A guide to orchestrate Smart Energy Hubs

Exploring the formation of Smart Energy Hub networks
to enable effective collaboration

Gemeente Amsterdam

A research for the **Municipality of Amsterdam**

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PREFACE

An energetic journey

Starting this journey into the world of energy has been an exiting experience. In a time when the energy industry was undergoing significant transformation, I had the privilege of exploring collaborations on the largest energy consuming sites in the Netherlands: business parks. This thesis allowed me to dive into the complexities of businesses, energy companies, and governmental institutions, aiming to make a meaningful impact in the energy transition.

However, this journey was far from easy, and I am grateful to the individuals who supported me along the way. Their guidance and assistance were valuable in navigating through the challenges during this research. I would like to express my heartfelt acknowledgments to them.

Acknowledgements

First and foremost, I would like to thank my graduation committee, Sine and Mahshid, for their unwavering support and guidance. You both provided me of advice and insights on moments where I felt completely stuck. It amazed me that you always knew what to do. Your interest and assistance in the project impressed me, and I am truly grateful for your contributions.

I would also like to extend my gratitude to Willem, my coach at the Municipality of Amsterdam. Your dedication to sustainable impact is truly inspiring. Despite your busy schedule, you always made time to discuss the project and provide constructive feedback. Your critical yet positive approach fuelled my motivation, and I sincerely appreciate your effort. Amsterdam is fortunate to have you driving change within the city.

To Rogier, Martijn, Jeanke, Jos, and Joris, who felt like colleagues throughout this project, thank you for your support. I am grateful for your responsiveness and willingness to assist, even though you were not directly involved in this project.

Lastly, I want to express my gratitude to my friends and family, particularly Noor, Max, and Boris, being on this graduation journey alongside me. Your support and encouragement kept me motivated throughout this process. I also want to thank Gijs, Philip, and Gianmarco for their valuable feedback when I needed it the most.

This thesis is the culmination of countless hours of hard work, collaboration, and the unwavering support of those around me. I am excited to share the findings and insights obtained during this energetic journey.

EXECUTIVE SUMMARY

The global energy transition presents significant challenges for large consumers, particularly business owners on business parks. These challenges often exceed the capabilities of individual businesses, necessitating collective approaches such as Smart Energy Hubs (SEHs) that enable resource, cost, and expertise sharing. However, many SEH collaborations encounter difficulties in initiating or sustaining a network. This research project aims to identify barriers to collaboration and explore the mindset of actors involved in SEHs, seeking to understand their perceptions of risks and motivations to participate.

Through a comprehensive literature review, interviews with current SEH initiatives, and engagement with relevant experts, this research project provides valuable insights into the barriers and opportunities within SEH collaborations. It becomes evident that the formation phase of SEHs is particularly complex, requiring the involvement of diverse actors and roles. Business owners often have a negative mindset, emphasising risks rather than recognising the potential benefits of collaboration. The value proposition of SEHs is not always apparent to them, leading to a lack of enthusiasm for engagement. Furthermore, valuable learnings from existing SEHs are often not effectively shared, limiting the collective knowledge of the community and hindering progress.

To address these challenges, the Smart Energy Hub GPS guide is introduced. It aims to counteract the negative mindset of business owners by visually demonstrating the value of SEHs. It fosters learning through a knowledge-sharing infrastructure. The GPS guide effectively communicates the urgency of collaboration, emphasises the advantages of collective efforts in addressing energy challenges, and provides guidance for taking the initial steps in setting up SEH collaborations. By clarifying expectations and presenting the value proposition of SEHs, the GPS guide strives to enhance the willingness of business owners to actively participate in SEH initiatives.

This research project highlights the fundamental issues encountered during the formation stage of SEHs, hindering effective collaboration. It addresses the need for visual tools and knowledge-sharing networks to shift the mindset of business owners and foster effective and successful SEH collaborations. The proposed strategy for implementing the GPS guide offers a clear pathway to enhance collaboration, bridging the gap between energy challenges and effective collaborative solutions. Ultimately, this research underscores the significance of collaboration in driving the transition to a cleaner and more resilient energy future.

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chapter **1**

The Introduction

This chapter introduces the project in two parts: the project context and project approach. It begins by discussing the context of the project, providing a background on Smart Energy Hubs. The nature of these hubs and the reasons for their existence are explored. Additionally, the role of the project stakeholder, the Municipality of Amsterdam, is explained. This leads to the research questions and objectives of the project. The second part of the introduction focuses on the project approach, providing an overview of the methodology, the data collection process, and the data analysis techniques.

PROJECT CONTEXT

The rise of Smart Energy Hubs

In a globalised world with a growing population nearing eight billion, the earth's resources are under immense pressure. The current high reliance on fossil fuels for energy consumption contributes to approximately three-quarters of the world's greenhouse emissions (World Economic Forum, 2022). To achieve a net-zero emission world by 2050, a transition in the consumption and production of energy is urgently needed.

This energy transition presents challenges, particularly for larger consumers like businesses. Implementing sustainable measures which phase out fossil fuels, such as solar panels or an electrical vehicle fleet, will more and more become required (RVO, 2023). Yet these crucial measures can be complex to understand and to execute (Brem et al., 2020). Moreover, the existing grid that transports electricity, struggles to handle the increasing demand and supply, resulting in grid congestion (Netbeheer Nederland, 2019). Consequently, businesses face limitations in expanding operations or even settling down in certain locations. Affordability of energy has also become a significant concern, with energy prices becoming volatile (CBS, 2023) and the substantial costs required for sustainable measures (KB index, 2023).

> **"The issues we face are so big and the targets are so challenging that we cannot do it alone. When you look at any issue, such as food or water scarcity, it is very clear that no individual institution, government, or company can provide the solution."**

This quote by Paul Polman (2012), CEO of Unilever, shows that creating a better world takes collaboration. Today's challenges in energy for businesses are large and complex and require collective measures (Strijker et al., 2021). This is where a Smart Energy Hub (SEH) comes into play. A SEH is a collaboration of local actors (e.g., business owners, area operators, distribution system operators) who collectively tackle these energy related issues in their geographical area (TNO, 2022). By sharing costs, resources, and expertise, these actors seek collective opportunities and solutions to mitigate or prevent their issues.

Numerous initiatives for SEHs are currently underway, driven by the significant and urgent interest in addressing grid congestion issues, and speeding up the energy transition. The hubs are primarily occurring in business parks, as these are the first areas that experience congestion due to their relatively high energy consumption rate combined with a large available surface area for renewable energy generation. This makes business parks crucial for the success of the energy transition (CE Delft, 2022; Strijker et al., 2021). However, the successful realisation of SEHs proves to be a complex challenge (LAN, 2022). Why is this the case?

