore, in the case studies, it benefitted the collaboration.

Next to the team formed by the public steering group, other groups are formed in the case studies as well. In the case study of Hessenpoort, all teams have an overlap of at least one actor. For the other case studies, not every team overlaps with the other teams. However, almost all main actors from the case studies are involved in a team and connected by a strong relation to the other teams. Ecofactorij is an exemption to this, as the regional network operator is not involved in a team. The teams and the overlap, ensure close collaboration. This can be seen as most barriers occur between actors from different teams, and not from actors within teams. Therefore, the assumption can be made that by creating overlap in the teams, these collaborational barriers can be mitigated even more, contributing to a better collaboration. Next to the barriers and enablers, the close collaboration as a result of overlapping teams, can also contribute to the shared vision. The vision of Hessenpoort seems to be to robust, specific and qualitative, while the other case studies lacks one of these aspects. Therefore, team overlap might contribute to aligning the project's vision, which stimulates the niche innovation.

As mentioned in the previous paragraph, the regional network operator at Ecofactorij is not as closely involved compared to the other case studies. In the case studies of Schiphol Trade Park, Hessenpoort, and Tholen, the role of the regional network operator remains largely consistent, as the local energy system involves a virtual layer above the physical grid, which falls within the responsibility of the regional network operator. In the case study of Ecofactorij, the local energy system is in the form of a closed distribution system, making the physical grid fall in ownership of a private party. This distinction results in a lot of barriers between these actors. Furthermore, the regional network operator and the other actors also have the biggest division in vision, which has a negative effect on the project according to the barriers and SNM, as described in Chapter 3. This implies that the regional network operator should be involved in the project, by its position, knowledge and influence, and to minimize the barriers.

Concluding, the aspects of the actor network, vision and learning activities, and barriers and enablers have been analyzed for the four case studies, and have an effect on the actor network of a project. Furthermore, it can be seen that the vision and the learning activities overlap with the barriers and enablers found in the literature review. By combining all the results from the research, a new generalized actor network has been proposed. This actor network aims to improve the understanding of stakeholder collaboration, and give an insight to the involved actors on how such a network could look like. The generalized actor network is based upon the findings and results discussed above, and serves as a proposal for future local energy system projects on business park. Its main purpose is to develop a better understanding of stakeholder collaboration for the actors involved, or those interested, in these kind of projects. The proposed actor network can be seen in Figure 6.1.

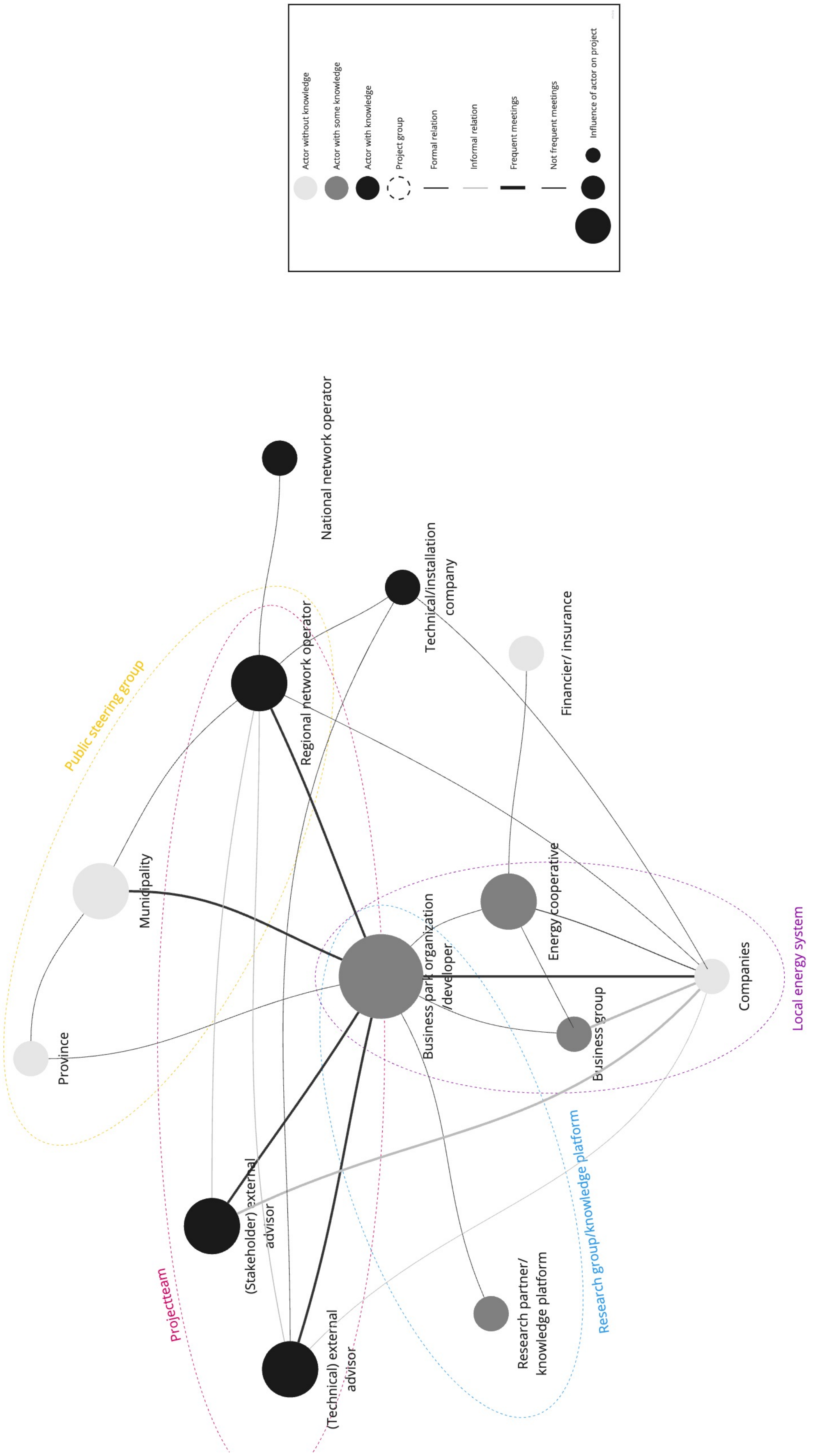

Figure 6.1: General Actor Network

6.2. Validation

To validate the results derived from the individual and comparative case studies, a focus group is organized. During the focus group, three experts working in the field of local energy systems are presented the aspects on the actor network, the vision and learning activities and the barriers and enablers within stakeholder collaboration. The experts will provide input on these aspects based on their experience in the working field. Furthermore, they were asked to compose an general actor network based on their experiences (and thus not based on the case studies), and the corresponding barriers and enablers that could occur between the actors. The results of this session can be seen in Appendix C.

One of the first actors positioned in the actor network composed by the actors was the 'ESCO'. An ESCO is an abbreviation for Energy Service Company. The ESCO takes over the management and maintenance of energy system solutions for other companies. Its aim is to improve the energy efficiency of their client (RVO, 2017). The ESCO can be compared to the overlapping business park organization, as the business park organization manages the local energy system for the connected companies. Therefore, the focus group agrees that the key actor of local energy system projects on business parks is the business park organization, as it holds a responsibility to managing the energy among the users, or outsources this, and represents all the end users. The position of the business park organization was also discussed, as there was a split on this in the case studies. For Schiphol Trade Park and Tholen the business park organization is not part of the project team, whereas for Hessenpoort en Ecofactorij it is. The focus group unanimously agreed that the 'ESCO' should be included in the project team, as it holds a key position in the network.

The focus group also agreed upon the aspect of the close involvement of the regional network operator. The experts of the focus group also highlight the importance of the regional network operator, and even indicated the actor as one of the key actors. Next to that, the experts in the focus group also emphasized the significance of public entities, particularly attributing this role to the municipality. They argued that the close involvement of these public entities will stimulate the project, as it can provide *"common ground"* and an *"level playing field"* for the involved actors. Both of these aspects is in line with the results of the case study, and the position of the actor in the proposed actor network.

An interesting remark, is the position of the end user in the general actor network created by the experts, as this differs from the analysis of the four case studies. The experts have given the end users a lot of influence, and placed them half into the project team. This was done as *"If the companies do not cooperate, the whole project will fail"* and *"participation is very important, to get the companies involved in the project"*. However, more was not mentioned about the companies. Another interesting aspect, is the division between the end users, and the real estate owner. This division was only mentioned by one out of the 16 interviews in the case study. *"The difference is that the owner of the buildings, does not always have to be the actor using the building".* This could mean that this division in actors could have an effect as they could have different needs and interests.

In addition, another actor was placed into the actor network by the experts: the project developer. *"For newly developed business park, a project developer could be involved".* However, as the scope of this thesis is on the current building stock, this actor was not mentioned in the case studies.

An actor only mentioned a couple times in the case studies, but multiple times by the focus group, was the ACM. This actor is the national regulator that oversees competition, consumer protection, and the regulation of specific sectors such as energy.*"The ACM in involved because it checks the markets, and because energy hubs are experimental projects, it keep a close eye".*

For the barriers and enablers, the experts focused most barriers with the end user. Barriers such as jargon, knowledge, lack of trust, investments and different interests are reoccurring themes. This matches the case study. One barrier that stood out, that was not mentioned in the literature or the case studies, was the lack of reference projects. As local energy system projects are still pilot projects, an actor will have to be one of the first ones to undertake such a project. *"You will have to be a pioneer, which most people are hesitant about".* This barrier is enhanced by another barrier formulated by the focus group: the uncertainty about law and regulation, meaning you do not only take risks as it is still an 'experiment', but also because national regulation do not yet permit the sharing of energy.

There was also an enabler that stood out during the focus group, which was: a drive for innovation. This enabler was attributed to the end users, the municipality and the ESCO. This overlaps with the personal enablers described in the literature, but was not as explicitly mentioned as a enabler. It focuses on the personal motivation of an actor to innovate, and try new things.

6.2.1. Changes of the proposed actor network

After the validation round, the preliminary results were analyzed again to adjust it to according to the validation when necessary. Overall, the experts agreed with most aspects of the findings and the result of the general actor network. However, it also differed in some aspects.

The position of the business park organization was not clear from the case studies, as it was included within the project team in two cases and excluded in two others. Furthermore, there was not enough sufficient information as to where the placement should be. Therefore, the business park organization was positioned on the edge of the project team. However, the focus group was very determined on the position of the 'ESCO', which is a equivalent for the business park organization, and placed within the project team. Therefore, the business park organization will be positioned within the project team. This could also benefit greater involvement, and better alignment of the vision as explained in Section 6.1.

The end user got special attention in the focus group, and was also placed within the focus group. However, the experts' arguments primarily focused on engaging the end user and involving them for participation, rather than assigning them a significant role within the project group. Therefore, the companies will not take place in this team. Yet, it is good to keep in mind that all companies are represented in the business park organization, and therefore are represented in the project team as a whole. As the ACM was mentioned a few times in the case study, and specifically mentioned by the experts. The actor will be added to adjusted actor network.

Lastly, the addition of the project developer by the focus group will not be taken into account, as this actor was mentioned in regard to newly developed business park, and this thesis focuses on the existing building stock, this actor will not be included in the general actor network. The adjusted general actor network will be presented in Chapter 7.

Conclusion & Discussion

7 Conclusions

In this chapter, the results of the research will be discussed, to formulate an answer to the proposed research questions of this thesis. Based on these questions, a conclusion will be drawn focusing on the adjusted actor network, to facilitate a robust, specific and qualitative vision, incorporates learning activities and tackles barriers by the enablers. First, the answers to the sub research question will be formulated, where after the main research question will be answered. The end product, the general actor network, will provide part of the answer to the main research question. Next to the conclusions, recommendations to further research and practice are also presented, based on this research.

7.1. Research questions

The main research question of this thesis was: *How can underlying factors influence stakeholder collaboration to improve further deployment of local energy systems on business parks?* To address this main question, four supporting sub-research questions were formulated. These questions will serve as the foundation for answering the main research question.

SRQ1: *What factors stimulate the further deployment of local energy systems?*
The aim of this research question was to investigate the aspects that had an effect on the stimulation of local energy systems. These aspects form the base for the further research on which factors have the most influence in the further development, in relation to the social aspects: collaboration.

This sub research question was answered with a literature review. The literature of the Multi Level Perspective framework by Geels (2011) and the Strategic Niche Management framework by Schot and Geels (2008), gave an answer to this sub research question. The Multi Level Perspective framework analyses the context of niche-innovations such as local energy systems. It provides the context of how a niche-innovation can settle into the socio-technical regime, which corresponds with the aim of this research. For this niche-innovation to enter the socio-technical regime, the Strategic Niche Management theory describes three core processes that support this transition: the articulation of expectations and visions, the building of social networks, and the learning processes. These are the factors that stimulate the further deployment of the local energy systems.

As the research gap discovered focused on the lack of insight into the collaboration practices in this field, a focus was put on the social network of the three processes. However, as these three core processes are interdependent, the other two factors will be taken into account as well, to research what effect these have on the social network.

SRQ2: *What are the current practices of collaboration on business parks?*
For this research question, case studies were used to, as the research question implies, analyse the current practices. The actor network analysis by Gerding et al. (2021) was used to investigate this. This tool visualizes the project actors through nodes. The color of each node indicates the actor's level of knowledge, while the size represents their influence. Additionally, connections between actors are depicted by lines, with the color indicating the formality of the relationship, and the thickness reflecting the frequency of interaction. Next to that, the case studies were used to determine the robustness, specificity and quality

of the vision of the projects, and the presence of first- and second-order learning activities. The outcome of these actor network analyses and the other factors for the case studies are described in detail in Chapter 4 and Chapter 5.

For the collaboration on business parks operating on a local energy system, one main actor has been identified. The business park organization has a central position in the network, as it has the most relations with other actors. Furthermore, as it holds the responsibility of the control of the local energy system to all its users, it also has the most influence on the project. The business park organizations does not have all the knowledge of the project, but outsources this to external advisors. In addition to the many relations the business park organization has with the other actors, these relations are also mostly frequent and formal ones. Next to the business park organization, the regional network operator and the connected companies also have quite a central role in the network. These are also actors that have a direct relation with the business park organization. This shows that every collaboration is centred and organized by the business park organization.

In addition to the social network factor, the study also investigated the vision and learning activities. Most case studies, lack some robustness. However, overall, the vision is shared. The division is mainly present between a few specific actors. The specificity of the case studies scores different for each case study. In some cases it is for every actor very clear what the next step are, while others do not have it that clear. The quality of the vision scores well for every case study, as the actors are content with how the experiment matches the expectations. Furthermore, the case studies underscore the role of both internal and external actors in organizing learning activities. In particular, the involvement of external advisors and research groups enhances second-order learning, contributing to the strategic management of niche innovations. On the other hand, subsidies and the knowledge platform stimulate the first-order learning. Both first-order learning, and second-order learning are important for strategic niche management.

SRQ3: *What are the barriers and enablers within stakeholder collaboration?*
For the research to barriers and enablers within stakeholder collaboration, the same case studies as mentioned in the previous research question were used. The case studies were examined based on the barriers and enablers experienced by the selected interviewees, and these were structured into three phases: initiation, research and design, and exploitation. To organize the identified barriers and enablers, the frameworks established by Papenhuijzen (2024) and Ganeshu et al. (2023) were used.

In all the case studies, companies encountered barriers to adopting local energy systems, primarily due to knowledge gaps and unrecognized common interests. External advisors played a crucial role in mitigating these barriers by raising awareness, fostering a shared vision, and closing the knowledge gap. Communication barriers, often caused by jargon, were present in the initiation phase but were typically resolved as stakeholders got used to working together. Different needs and interests posed additional challenges, particularly among companies content with their existing energy systems. These barriers were addressed through knowledge-sharing initiatives led by external advisors.

A lack of supportive policies from the government also hindered collaboration, but pilot project exceptions and financial resources from public actors helped overcome these obstacles. Trust-based relationships, particularly in the Schiphol Trade Park case, emerged as a vital enabler for smooth collaboration. Lastly, knowledge-related barriers in later phases underscored the importance of ongoing capacity-building efforts to grow actors' knowledge and reduce uncertainties. Overall, the barrier and enablers highlight the importance of shared vision, knowledge sharing, close involvement of stakeholders, and nurturing trust-based relations. The further details of the barriers and enablers of the case studies can be seen in Chapter 4 and Chapter 5.

SRQ4: *To what extent do these collaborations facilitate the underlying factors?*
This research question provides a first step for combining the factors which influence the further deployment of local energy systems with the experienced barriers and enablers within stakeholder collaboration. It describes how collaboration facilitates the underlying factors, so the further deployment of the local energy system can continue. A comprehensive analysis on this combination can be seen in Chapter 6.