The major obstacle to deploying SEHs is getting the local actors to participate and work together (see Figure 1), leading to a stagnation of SEHs in the initial stage (Norouzi et al., 2022; Strijker et al., 2021). Current research is mostly focussed on technical and policy barriers, while social and economic dimensions of SEHs can be seen as the core focus, regardless of the used technologies (Norouzi et al., 2022). Currently, there is a lack of research and knowledge about the exact barriers that hinder the collaboration between local actors on a business park to set up a SEH.

The Municipality of Amsterdam

The Municipality of Amsterdam initiated this project as they want to know how they can contribute to the development of SEHs, as the city already faces areas where congestion has been announced and expects its demand for electric power to triple or quadruple by 2050 (Kroese, 2021; Municipality of Amsterdam & Liander, 2021). To cope with these pressures for decarbonisation, the impacts of climate change, and broader economic and demographic changes, cities need to increase their adaptive and innovative capacities (De Koning et al., 2018). This not only includes improving current planning practices (e.g., grid reinforcements), but also stimulating the rise of a diversity of local initiatives, enhancing citizen or business engagement, as well as scaling promising solutions. Right now, the Municipality of Amsterdam mainly focuses on spatial planning for the necessary expansions for grid reinforcements, with their EVA team (ElektriciteitsVoorziening Amsterdam). With this project the municipality would like to explore the opportunities for collaborations between businesses for energy-related issues.

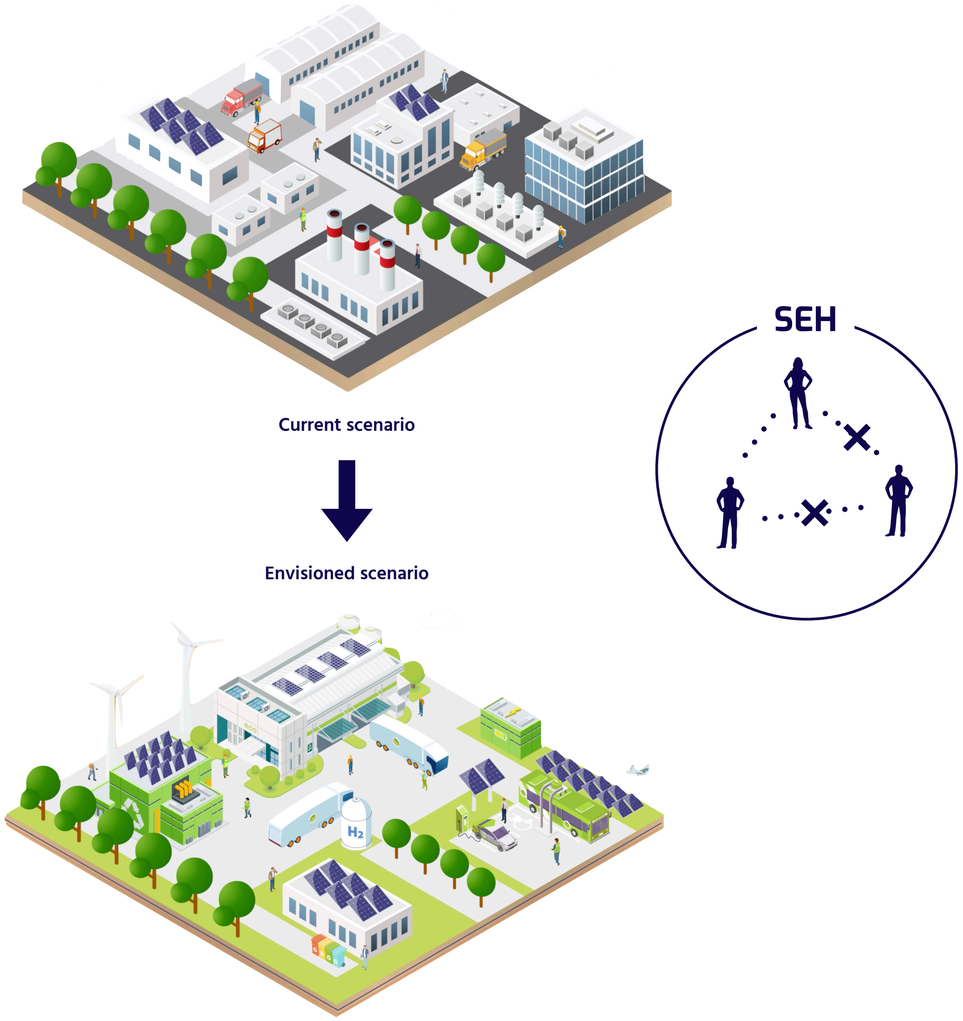


Figure 1 - SEHs, which help in the energy transition on business parks, are facing obstacles in collaboration (PVB, 2023)