The organization representing all companies in a business park, forms the main actor in the actor network. This organization manages the local energy system and, at times, the electricity storage. The companies using, generating, and occasionally storing electricity are the end users, occupying a central but less influential and knowledgeable position in the network. This is because electricity is not their primary business focus. Initial barriers include jargon, knowledge gaps, and differing needs, hindering effective collaboration. Overcoming these barriers involves external advisors and public entities, who facilitate knowledge sharing and synergy between actors, thus enhancing collaboration. Companies see net congestion as the main reason for collaborating on a local energy system, recognizing that it can impact their core business operations and growth. Furthermore, business groups established in case studies provide more support to the local energy system than case studies without such organizations, engaging end users informally and formally through workshops and knowledge sessions. This helps in promoting more enablers in the exploitation phase, and builds upon the vision and learning activities within the project.

The public steering group plays a crucial role in the network. Case studies with an active public steering group encountered fewer barriers, unlike Schiphol Trade Park, which faced obstacles in the initiation and research phases. Active public engagement increased trust among companies, ensuring the project was seen as a collective effort rather than driven by a single actor, thus enhancing collaboration. Additionally, the public steering group can provide financial support through subsidies and set conditions like knowledge sharing, aligning with the core processes of Strategic Niche Management.

In addition to the public steering group, other teams were formed in the case studies. Close collaboration through team overlaps mitigates barriers, particularly those occurring between different teams, and contributes to a shared vision. The robust vision seen in case studies with overlapping teams suggests that team overlaps might help align project visions, thereby stimulating niche innovation.

The case studies highlight the importance of the regional network operator's involvement, showing that their participation is associated with fewer barriers and a more aligned vision among actors.

7.2. General conclusion

The answers formulated for the sub research questions lead to answering the main research question:

How can underlying factors influence stakeholder collaboration to improve further deployment of local energy systems on business parks?

The vision of a project, the (social/actor) network and the learning activities are derived as the underlying factors for the further deployment of local energy systems. Based on this study, it seems that the vision is supported in an actor network where close relations between the different actors are formed. Furthermore, team overlap has a positive impact on the vision alignment. The business park organization seems to be the most central actor, where everything is organized around it. In accordance to the literature, it seems that external actors stimulate second-order learning, whereas first-order learning is mostly implemented by internal actors. This highlights the importance of a broad network. A close collaboration with the public steering group and the regional network operator also seems to mitigate the barriers experienced by other actors in the earlier phases, whereas the informal ties with a business group stimulate the enablers in the exploitation phase, keeping the companies engaged and informed in the project. Ultimately, the general actor network fosters a more cohesive and knowledgeable network, driving the project forward with shared expertise and commitment.

The conclusions combined, based on the literature review, the actor networks, visions, learning activities, barriers and enablers derived from the case study and validated by the focus group, has lead to an adjusted, generalized actor network. This actor network can be seen in Figure 7.1.

7.3. Recommendations

Since local energy systems are still in their pilot phase in the Netherlands, this research was conducted during the early stages of their development. Next to that, there is not yet clear regulations on these collaborative practices on business parks, which has its effect on the collaboration. The introduction of the new group contract might bring changes to the collaboration, and an new analysis could give different outcomes. Additionally, it is possible that other barriers may become more prevalent than the social ones, necessitating further research on those issues. In this section the recommendations for further research will be discussed, as well as my personal recommendations for practice.

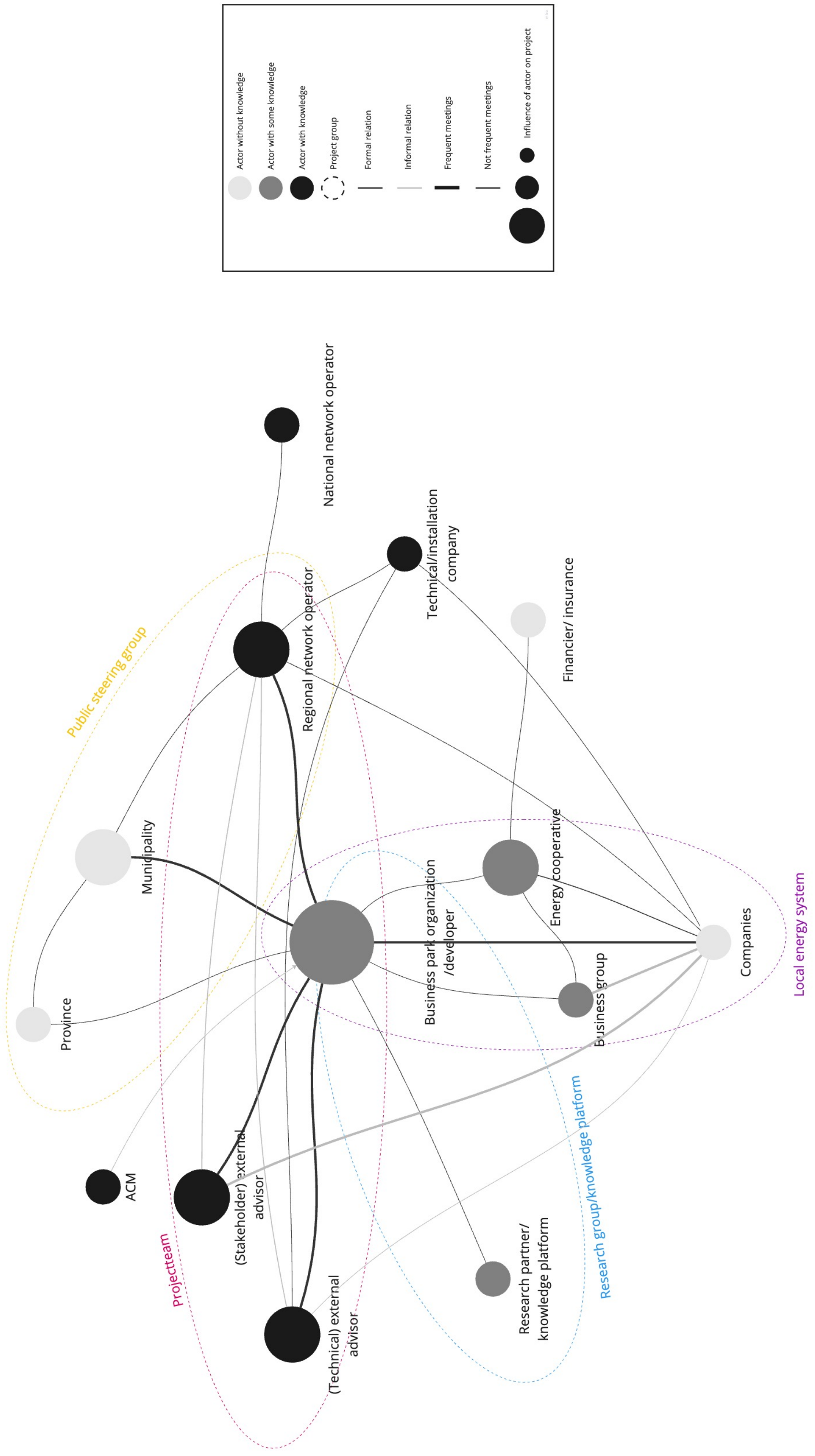

Figure 7.1: Adjusted General Actor Network

7.3.1. Recommendations for further research

This research aimed to get an insight on the stakeholder collaboration, and did so by proposing a general actor network. The actor network helps all involved stakeholders to visualize what other stakeholders are involved and how these relate to each other to stimulate the local energy system. It serves as a guideline how the social network could look like, but does not say anything about how to set it up, or in which phase which actor should join the collaboration.

Further research could focus on the way to the actor network. What steps should be taken to set up the organisation and the collaborations? Which actor is involved in what phase, and who should take the lead? Furthermore, research focusing on the end-users role in this collaboration could be beneficial for the academic field. The analysis on barriers indicated that companies experience different needs and interest as one of the main barrier to the development of the local energy system. An insight into what these needs and barriers are, en how to join them into one shared vision, would be very valuable. The use of assets could also influence this, as companies with large production halls have more roof space for solar panels compared to those with office buildings.

Most importantly, as the business park organizations was identified as the main actor in the social network, research on how companies on a business park can join together in such a business park organization would be valuable. Nearly 90% of Dutch business parks does not have such a organization set in place (CE Delft, 2023), and therefore a lot of impact can be made on researching this subject.

This research focused on existing business parks, with Schiphol Trade Park being a unique case as it was partially developed with both existing and new buildings. This distinction influences collaboration since newly developed business parks face uncertainty in securing sufficient capacity, making companies more inclined to collaborate on a local energy system out of necessity. In contrast, companies on existing business parks already have adequate electricity supply and must adapt their systems to participate in a local energy system. Therefore, this difference has its influence on the collaboration, and could lead to other results. As there are more business parks being developed, research focusing on this aspect would add value as well.

7.3.2. Recommendations for practice

This study is aimed at all involved stakeholders in local energy systems on Dutch business parks. It gives them an insight into the actors and their relationships, demonstrating how these interactions, supported by a shared vision, learning activities, and barrier mitigation, could contribute to the further deployment of local energy systems. However, as mentioned above, for companies located on a business park and interested in setting up a local energy system, the first step would be to set up a business park organization. Several organizations have published a blueprint for this, such as: EIGEN (Eigen, 2023), Firan (Firan, 2024), and RVO (RVO, n.d.), however these are still from quite a broad perspective, and does not get into detail on the different needs and interest of the end-user.

In the case studies it became apparent that the financiers and insurance companies showed reluctance at first, as they did not know how to guarantee their investments. For these actors, the local energy system is still a novel concept. Hence, this knowledge gap needs to be tackled upfront to stimulate the process. Therefore, these organizations should acquire more knowledge to make informed decisions about participating in such projects. This could either be done by the organizations themselves, or the government could set up knowledge sessions to accelerate the the speed on the project progress.

Furthermore, for organizations that want to set up a local energy system such as a municipality or area developer, one of the first steps would be to make the end user aware of positive and negative aspects of collaboration. Net congestion helps with this, as more companies become aware that net congestion could also effect their company, and the local energy system could form a solution. In the case studies can be seen that the companies show hesitancy in the starting phases as they do not have sufficient knowledge on the project. Therefore, sharing knowledge about the problem and the solutions, will help in mitigating this barriers and help the project move along.

However, one of the main barriers still remaining, is the uncertainty about the actual guidelines of the group contract. Several forms have been discussed, but there is no clarity on which the formal form will be. This barrier is also visible in the case studies, as there is a lack of regulations and policies coming from the national government. Therefore, the government should publish these guidelines as soon as possible, so all organizations can act upon the new ways of sharing energy.

8 Discussion and Limitations

This chapter discusses the findings of the research and its methods and outlines its limitations. Furthermore, it discusses the local energy system in a more broader context.

8.1. Discussion

The current world of energy systems is a very fast paced world. Net congestion is a problem of the recent years, and therefore a relative novel practice for many. The literature highlighted there is a need for a better understanding of the social aspect of this energy system transition, which this research dived into. It contributes to the academic field by offering a deeper understanding of stakeholder collaboration and identifying factors that can influence and enhance the deployment of local energy systems.

"Technically, and financially, everything is already possible, but socially this remains the biggest task" (STP-4.2). This quote is a sound you hear everywhere when talking about local energy hubs. It comes from the general barrier, that there are many actors involved. However, multi-actor projects are not new to the world, and being performed successfully every day. The main difference here, is that most actors are not used to working together, and have no knowledge on the project. This creates the friction for initiating local energy systems. As can be seen in the case studies, the knowledge mostly comes from external stakeholders. Therefore, these actor networks need to be designed in such a way that the knowledge of these external actors is well integrated into the project. This is also one of the core processes for pilot projects/niche-innovations to settle into the day-to-day standard. Both literature and practice therefore highlight this importance.

Next to the knowledge of the stakeholders, the uncertainty also plays a crucial factor in the development of the local energy system. This mainly stems from the lack of policies or regulations. Everything you do now, can be changed in the upcoming future. This result can also be seen in the barrier coming from the national network operator in the exploitation phase of the case studies. As can be seen in the actor networks of the case studies, the national network operator is not directly involved with the project. However, it has announced in February 2024 that the local energy systems are not aligned with the national grid (Tennet, 2024), and therefore could make the net congestion issues locally even worse. This is because the local energy systems are only aligned with the regional grids. This news article created even more uncertainty for actors and therefore hesitance for the further deployment of the local energy system.

Another uncertainty factor, is the outlines of the group contract. In the letter send out by the minister of Economic Affairs and Climate in October 2023 (Ministerie van Economische Zaken en Klimaat, 2023), the new group contract was announced, however the outlines remain unknown. In the position paper of Netbeheer Nederland, they proposed the 'Group Transport Agreement' (Netbeheer Nederland, 2023), however regional network operators like Stedin have announced that they wont be working with that form anymore, but are leaning towards the 'Capacity Limiting Contract' (CBC, NL= Capaciteits Beperkend Contract) form (THO-2), a more flexible contract where the capacity can be down scaled by the regional network operator, announced 24 hours beforehand when congestion is likely to occur. Due to the lack of clear guidelines, end-users are hesitant to commit to a collective version. Therefore, the government needs to be clear in their communication, and give clear guidelines on what the end-user can expect in the coming years. This needs to be coordinated with network operators to ensure the new regulations do not cause issues on the grid and are beneficial for its stability. However, according to interviewee STP-2, the baseline will be the group contract, and the variations in execution will not directly impact the collaboration practices.

In accordance to this clarity demanded from the government, several steps have already been taken. In May 2024, the ministry of Economic Affairs and Climate announced that the sharing of energy will be adopted by the new Energy Law (which will replace the Electricity Act 1998, see Section 3.3 Ministerie van Economische Zaken en Klimaat, 2024a). This means that local energy systems will be implemented not only through pilot projects but also as standard practice. Furthermore, a subsidy has been announced to stimulate the further deployment of energy hubs (Ministerie van Economische Zaken en Klimaat, 2024b). The term energy hub is defined in the letter as: "A defined area where energy supply and demand are matched, through smart design and control of public infrastructure". As they define "through public infrastructure", this means that the form of Ecofactorij will not be stimulated. These closed distribution systems are not preferred because a private organization would then control a part of the grid. Due to strict regulations on stability and safety, it is essential to keep control in the hands of the network operators (STP-4.2). This means the local energy system would be in the form of a virtual grid.

This then also awakens the question, who should control this virtual grid? The physical grid is in the hands of the network operator, while the demand comes from the end-user. The virtual grid, needs to ensure the stability of the public grid. If we compare it to the heat sector, which was previously dominated by private companies, the new Energy Law will require a shift towards public entities holding a majority stake. Therefore, although the control of the local energy system in the case studies is currently in the hands of the business park organization, it raises an interesting discussion about whether this model will be sustainable in the long term.

This research is based on theory, by conducting a literature review as the first phase. The literature highlighted, next to the base knowledge of local energy systems, the three core processes to stimulate niche-innovations, such as local energy systems. The SNM theory describes that the three core processes are interdependent. Due to the research gap defined in this research, the focus on the social network got highlighted in this research, while also taking vision and learning activities into account as described by SNM. By taking this approach, it became apparent that they are indeed interdependent, as they influence each other. The alignment of the vision gets stimulated by a coherent network, as well as the involvement of certain actors for stimulating the learning activities. Therefore, by focusing on one of the three processes, it will influence the other two as well. Furthermore, these core processes also overlap in the list of barriers and enablers, especially when testing them to the case studies. The main barriers and enablers were about knowledge or needs and interest of the stakeholder, underlining the importance of the core processes as well.

Cultural differences in business parks were highlighted by several interviewees. One interviewee noted, "In the western part of the Netherlands, people often wonder what's in it for them when asked to help a neighbor, and why they should assist a competitor. However, in the eastern part, people are more willing to cooperate." These cultural differences can influence collaboration practices in business parks, as can differences in operating areas. Technically, a variety of building functions benefits the local energy system by ensuring that peak usage times are distributed throughout the day. Additionally, this functional diversity might enhance collaboration, as the end-users are not direct competitors. Understanding this synergy between the cultural and operational differences, could enhance not only the technical aspects of the local energy system, but also the collaboration aspects.

For the focus group of this research, independent experts were selected to validate the findings of the case study. This was done to not get any sentiment or bias involved. A risk when selecting stakeholders from the case studies that they would prefer they own way of working. However, by choosing independent experts, this also meant that the suggestion made based on the case study, could not be tested with the actual people working on these projects. The independent experts could give their honest opinions, without any personal emotions getting in the way. On the down side, this also meant that they are not aware of the details of the projects which could influence the outcomes. This consideration should be made for every research, and be motivated which selection would add the most value. For this research, to validate the findings and apply them to a general setting, the independent experts were chosen.

8.2. Limitations

This research tried to gain a better understanding of the collaboration on business parks using a local energy system. As there was only limited research done, this study provides a broad overview of the collaboration, on multiple aspects. By selecting four case studies and conducting 4 to 5 interviews for each, detailed aspects had to be prioritized over comprehensive coverage. However, this limited number of cases was selected to allow for both individual case studies and comparative case-studies. On the other hand, this also meant that a more detailed description of collaboration on the business park itself, between the end users is lacking because of time restrictions, too many end-users and low response. In this research, this part was covered by conducting a questionnaire, however this did not result in in-depth findings. This recommendation for further research, has been described in Section 7.3.