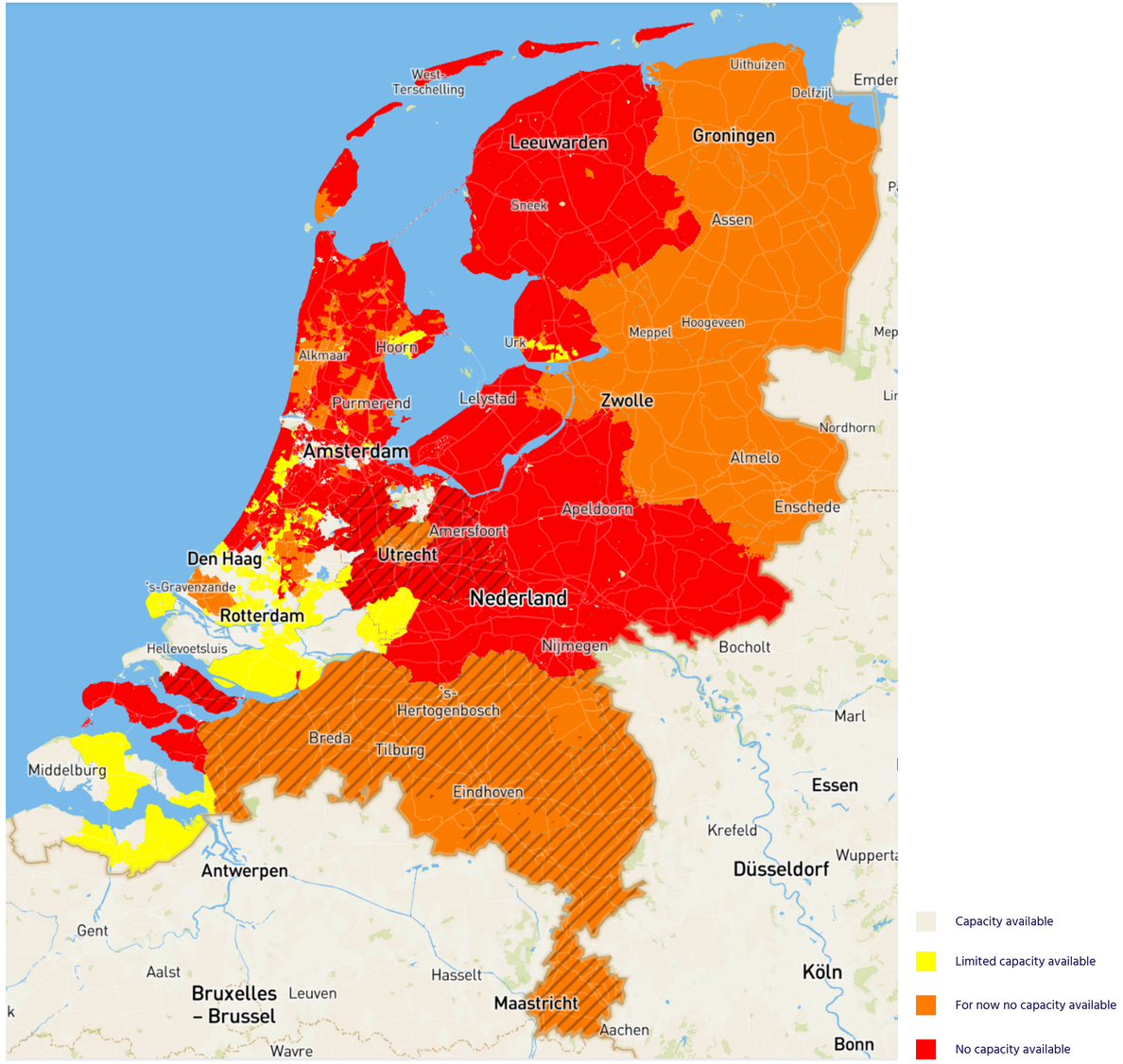


Figure 2 - This map shows congestion areas in red and orange for electricity consumption (Netbeheer Nederland, 2023)

Project goal

Although the Municipality of Amsterdam is interested in understanding how they can support the successful development of SEHs, this project will not be a policy study. The strength of this project lies in discovering the needs of the involved actors and translating them into (visual) strategies and/or tools to provide assistance. This is where the power of strategic design comes into play. The objective of this project is to thoroughly comprehend and analyse the current process of SEHs, gain insights into the experiences of the participating actors, and identify opportunities and strategies to enhance collaboration within a SEH.

Research question

This research aims to understand the experiences and barriers in the current initial stage of SEHs, to define the necessary changes, and to develop a way to improve the collaboration. Therefore it is crucial to investigate the effectiveness of collaboration rather than solely focusing on efficiency. Efficiency alone cannot be achieved without effectiveness. Effectiveness entails being goal-oriented, while efficiency emphasises resourcefulness and achieving goals in the most optimal way. To optimise the initial stage of SEHs, the focus lies on effectiveness and being goal-oriented. Only once the network is well-established and functioning effectively, efficiency truly can be maximised. This resulted in the following research question:

What are specific strategies to enable collaborative effectivity among actors during the initial stage of SEHs in business parks?

The following sub-questions will help in structuring the research into smaller bits aiming to gain a comprehensive understanding of the complex dynamics and requirements for successful collaborations in SEHs on business parks:

- What constitutes a SEH? - Who are the involved actors, which roles are needed, and what are the typical steps and stages involved in setting up SEHs?
- How do actors experience the development of SEHs? - What are their interests to join, which risks to they perceive and what barriers to they encounter?
- What are the factors that define successful collaboration within SEHs?
- What specific strategies are needed to facilitate the successful realisation of a SEH?

Project scope

The project's scope is defined by four factors: territory, type of energy, stage of development SEH, and timeline for implementation.

First, the territory scope of this project concerns business parks in the Netherlands. Instead of solely concentrating on Amsterdam, the research encompasses a broader range of locations due to the limited number of current SEH initiatives in the city. Given the widespread congestion issues faced by a significant portion of the country (see Figure 2), SEHs have emerged across various locations. This broader scope ensures a more diverse context and set of actors, enhancing the generalisability of the project. Business parks specifically serve as the main focus of the research, considering that most current SEH initiatives are concentrated in these areas and their crucial role in the energy transition (Cappellen et al., 2022; Strijker et al., 2021). Although the initial starting point of this project was focussed on train stations, the shift to business parks allows for better accessibility and a more comprehensive investigation.

Secondly, this research primarily centers on electricity as the main energy form within SEHs. This focus is chosen to avoid diving into technological complexities and debates beyond the researcher's expertise and objectives. Given that the majority of existing SEHs primarily deal with electricity, which was discovered during user interviews, this scope is appropriate and aligned with current initiatives.

Thirdly, the project narrows its focus to the initial stage of collaborations, recognising it as the most challenging phase for most actors involved (Kelly et al., 2002). This stage is crucial for establishing a solid foundation and fostering effective working relationships.

Finally, the aim of this research is to provide effective strategies and tools to support the successful development of SEHs. The chosen timeline for implementing these strategies is within the next four years, considering the involvement of various actors and the immediate need for SEH implementation. This timeframe also allows for adaptation and improvement in the face of evolving energy regulations, ensuring the continued relevance and effectiveness of the strategies in the future.

PROJECT APPROACH

Project approach

This project adopts the double diamond framework for the design approach, developed by the Design Council (Design Council, 2019). This framework facilitates both divergent and convergent thinking, providing a structured approach to the research and design process and allowing for broad exploration. It consists of four phases, each with defined objectives, outcomes, and methods (see figure 3). It is important to note that the process of this project was non-linear, involving iterations and continual questioning to enhance and modify the overall research direction.

Discover phase

The first phase, Discover, involves understanding the context of SEHs in the Netherlands. Through a literature review and exploratory interviews, qualitative data is collected to identify the key actors, required roles, typical stages of SEH development, and general criteria for successful collaborations. Semi-structured interviews are conducted to complement existing data and gather empirical insights. These interviews engage the involved actors to gain their perspectives on the challenges and experiences of setting up SEHs.