Another limitation in the case study was the missing interview of the regional network operator of Ecofactorij. This was an important interviewee, as this actor seemed to experience and show a lot of barriers, based on the interviews of the other actors. Unfortunately, this actor did not response to the multiple invitation send, and therefore their point of view could not be taken into account.

The experienced barriers and enablers by the interviewees, were divided between three phases. However, the actor network was only focused on the exploitation phase of the local energy system, aiming to provide insights into collaboration aspects rather than focusing on the setup process. This limits the research as the network also changes over time. Therefore, this study serves as an initial exploration into the stakeholder collaboration during the exploitation phase of local energy systems. Further research is needed to understand the entire life-cycle of these systems, including their initial and research and design phases, in order to develop strategies that address all underlying factors to stimulate further deployment.

Lastly, the research is based upon case studies in the Netherlands, and uses the context of Dutch law. Therefore, the results are aimed at Dutch stakeholders involved in local energy systems on business parks. An exploration on the differences between this Dutch model and international examples would be valuable to provide an insight for such project all over the world. Furthermore, the results are based on four case studies in the Netherlands and validated through a focus group. To increase its validity, the general actor network should be compared to more projects to see if there are major differences, and if the actor network could be improved.

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A

Appendix A: Interview Questions

Check if the consent form has been signed and emailed!

Part 1: Introduction
1. Can you briefly introduce yourself?
2. Can you describe your role?
3. Can you briefly describe the organization you work for?

Part 2: Network
Bring the first draft of actor-network analysis to discuss with interviewee.
4. What is the position of your organization within this network?
a. What is your role and contribution?
5. Which actors are indirectly/directly involved in the project?
a. What is their role, contribution, and position?
b. How many companies are connected?
6. What is the relationship between these actors and how do they collaborate?
a. How should they collaborate?
b. How often do the actors meet
7. Which actors has the most…
a. Influence on the project
b. Knowledge on the project

Part 3: Interactions influencing actors/the project
If the conversation gets stuck: reference to barriers and enablers list
8. Have you experienced any barriers coming from a specific actor to another actor or yourself?
a. What were these barriers and between what actors were they?
b. Including your own organization
9. Have you experienced any enablers coming from one specific actor to another actor or yourself?
a. What were these enablers and between what actors were they?
b. Including your own organization

Part 4: Expectations and vision and learning activities
10. What is a smart grid, and what was the main reason for implementing a smart grid in this location?
a. Possible answers: net congestion, high grid investments thus efficient energy system or local energy trading.
b. If net congestion: would this smart grid still exist if there was no congestion anymore?
11. What are your expectations for this smart grid project for the next five years, and further?
a. And what are those expectations specifically for your organization?
12. What is the vision of your organization regarding the next five years, and further <specific case>?

a. What factors influence this vision?
13. To what extent does your vision align with the visions of other actors within <specific case>?
a. Are the next steps for achieving those expectations and visions clear? Who does what?
14. Are there any learning activities organized in the smart grid?
a. Are there feedback mechanisms included in the collaboration of the network of the smart grid?
15. Were there any barriers in the past that have been tackled?
a. What were these and how have they been tackled?

End: This was the end of the interview, thank you for participating. After transcription, I will email the transcription and the first draft of the actor-network for a check. Please let me know if any adjustments are necessary afterwards.

• *Any missing interview participants? Ask the interviewee for recommendations.*

B

Appendix B: Questionnaire questions

Introduction
Beste,
Ik nodig u graag uit om deel te nemen aan mijn enquête, gericht aan de gevestigde bedrijven op Schiphol Trade Park. De enquête zal 10 minuten duren, en wordt gebruikt voor mijn afstudeerproject voor de master Management in the Built Environment aan de TU Delft. Tijdens mijn project doe ik onderzoek naar de samenwerking van betrokken partijen op bedrijventerreinen die gebruik maken van een lokaal energie systeem, zoals een smart grid, virtueel net of energy hub. In de afgelopen weken heb ik interviews afgenomen bij de organisatie van uw bedrijventerrein, de netbeheerder en externe adviseurs. Heel graag neem ik in mijn onderzoek ook het oogpunt van de gevestigde bedrijven op het bedrijventerrein mee, vandaar aan u de vraag om onderstaande enquête in te vullen.

De enquête is vertrouwelijk en anoniem. De enige ‘specifieke’ informatie is de naam van uw organisatie en uw rol. Dit is om alle stakeholders goed in kaart te kunnen brengen, en te weten vanuit welk oogpunt er informatie gegeven wordt. De antwoorden van de enquête zijn alleen inzichtelijk door mij, Floor Berkouwer (student TU Delft), en mijn afstudeerbegeleiders van de TU Delft, Henk Visscher en Erwin Mlecnik. Uw deelname aan dit onderzoek is volledig vrijwillig, en u kunt zich elk moment terugtrekken zonder reden op te geven. U bent vrij om vragen niet te beantwoorden of om naderhand toegang te vragen tot het transcript en informatie te wijzigen/verwijderen.

Als u vragen heeft over het onderzoek kunt u contact opnemen via e-mail (.....@student.tudelft.nl) of telefoon +31 (0)6 ....

Het doorklikken naar de survey betekent dat u dit opening statement begrijpt en hier mee instemt.

In de enquête wordt gesproken over ‘het project’. Hiermee wordt het opzetten, beheren en gebruik maken van het lokale energie systeem bedoelt.

Part 1, Introduction 1. Wat is de naam van het bedrijf?
2. Wat is uw rol binnen het bedrijf?

Part 2, The Social Network
3. Wat is de positie van uw organisatie binnen het project? Wat is de rol van het bedrijf en eventuele bijdrage aan het project?
4. Met welke stakeholders betrokken bij het project heeft uw organisatie contact?
5. Welke andere stakeholders zijn er betrokken bij het project?
6. Welke stakeholders hebben de meeste invloed in het project?

a. relevant options for the specific case
7. Welke stakeholders hebben de meeste kennis over het project?
a. relevant options for the specific case

Part 3, Interaction
Kunt u voor de volgende stakeholders aangeven of hun onderlinge relatie stimulerend, neutraal of demotiverend of ontbrekend is, en waarom?
Relaties tussen:
8. De gevestigde bedrijven en Cooperatie, Gemeente, externe adviseurs, overige
a. Stimuleren
b. Neutraal
c. Demotiverend
d. Niet aanwezig
e. Anders, ..
9. Kunt u de gekozen relatie tussen De gevestigde bedrijven en <insert other actor> beschrijven?

Part 4, Vision and Learning Activities
10. Wat was de belangrijkste reden om een lokaal energie systeem te realiseren op Schiphol Trade Park?
11. Wat is uw visie/verwachting voor het project voor de volgende 5 jaar?
12. Zijn de volgende stappen om die verwachtingen en visies te bereiken duidelijk? Wie doet wat?
13. Denk u dat uw visie aansluit bij de visie van de andere betrokken partijen?
14. Worden er leeractiviteiten georganiseerd binnen het project? (feedback momenten, kennis delen etc.)

The end
Zijn er nog andere punten die u graag wilt toelichten met betrekking tot het samenwerken van stakeholders op Schiphol Trade Park met betrekking tot het lokale energie systeem?