Define phase

In the second phase, Define, the two types of data (existing and empirical) are compared to determine the appropriate criteria for successful collaborations within SEHs. The Strategic Niche Management approach is used as an analytical framework for this purpose, as this framework has proven useful for the analysis of success and failure in the introduction of innovations (Caniëls & Romijn, 2006). The interviewed SEH cases are analysed, reviewed, and scored using the success criteria in the SNM framework. From this analysis, specific needs are distilled. One particular need is selected to reframe the project and establish a new design goal.

Develop phase

The Develop phase marks the transition to the design phase. Opportunities are identified, and new concepts are generated within the solution space. Co-creation sessions are conducted to explore potential solutions in collaboration with actors and experts involved in SEHs.

Deliver phase

The final phase, Deliver, involves finalising a chosen concept. The details of the selected concept are designed and validated with relevant experts, and an accompanying strategy for implementation and best practices is developed to contribute to the successful development of SEHs.

Research Approach

This project addresses the need for an approach that promotes actor collaboration during the initial stage of SEH development. As the success of SEHs often hinges on collaboration challenges, a deeper understanding of the dynamics and contextual factors is crucial. To explore this problem in depth and provide detailed descriptions, a qualitative research approach is employed (Mahoney & Goertz, 2006). A case study methodology is chosen to closely analyse data within the context of business parks in the Netherlands. This approach allows for a comprehensive exploration within a specific context and the collection of empirical data (Yin, 2009).

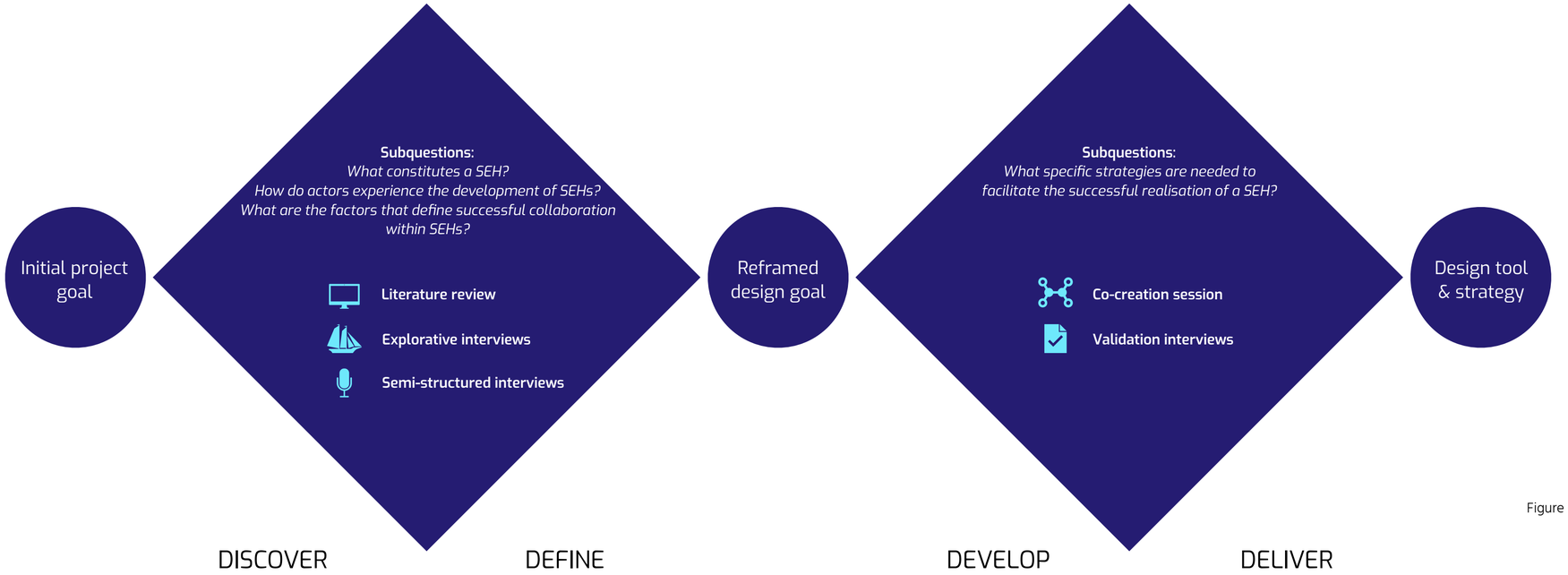


Figure 3 - Visualisation of project approach

Data collection

To collect the data multiple methods are used. First, existing qualitative knowledge was gathered trough a desk research to collect existing qualitative data in grey and scientific literature. In addition, explorative interviews with experts were done to further explore the initial identified problem. The experts were chosen based on their expertise related to SEHs or setting up business collaboration in general. To further broaden the researcher's perspective various events were participated in. The list of interviewed experts and attended events can be found in Appendix A.

To complement the existing qualitative data from desk research, empirical data was gathered by semi-structured interviews. These type of interviews are suited for in-depth conversations, while leaving flexibility during the conversation. This is well suited for the purpose of this research to find the cause of difficulties in collaborations. The interview questions are based on the executed desk research, and the explorative interviews, and were later validated with academici. They follow the principles of first general and then more in-depth questions. The themes which were explored during the interviews were the experiences of involved actors, including their interests, perceived risks, and experienced barriers associated with the development of SEHs. The interview guide with questions can be found in Appendix C.

Most of the interviews were conducted in a one-on-one format, lasting between 60 and 120 minutes. Some interviews were held offline, while others were conducted online. While the interviews were recorded, extensive notes were taken during the interviews and later supplemented and refined using the recordings. In total 13 interviews were conducted with different types of actors. The participants of the interviews needed to be actors directly involved in the development of setting up a SEH located on a business park in the Netherlands. The exact type of actors were identified during the desk research and explorative interviews. There were not enough SEH initiatives located in Amsterdam to solely focus on this location. The list of interviewed participants can be found in Appendix A.

Lastly, co-creation sessions were organised with the goal to move from the identified needs to opportunities together with selected actors. These sessions were organised in groups or one-on-one. They helped in making sense of the needs and transforming this into relevant solutions. In later sessions with actors the design was further developed and iterated on based on the feedback, it had several iteration sessions.

Data analysis

The data from the desk research and explorative interviews were categorised into relevant topics related to the subquestions. The collected data from the interviews were coded based on the same topics the desk research was categorised in. In this way the existing information was more easily comparable to the empirical data. To analyse and compare these two types of information, this research used the Strategic Niche Management (SNM) approach. The SNM approach focuses on the development and management of niche formation processes. A niche can be seen as space where innovative activity takes place and radical innovations emerge. SNM is specifically focussed on the introduction and diffusion of socially desirable innovations that face a mismatch with existing infrastructure, user practices, and regulations (Schot and Geels, 2008). Due to the similar characteristics between niches and SEHs, this research believes SNM is the right fit for analysing and reviewing the development of current SEH initiatives. Although SEHs share similarities with niches, their broader scope and incorporation of existing and emerging technologies distinguish them from the SNM framework. While SNM provides a valuable framework, it may not fully capture the diverse elements and dynamics inherent in SEHs.

The processes of the SNM approach will serve as a framework to determine factors for successful collaborations within SEHs. These factors are used to analyse and review the development of the initial stage of the interviewed SEHs, see Figure 4 for a visual representation of this analysis framework. By applying these SNM processes as analytical criteria, a comprehensive understanding of the current SEHs can be gained. It is important to acknowledge that SNM is not a standalone theory for SEHs but rather provides a valuable framework to guide research and analysis of collaborative processes within SEH formation.

Success factor	❒	❒	❒	❒	❒
Success factor	❒	❒	❒	❒	❒
Success factor	❒	❒	❒	❒	❒
Success factor	❒	❒	❒	❒	❒
...	❒	❒	❒	❒	❒

Figure 4 - SNM framework to analyse current SEH initiatives

chapter **2**

Understanding Smart Energy Hubs

This chapter focuses on the existing data about the context of SEHs, which will help in providing a clear definition and image of what a SEH is and what its building blocks are. This is categorised into two parts: the foundation of SEHs and actors & roles of SEHs. The foundation section explores the origin of a SEH, understanding the triggers which fuel the urgency to start a SEH. The measures that can be implemented within a SEH, and examples of different forms of SEHs are made tangible. The section about actors & roles discusses the key actors and roles to establish a SEH.

FOUNDATION OF SMART ENERGY HUBS

Business parks in the Netherlands

In the Netherlands, there are approximately 3800 business parks (IPO, 2021). A business park is an area dedicated to various economic activities, such as manufacturing, large-scale retail, or transportation and distribution activities (CBS, n.d.). Multiple businesses are clustered on these parks (see 65). Despite covering only 2.6% of the country's land area, these business parks play a crucial role in the prosperity and economy of the Netherlands. They contribute to 30% of employment and generate 40% of the country's GDP (VNO-NCW, 2023).

Despite their relatively small size, business parks account for a significant portion of the total energy consumption. In 2019, they were responsible for nearly half (48%) of the country's total gas consumption and over a third (35%) of its electricity consumption (CBS, 2019), see Figure 5. The high energy consumption profile of business parks, combined with the large available surface area (such as rooftops) for renewable energy generation, makes business parks crucial to the success of the energy transition (CE Delft, 2022; Strijker et al., 2021). However, this transition is not without challenges. Due to their high consumption and potential for energy production, businesses located in business parks are often the first areas who face various energy challenges. Given the societal importance of business parks, a comprehensive approach is necessary to assist businesses in addressing these challenges and maintaining their economic activities. So, what exactly are these energy challenges?

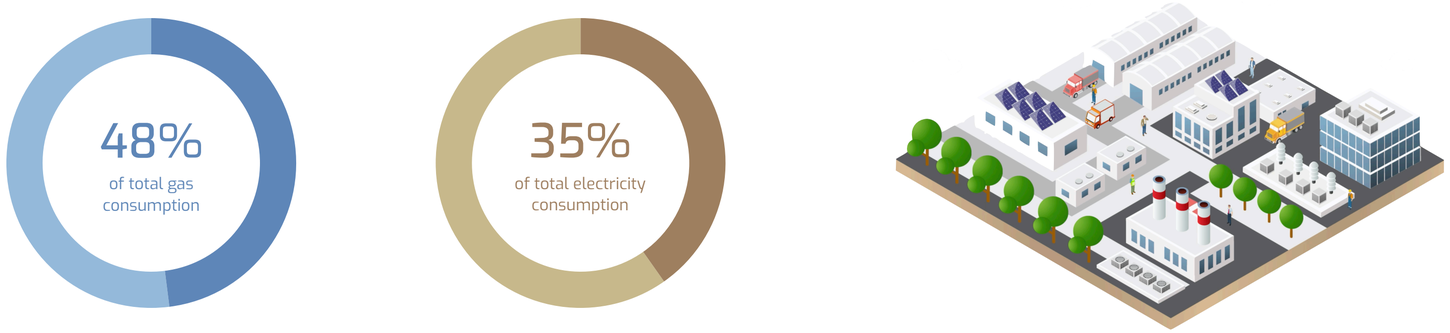


Figure 5 - The energy consumption rate percentage of Dutch business parks (PVB, 2023)

Figure 6 - The cluster of businesses on a business parks in the Netherlands

Challenge 1: Sustainability compliance & complexity

The majority of the countries heavily depends on fossil fuels for producing electricity, where fossil fuels account for around 60% of the total global electricity generation (International Energy Agency, 2022). The negative impact of fossil fuels on the climate and its limited availability (Martins et al., 2019; Bilgen, 2014) has led to a global call for action to phase out the use of fossil fuels (UNFCC, 2022). This is done by embracing renewable energy sources such as wind, solar, and water (Bilgen, 2014), and many sectors who are dependent on fossil fuels, such as heating and transportation, need to switch to electric power (Hers et al., 2021).

In response to this, the Dutch government has implemented legislation to achieve a net-zero emission goal by 2050. Legislation for businesses focusses on transitioning to emission-free mobility, eliminating natural gas for heating, reducing energy demand, implementing energy labels for buildings, and incorporating renewable generation assets like solar panels (RVO, 2023). By 2030, a 55% reduction in CO_2 emissions is already required (Rijksoverheid, n.d.). So, taking action is becoming increasingly urgent, yet for many industries, it is becoming difficult and complex to comply with these regulations (Brem et al., 2020). This is the case since business owners often lack the knowledge and expertise to implement sustainable measures and they have limited time to get involved (TNO, 2023). If they decide to stay dependent on traditional fossil fuel energy production or reliance on an outdated grid supply, they can face costly fines (Brem et al., 2020).

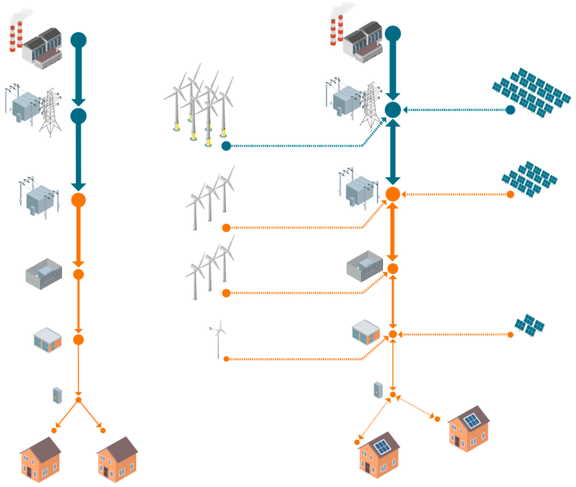
Challenge 2: Dealing with congestion

The measures taken for the energy transition have a significant impact on the grid that transports electricity (Netbeheer Nederland, 2019).