C

Appendix C: Outcomes Focus Group

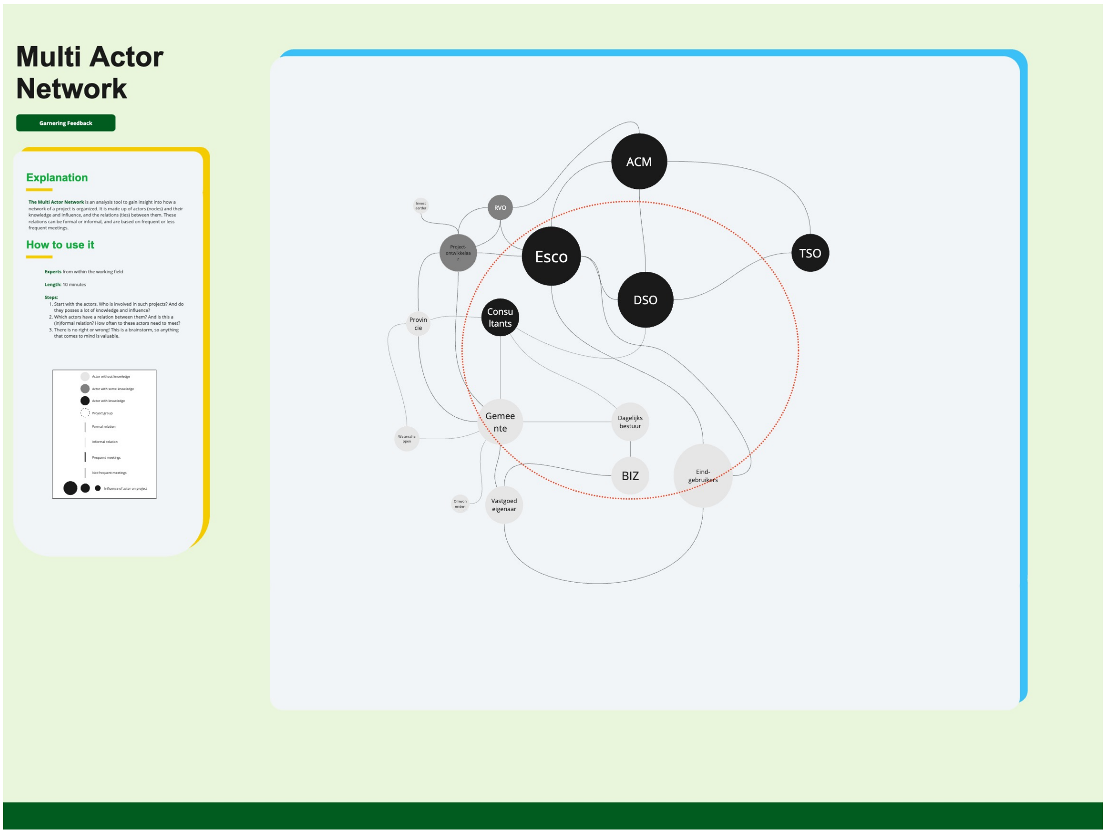


Figure C.1: Outcome Focus Group Step 1

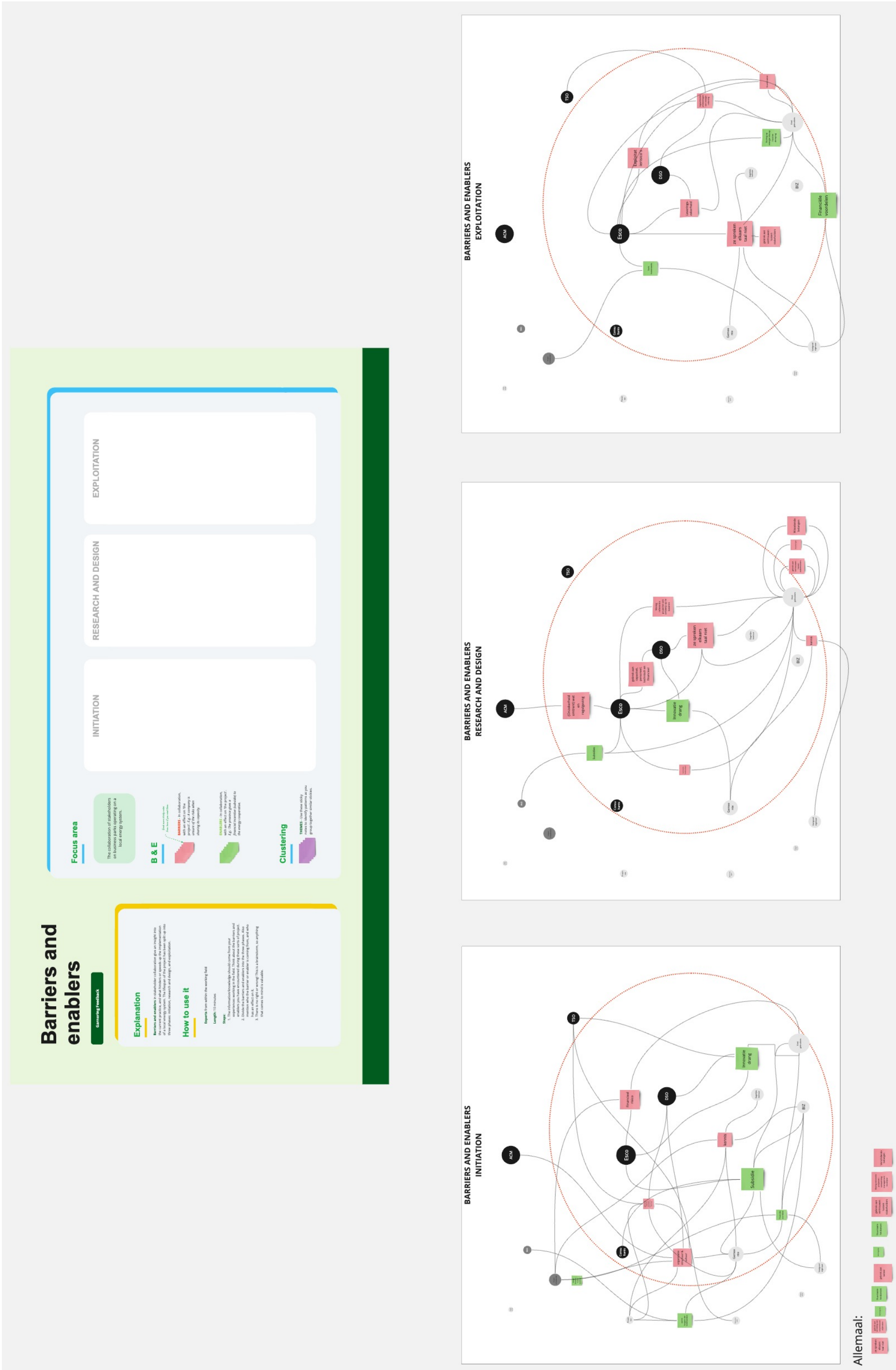


Figure C.2: Outcome Focus Group Step 2

D

Appendix D: Synthesis Findings

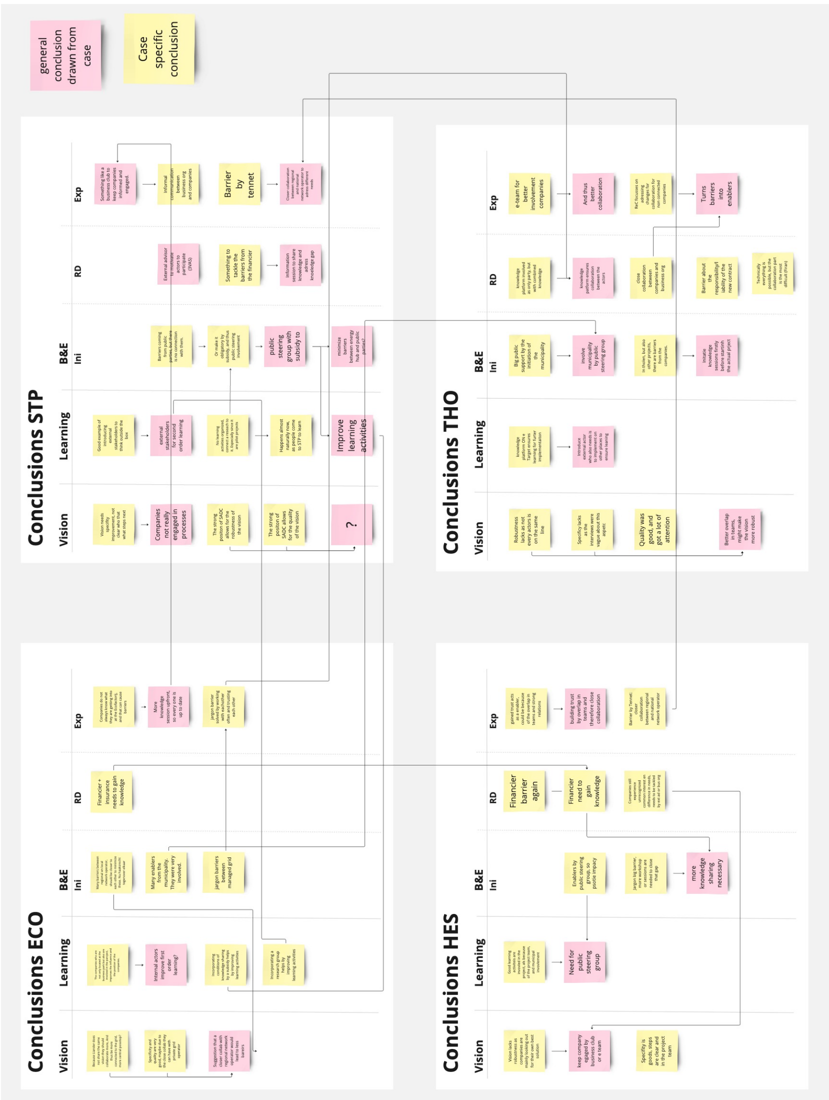


Figure D.1: Outcome Synthesis findings

E

Appendix E: Desk Research Documents

Schiphol Trade Park
Documents

- Presentatie SADC
  - Overzicht van de werking van het virtuele net, aandeelhouder constructie, locaties op de kaart
- Stakeholder document SADC
  - Omschrijving vier belangrijke stakeholders
- Podcast BNR
  - Ins and outs van het virtuele net, en waarom deze oplossing
- Strategisch Meerjaren plan SADC
  - Inzet op innovatie in de omgeving zoals het virtuele net