> **"The Netherlands traditionally has a modest electricity grid and a significant gas infrastructure. With the current electrification and rise of renewables, we are rapidly filling up our grid. During peak demand and supply, we are unable to accommodate a sufficient flow of electrons through the grid. If we can spread out this peak, we can better utilise the electricity grid and connect more users. Flexibility is crucial for balancing the electricity grid and matching supply and demand."**

This quote from David Peters (TKI Energy, 2022), CTO of grid operator Stedin, explains the consequences of the transition on the grid. Traditionally, the grid transported electricity in a one-way direction from large, central power plants to end-consumers (Koirala et al., 2016), as shown in the left part of Figure 7. However, with the increasing use of renewables, electricity generation is happening closer to end-users (Koirala et al., 2016), resulting in a two-directional grid (see right part of Figure 7). The grid was not designed for such input, which is one of the reasons for the current congestion problems in the Netherlands (Koirala et al., 2016). The second reason for congestion is the increasing demand for electricity due to developing economies, population growth, and the rising use of electrical power through

Figure 7 - The traditional grid (left) transforming into the new grid (right) (Netbeheer Nederland, 2019)



electrification (International Energy Agency, 2022). For instance, in Amsterdam, the current demand is projected to grow by a factor of 2.5 to 3 by 2030 and 3 to 4.5 by 2050 (Municipality of Amsterdam & Liander, 2021). Congestion is similar to a traffic jam, where the grid's capacity can be exceeded by excessive demand or supply at certain times, similar to rush hour. This leads to areas where new power requests are denied (see Figure 2 on page 7), resulting in businesses not being able to expand or settle in certain areas.

“More cables in the ground" may seem like a straightforward solution to this problem. However, the semi-governmental grid operators (Distribution System Operators) responsible for grid reinforcements face long lead times, permit requirements, high investments, limited space, and shortages of personnel and materials (Netbeheer Nederland, 2019; Liander, n.d.). If grid reinforcements are the only option without alternative solutions, the energy transition and the economy will face stagnation in the coming years.

Challenge 3: Keeping energy affordable

The last energy challenge is related to the affordability of energy. Investments for taking sustainable measures for the energy transition, can become quite costly. At the moment, almost two-third of the smaller businesses want to make investments in sustainable measures, but they cannot afford it themselves (KB Index, 2023). Only 4% of the businesses know their way to cheap loans for sustainable measures, while 40% of the businesses need capital for the measures (KB index, 2023).

Next to that, the year of 2022 showed an energy crisis. The prices of energy on the market proved to be volatile (CBS, 2023). The rising prices had a great influence on businesses, resulting in businesses not being able to pay their energy bills and the numbers of bankruptcies were rapidly increasing (BusinessEurope, 2023). With shrinking supplies of fossil fuels due to its limited availability (Martins et al., 2019), it is not unthinkable that this will lead to a sustained increase in electricity prices, as long as we keep relying on these fossil fuels.

These energy related challenges are triggering businesses to seek for mitigating measures. What are these measures?

Measures for energy challenges

The measures for addressing energy-related challenges are not one-size-fits-all solutions (de Bruin et al., 2023). The appropriate solution will vary greatly depending on the specific triggers, the needs of businesses, and the existing energy infrastructure. However, these measures all have a common goal: increasing grid flexibility. Flexibility solutions offer a way to tackle congestion issues, meet sustainability requirements, and potentially reduce costs. Their purpose is to adapt to the varying supply of renewable sources and the varying demand from users as seen in Figure 9 (Koirala et al., 2016). By implementing greater flexibility in the energy system, we can achieve a grid that can effectively reduce or shift consumption and production peaks (TKI Energy, 2020).

Flexibility solutions can be classified into two layers: the virtual layer and the physical layer (see Figure 8). In the physical layer, solutions focus on optimising demand and supply through physical modifications to the energy system. This may involve integrating storage systems (e.g., batteries), as well as optimising grid connections (e.g., cable pooling). On the other hand, the virtual layer emphasises the integration of data-driven solutions that intelligently manage the exchange of electricity, such as energy management platforms or aggregators. While this research does not delve into the specifics of these flexibility measures, the overview in Figure 8 provides a range of options for businesses to choose from.

For many of the flexibility measures collaboration is needed between businesses, grid operators, technological service providers, and the government (Planko et al., 2019; Strijker et al., 2021). This collaboration is essential as many flexibility measures require the participation of multiple businesses and cannot work with a single organisation. While there are individual measures possible as well, this research focuses on the collaboration aspect. Through collaboration, organisations can share expertise, knowledge, and resources, which is a major advantage in realising the flexibility potential. However, the participation of these actors presents a significant challenge, as alignment and engagement are necessary for the successful implementation of flexibility solutions (Norouzi et al., 2022). This is where Smart Energy Hubs play a crucial role.

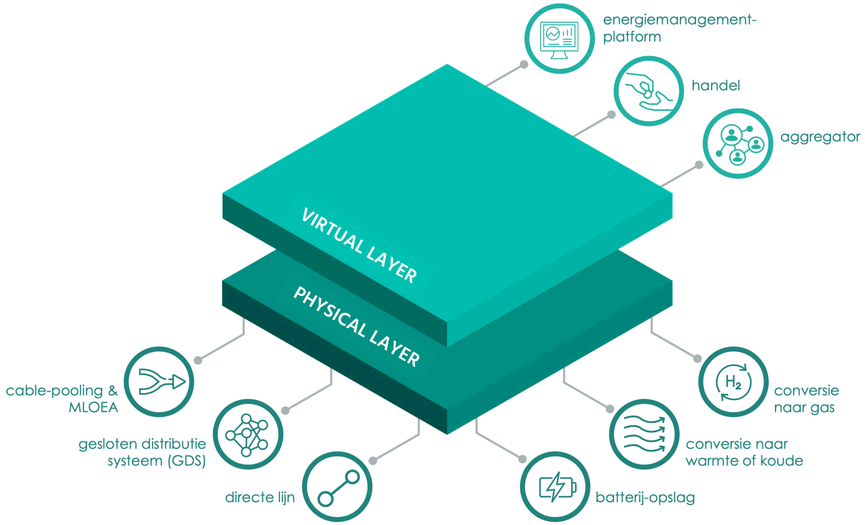


Figure 8 - Measures for improving flexibility (de Bruin et al., 2023)

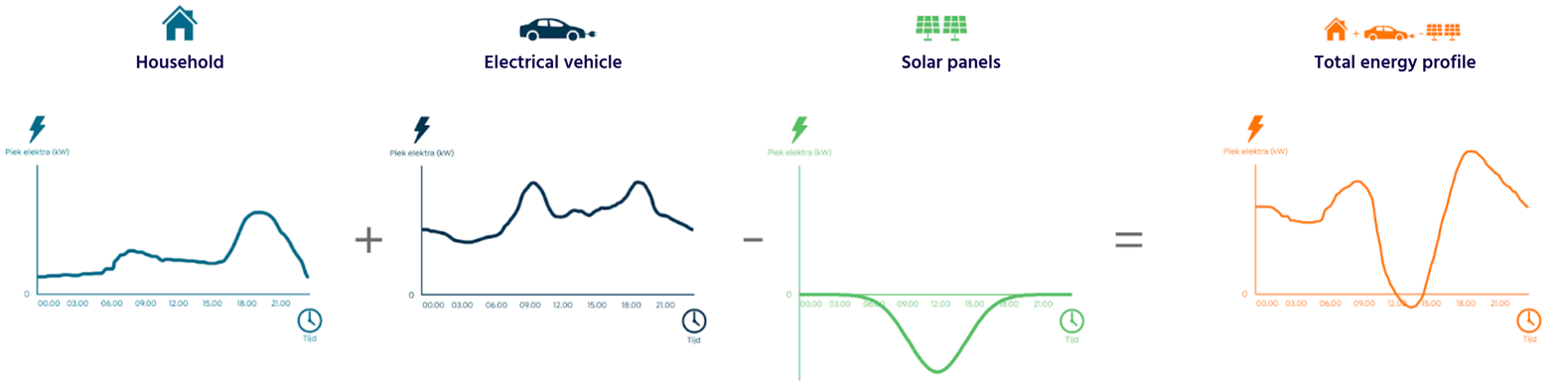


Figure 9 - The varying demand of users and varying supply of renewables

Examples of Smart Energy Hubs

The different energy challenges are triggering businesses to seek collaboration in order to collectively enhance the grid flexibility. This collaborative effort is embodied and organised in a Smart Energy Hub. In this research, a SEH is considered as an overarching concept where local actors collaborate with the goal to match and balance generation, storage and consumption of energy among the local users in their geographical area (TNO, 2022). By doing so, the grid can better accommodate the energy flows (Norouzi et al., 2022; Camarinha-Matos, 2016).

The specific ways in which SEHs enhance grid flexibility may vary, depending on the chosen flexibility measures and the various interests of the involved actors (TKI Energy, 2020). As a result, various forms of SEHs are possible. It's important to note that not every business on a business park is required to participate in an SEH; it can start with just two parties engaging in bilateral collaboration. However, all SEHs share the common goal of implementing measures to improve energy flows, mitigate congestion, meet sustainable regulations, share knowledge and expertise, and distribute cost to make these activities more affordable.

To provide concrete examples of SEHs, two scenarios are presented. Example 1 involves collaboration among multiple businesses that hire an aggregator to perform demand-side management, see Figure 10. This means the aggregator has the capability to control smart devices in businesses based on data about energy consumption and weather forecasts (de Bruin et al., 2023). This approach has for example been implemented in the SEH of Schiphol Trade Park.

Example 2 showcases collaboration between two businesses, one being a solar developer and the other a wind developer, see Figure 11. Since sunshine and strong winds often do not occur simultaneously, both solar and wind parks can be connected to a single grid connection, making a more efficient use of the connection (de Bruin et al., 2023).

In addition to businesses, other actors play essential roles in realising SEHs. It is a collective effort, and these specific actors and their respective roles are further explored in the next section, which focuses on the building blocks for setting up SEHs.

Example 1
Aggregator in multi-business collaboration

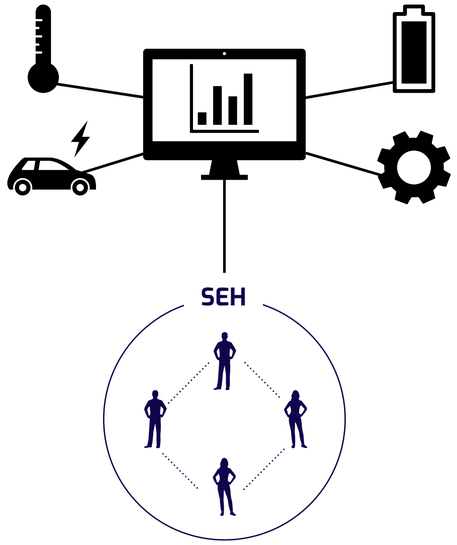


Figure 10 - Visual of SEH example of an aggregator with multiple businesses

Example 2
Cable pooling in bilateral collaboration

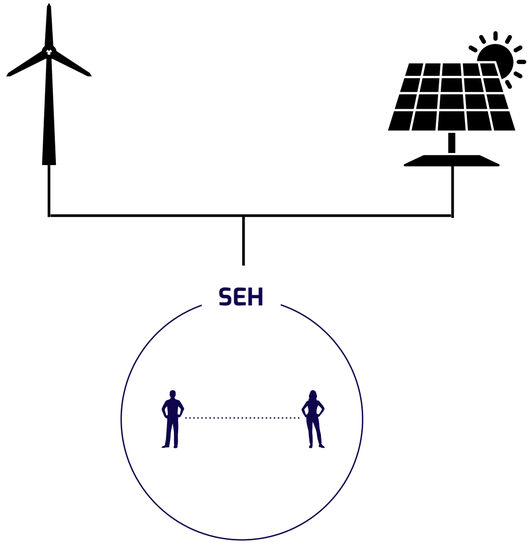


Figure 11 - Visual of SEH example of cable pooling between two businesses

ACTORS & ROLES

While the reasons behind the formation of SEHs have been explored, it is essential to understand the process involved. This project was initiated due to several unsuccessful attempts at developing SEHs, highlighting the need to understand the underlying process, including its stages, key actors, and their respective roles. Such understanding will lay the groundwork for identifying barriers and their underlying causes. Additionally, the information from this section will serve as the building blocks for developing strategies to enhance collaborative effectiveness.