Websites

- https://www.schipholtradeparkservices.nl
  - Algemene website
- https://www.schipholtradeparkservices.nl/businessclub/bedrijven/
  - Gevestigde bedrijven
- https://www.sadc.nl/beschikbare-kavels-bedrijven/schiphol-trade-park-energy-hub/
  - Algemene website vanuit SADC
- https://www.sadc.nl/schiphol-trade-park-meest-duurzame-logistieke-business-park-ter-wereld/
- &
- https://www.breeam.nl/projecten/schiphol-trade-park-5229
  - Meest duurzame bedrijventerrein
- https://spectral.energy/nl/project/schiphol-trade-park-smart-grid/
  - Process beschrijving project + enkele stakeholders

Hessenpoort

Documents

- Presentatie Enexis
  - Stakeholder map, beweegredenen Enexis

Websites

- https://www.enexisgroep.nl/nieuws/provincie-overijssel-gemeente-zwolle-en-enexis-netbeheer-ondersteunen-bedrijven-in-zwolle-voor-collectieve-samenwerking-bij-netcongestie/
  - Opzet vanuit public steering group
- https://oostnl.nl/nl/nieuws/smart-energy-hub-regio-zwolle-noord-van-start
  - Speciale focus op samenwerking met regionale netbeheerder
- https://solarmagazine.nl/nieuws-zonne-energie/i35499/het-bedrijventerrein-van-de-toekomst-is-een-smart-energy-hub
  - Interview met de parkmanager van Hessenpoort
- https://www.zwolle.nl/hessenpoort
  - Algemene gemeente site Hessenpoort
- https://www.deswollenaer.nl/nieuws/algemeen/290992/samenwerking-op-hessenpoort-voor-betere-benutting-elektricite
  - Start SEH en samenwerkingen

Ecofactorij
Documents

- Presentatie Managed Grid Intern
  - Inzichten in de techniek en systemen die alles regelen.
- Beeldkwaliteitplan Ecofactorij - Gemeente Apeldoorn (2012)
  - “Het werken op basis van een Handreiking vraagt om een heldere procesmatige borging gericht op samenwerking tussen de gemeente, de initiatiefnemers en de ontwerpers. Deze samenwerking moet leiden tot probleemloze vergunningprocedures, het maken van goede plannen en het borgen van de ruimtelijke samenhang tussen alle ontwikkelingen in het gebied.” - p. 8
  - Duidelijke eisen over duurzaamheid en uiterlijk.
- Openbare Notulen van de vergadering van Burgemeester en Wethouders gemeente Apeldoorn van 30 mei 2023
  - Besluit: Het college besluit conform het voorstel, met dien verstande dat redactionele wijzigingen worden aangebracht.
  - V: Specificity, robust. Wordt door de gemeente gedragen.

Websites

- https://ecofactorij.nl/project/mooi-project/
  - Betrokken stakeholders beschreven
- https://ecofactorij.nl/bedrijven/
  - Gevestigde bedrijven
- https://ecofactorij.nl/nieuws/rabobank-financiert-de-aanschaf-van-batterijen/
  - Betrokkenheid Rabobank
- https://www.ivn.nl/werklandschappen-van-de-toekomst/innovatiedatabase/eigen-gesloten-elektriciteitsnet/
  - Uitleg GDS
- https://www.sparklingprojects.nl/nieuws/cooperatie-de-ecofactorij-zet-energieke-stappen-dankzij-rabo-financiering
  - Betrokkenheid stakeholders beschreven, financiering beschreven
- https://www.8rhkverbindt.nl/op-bezoek-bij-energie-hub-ecofactorij/

  - Informatiebijeenkomst Ecofactorij voor geinteresseerde
- https://ecofactorij.nl/eigen-elektriciteitsnet/
  - Uitleg over de GDS

Tholen *Documents*

- Video opening energy hub Tholen (https://www.youtube.com/watch?v=MeeuBs6A2gg)
  - Stakeholder map, beweegredenen Enexis

Websites

- https://slabbecoornpolder.on-e-target.nl
  - Algemene site
- https://slabbecoornpolder.on-e-target.nl/index.php/services/
  - Gevestigde bedrijven
- https://slabbecoornpolder.on-e-target.nl/index.php/eteam/
  - E-team van Tholen
- https://www.stedin.net/over-stedin/pers-en-media/persberichten/in-gebruik-genomen-energy-hub-rec-tholen-leidt-tot-meer-ruimte-op-het-elektriciteitsnet
  - Actief worden van de energy hub
- https://solarmagazine.nl/nieuws-zonne-energie/i35417/groepscontract-stedin-met-energy-hub-rec-tholen-voor-ontlasten-stroomnet
  - Tekenen van het groepscontract
- https://www.stichtingzeeuwsepubliekebelangen.nl
  - Partner Stichting Zeeuwse belangen

F

Appendix F: Codes

SRQ2: INTERACTIONS INFLUENCE THE PROJECT / BARRIERS & DRIVERS

STAKEHOLDER COLLABORATION BARRIERS (33)

External barriers

Theme	*Code*	*Barrier*
Policies and Legislation	A1	Absence or lack of policies that promote collaboration
	A2	Lack of coherence in government policies and legal instruments
	A3	Lack of legislation support, legislative authority to delegate stakeholders' responsibilities and duties
	A4	Lack of defined financial plans and implementation roles
Governance	B1	Lack of clear-cut responsibilities and overlapping responsibilities among stakeholders making the system ineffective and less accountable
	B2	Rigid formal governance structure
	B3	Lack of coordination mechanism in governance arrangements
Politics	C1	Lack of political guidance/support/leadership /willpower for planning and implementation
	C2	Political interference
	C3	Competing interests and visions among politicians
	C4	Thematically structured political committees

Inter-organizational barriers

Theme	*Code*	*Barrier*
Leadership	D1	Lack of leadership among stakeholders
	D2	Disagreement in the selection of key leading organizations for collaboration
Organizational interests	E1	Competing interests
	E2	Different needs, interests, and issues
	E3	Unrecognized common interests
Communication and coordination	F1	Limited coordination and breakdown in communication among many fragmented actors at different levels
	F2	Lack of information-sharing between stakeholders
	F3	Communication breakdowns due to skepticism, use of jargon, and different official languages
	F4	Lack of knowledge-sharing
Collaboration processes	G1	Involvement of a large number of organizations
	G2	Lack of trust between stakeholders
	G3	Long-term and inelastic collaborative process

Intra-organizational barriers

Theme	*Code*	*Barrier*
Organizational structure	H1	Unsupportive organizational structure for collaboration
	H2	Existing roles and responsibilities which do not allow or support collaboration activities
Organizational culture	I1	Traditional silo-based organizational capabilities and thinking
	I2	Following old routine practices
Organizational resource capacity	J1	Lack of financial and human resources
	J2	Inadequate technical capacity to collaborate
	J3	Mitigating the impacts on the livability of the environment during an inter-vention to reinforce the power grid

Personal barriers (PB)

Theme	*Code*	*Barrier*
Intrinsic	K1	Lack of enthusiasm and commitment to collaborative initiatives
Profession-related	L1	Conflicting interest and competition
	L2	Fear of losing power
Knowledge-related	M1	Lack of knowledge of stakeholders
	M2	Stakeholders' reluctance to exploratory learning

INDUCTIVE CODES (IDB)

Theme	*Code*	*Barrier*
	IDB1	Only talking, no action
	IDB2	Personal conflict between stakeholders
	IDB3	Unknown aspects, uncertainty
	IDB4	It takes time to convince stakeholder
	IDB5	Lack of professional attitude stakeholder
	IDB6	Complex processes
	IDB7	(Inter)dependency
	IDB8	Not core business

STAKEHOLDER COLLABORATION ENABLERS/DRIVERS (45)

External enablers

Theme	*Code*	*Enabler*
Politics	N1	Bridge different political interests and values
	N2	Secure political will and commitment
	N3	Seek support and approval of dedicated politicians
	N4	Introduce and encourage an apolitical approach
Policies and legislation	O1	Harmonize and strengthen the laws and policies that can support collaboration
	O2	Introduce policies and legislations to mainstream collaboration
	O3	Ensure policies provide space for setting up informal structures that promote collaboration
	O4	Provide guidance and support that assists policymakers' awareness
	O5	Policy development with stakeholder involvement
	O6	Develop and implement adaptive policy
Governance	P1	Create collaborative governance structures that remove traditional power-based relationships
	P2	Adopt accountable governance mechanisms
	P3	Shift towards flexible and self-organized network governance
	P4	Establish decentralized organizational arrangements linked with the centralized system
	P5	Establish reporting mechanisms and assessments of progress
	P6	Incorporate formal and informal ways of inter-organizational arrangement in collaborative governance

Inter-organizational enablers

Theme	*Code*	*Enabler*
Leadership	Q1	Establish a dedicated coordination organization
	Q2	Engage partners to facilitate multi-stakeholder collaboration processes
Organizational Interest	R1	Establish synergies by creating a joint vision among organizations
	R2	Harmonize and strengthen policies and laws that support collaboration
Communication and coordination	S1	Establish formal agreements for information-sharing
	S2	Improve understanding of the information needs and requirements of organizations
	S3	Establish regular and transparent information flows and communication among organizations

Collaboration process	T1	Nurture trust-based relationships
	T2	Select appropriate stakeholders and maintain continuous engagement
	T3	Anticipate and manage conflicts

Intra-organizational enablers

Theme	*Code*	*Enabler*
Organizational structure	U1	Re-organize or set up new structures with clear rules and responsibilities for promoting collaborative working
Organizational culture	V1	Establish collaborative practices as regular routines
	V2	Encourage top management to influence the change in culture
	V3	Incorporate responsibilities for collaborative tasks along with their official job description
Organizational resource capacity	W1	Identify and provide essential technical and financial resources to build organizational capacity for collaboration
	W2	Better financial planning to optimize the available funds to support collaboration requirements
	W3	Recruit additional skilled staff to strengthen collaboration capacity
	W4	Introduce digital technology to improve efficiency
	W5	Allocate funding for building collaboration capacity through policies

Personal enablers

Theme	*Code*	*Enabler*
Intrinsic	X1	Establish indicators to monitor the progress and ensure participation
	X2	Offer incentives and rewards for their collaborative performance
	X3	Address personal interests and concerns for collaboration
Profession-related	Y1	Acknowledge and enable power-sharing, shared responsibility, and accountability towards other stakeholders which are important in multilevel governance
	Y2	Raise awareness of the positives and negatives of collaborative ventures to reduce hesitancy in collaborative working
Knowledge-related	Z1	Build capacity through knowledge development and training programs
	Z2	Encourage knowledge-sharing
	Z3	Collaborative knowledge-brokering with the help of an expert
	Z4	Implement measures to address the knowledge gap, build trust, clarify uncertainties, and bridge values
	Z5	Facilitate knowledge co-production through formal and informal social relationships

INDUCTIVE CODING (IDE)

Theme	*Code*	*Barrier*
	IDE1	Trust because of public entity
	IDE2	Geographical driver
	IDE3	Personal motivation stakeholder

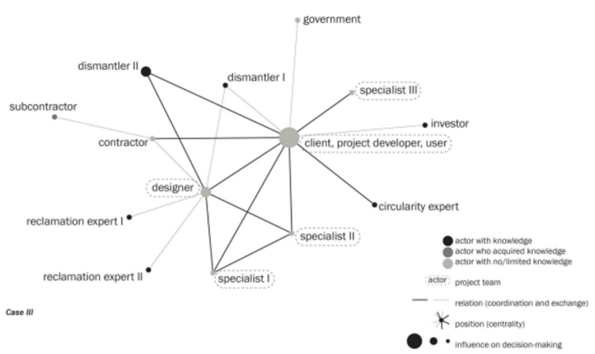
G

Appendix G: Construction of the Actor Network

Codes Network formation:

Concepts	*Visualization*	*Visualization*	*Interview data*
Actor	Node	Dot	Social entity (person or organization)
Relation	Connection to other actors displayed by a line	Thick line Thin line Black line Grey line	Relation displaying weekly interaction Relation displaying biweekly interaction Formal relationship (contractual) Informal relationship (collaboration)
Position	Position in the network based on the number of relations / centralities in the network	Distance to the center	Actor with the highest number of relations and the highest number of relations that display frequent communication is positioned in the center, other actors are positioned consecutively
Influence	Size of node	Large Middle Small	Substantial influence Moderate influence Little influence
Knowledge	Color of node	Black Dark grey Light grey	Existing knowledge Acquired knowledge Little to none knowledge

Result:



(This is an example of Gerding et al (2021)

H

Appendix H: Cross Case Analysis Table

Code		Ecofactorij (4, 174)	Hessenpoort (5, 230)	Schiphol Trade P... (4, 194)	Tholen (5, 186)	Totals
EB: Governance: Lack...	2	1	1	1		3
EB: Governance: Lack...	0					0
EB: Governance: Rigid f...	2	1	1	1		3
EB: Policies and Legisla...	3	2			1	3
EB: Policies and Legisla...	0					0
EB: Policies and Legisla...	1		1			1
EB: Policies and Legisla...	0					0
EB: Politics: Competing...	0					0
EB: Politics: Lack of pol...	1		1	1		2
EB: Politics: Political int...	1	1				1
EB: Politics: Thematical...	0					0
EE: Governance: Adopt...	0					0
EE: Governance: Creat...	1		1			1
EE: Governance: Establ...	0					0
EE: Governance: Establ...	2		2			2
EE: Governance: Incorp...	6	1	2	1	2	6
EE: Governance: Shift t...	0					0
EE: Policies and Legisla...	0					0
EE: Policies and Legisla...	1				1	1
EE: Policies and Legisla...	1		1	1		2
EE: Policies and Legisla...	1		1			1
EE: Policies and Legisla...	0					0
EE: Policies and Legisla...	0					0
EE: Politics: Bridge diff...	2		2	1		3
EE: Politics: Introduce a...	1		1	1		2
EE: Politics: Secure poli...	0					0
EE: Politics: Seek supp...	0					0
IB: Collaboration proce...	9	2	6	2	1	11
IB: Collaboration proce...	1		1			1
IB: Collaboration proce...	1				1	1
IB: Communication and...	9	4	4	1	1	10
IB: Communication and...	0					0
IB: Communication and...	1	1				1
IB: Communication and...	1	1				1
IB: Leadership: Disagre...	0					0
IB: Leadership: Lack of...	0					0
IB: Organizational inter...	0					0
IB: Organizational inter...	16	7	9	2		18
IB: Organizational inter...	0					0
IE: Collaboration proce...	0					0
IE: Collaboration proce...	9	4	2	3		9
IE: Collaboration proce...	1			1		1
IE: Communication and...	0					0
IE: Communication and...	0					0
IE: Communication and...	1	1				1
IE: Leadership: Engage...	0					0
IE: Leadership: Establis...	2				2	2
IE: Organizational inter...	14	1	8	7	4	20
IE: Organizational inter...	0					0

IntraB: Organizational c...	2	2				2
IntraB: Organizational c...	1				1	1
IntraB: Organizational r...	0					0
IntraB: Organizational r...	8	1	4		3	8
IntraB: Organizational r...	0					0
IntraB: Organizational s...	2	1			1	2
IntraB: Organizational s...	5	2			3	5
IntraE: Organizational c...	0					0
IntraE: Organizational c...	0					0
IntraE: Organizational c...	0					0
IntraE: Organizational r...	0					0
IntraE: Organizational r...	2	1	1			2
IntraE: Organizational r...	5		2	1	3	6
IntraE: Organizational r...	0					0
IntraE: Organizational r...	0					0
IntraE: Organizational s...	2		1		1	2
PB: Intrinsic: Lack of en...	2	1		1		2
PB: Knowledge related:...	10	7	3	1		11
PB: Knowledge related:...	6	5	1			6
PB: Profession related:...	2	1		1		2
PB: Profession related:...	0					0
PE: Intrinsic: Address p...	7	1	2	2	3	8
PE: Intrinsic: Establish i...	1	1				1
PE: Intrinsic: Offer ince...	0					0
PE: Knowledge related:...	2	1			1	2
PE: Knowledge related:...	1		1			1
PE: Knowledge related:...	5	3	2	1		6
PE: Knowledge related:...	4		1		3	4
PE: Knowledge related:...	3		3	2		5
PE: Profession related:...	1				1	1
PE: Profession related:...	2		1	1	1	3
Totals		54	66	33	34	187