This section provides a comprehensive explanation of the necessary actors and their roles within the SEH context. Additionally, a framework for establishing collaborations is examined, serving as a valuable reference for analysing the process of setting up SEH initiatives. Prior to conducting user research, an exploration of the factors influencing the success and effectiveness of collaborative efforts is undertaken. To accomplish this, an in-depth investigation into the Strategic Niche Management approach is conducted, providing a detailed overview of its application and relevance.

Involved actors in Smart Energy Hubs

When establishing a SEH, the involvement and engagement of various actors is needed (Strijker et al., 2021). These actors engage in collective action, which is described as a decision-making process where all involved actors can weigh their own interests against those of others (Norouzi et al., 2022). It is essential for them to align their interests to make collaboration effective (Gulati et al., 2012). This interaction among actors is an example of one of many interaction in the SEH process (de Bruin et al., 2023). Roger (2003) explains that networks are formed through the interactions of numerous actors. Understanding these interactions and the roles of actors is vital for successful innovation development (Çelik, 2018), which is why they are thoroughly discussed in this section.

The list of actors, including their general responsibilities, known interests in SEH, and role in SEHs, is presented in the table below (see Figure 12). This is list is based on existing literature (Van Wijk, 2019; Kelly et al., 2002; Sepponen and Heimonen, 2016; Strijker, 2021; Koirala, 2016; de Bruin, 2023) and expanded with insights from experts during explorative interviews. By examining two ecosystems, specifically business parks and the electricity system, it becomes possible to identify the diverse actors involved in SEHs and their respective roles. On the next page an overview is presented of the actors from the table relevant to their respective operating areas (see figure 13).

Actor	Responsibility	Interest in SEH	Role in SEH
Distribution System Operator (DSO)	Distribution of electricity to consumers Maintaining and improving the electricity grid keeping it safe, reliable and affordable	SEHs contribute to better access to power and a more affordable grid	Legally constrained as semi-governmental institution in organising SEHs (not authorised to engage in energy storage, or taking the role as aggregator). Their approval and cooperation is however essential for success SEH.
Local government (province & municipality)	Responsible for matters that are of direct and exclusive interest to its own inhabitants and the region	SEHs contribute to the economic prosperity and sustainability of a business climate	While the role and involvement of municipalities varies per SEH, they often serve as promoters and process investors of SEHs. However, they don't want to become too involved in SEHs, to limit their liability for the organisation.
Area management (province, municipality, commercial party)	Maintenance and operation of a business park, in the field of public space, safety, mobility and sustainability	SEHs contribute to the economic prosperity and resilience of their business climate	Due to their active involvement in a business park, the area management often is seen as the actor to organise and facilitate a SEH. However not every business park has an area management and the level of responsibility differs.
Business owners (property owners & tenants)	Keeping the business operations ongoing	SEHs contribute better accessibility to power, meet complex legislation, and keeping energy affordable.	The grid-connected business owners can share resources with other businesses in SEHs. Business owners can organise a SEH, however they often lack the expertise and time to do this.
Service providers (technological solutions)	Developing and offering technological solutions which enhance flexibility	SEHs contribute as an opportunity to innovate and gain commercial advantages	Service providers provide technological solutions and advise for the SEH. They lack the expertise to organise a SEH. They are the only actor who is not bound to the location.

Figure 12 - Table showing overview of actors in SEH

Overview of involved actors in their operating areas.

DISTRIBUTION SYSTEM OPERATOR (DSO)

Interests in SEH:
- Better access and affordability energy

Role in SEH:
- Legally constrained
- Gatekeeper

LOCAL GOVERNMENT (PROVINCE & MUNICIPALITY)

Interests:
- A social, green and wealthy business climate

Role in SEH:
- Facilitate (financially)

SERVICE PROVIDER

Interests:
- Commercial gain
- Innovation

Role in SEH:
- Advise
- Realise

AREA / PARK MANAGEMENT

Interests:
- A future-proof business park

Role in SEH:
- Facilitate

BUSINESS OWNERS

Interests:
- A future-proof business

Role in SEH:
- Share resources

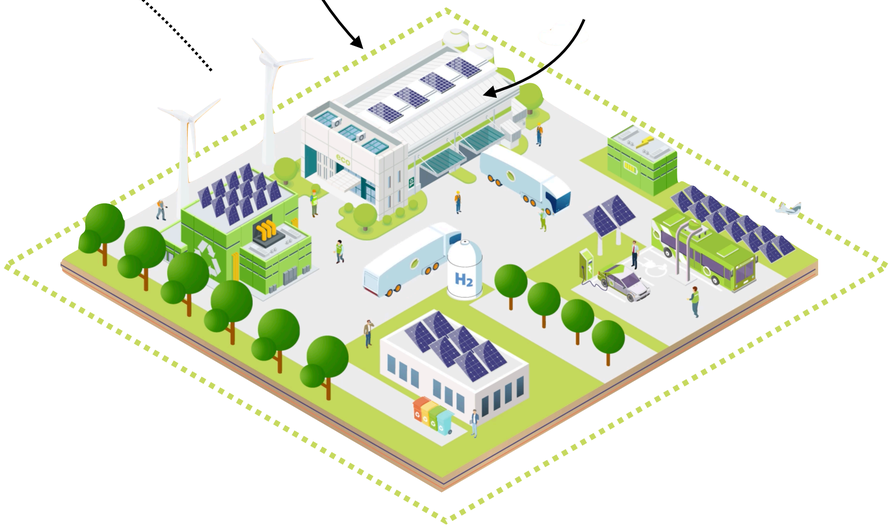


Figure 13 - Overview of actors on their respective areas

Actor map of key actors

In figure 14 you see an actor map for each of the key actors in a SEH. The objective of an actor map is to explore the relationships and power dynamics between the identified actors (Jones & Van Ael, 2022). For this research the purpose of this map is showing the complexity of the different relations between the actors. The business owner is split into two different types, as their position of power changes significantly when they can or can't offer flexibility. Offering flexibility means they can share resources to enhance grid flexibility, which gives them a position of power in comparison to the businesses who are in need, and cannot offer flexibility. This actor map was made together with experts in the field. For the list of experts, see Appendix A.

Conclusion involved actors

From the actor map it can be concluded that interplay between actors who are needed for a SEH is a complex context. Observing the table shows that the DSO who is responsible for the electricity grid is legally restricted from organising SEHs. Consequently, the responsibility falls upon the remaining actors in the table. However, each of these actors face limitations in taking organisation. So, currently there is no specifically assigned party to undertake this organisation and facilitation. This raises the following question: to ensure the success of SEHs, what external roles are required?

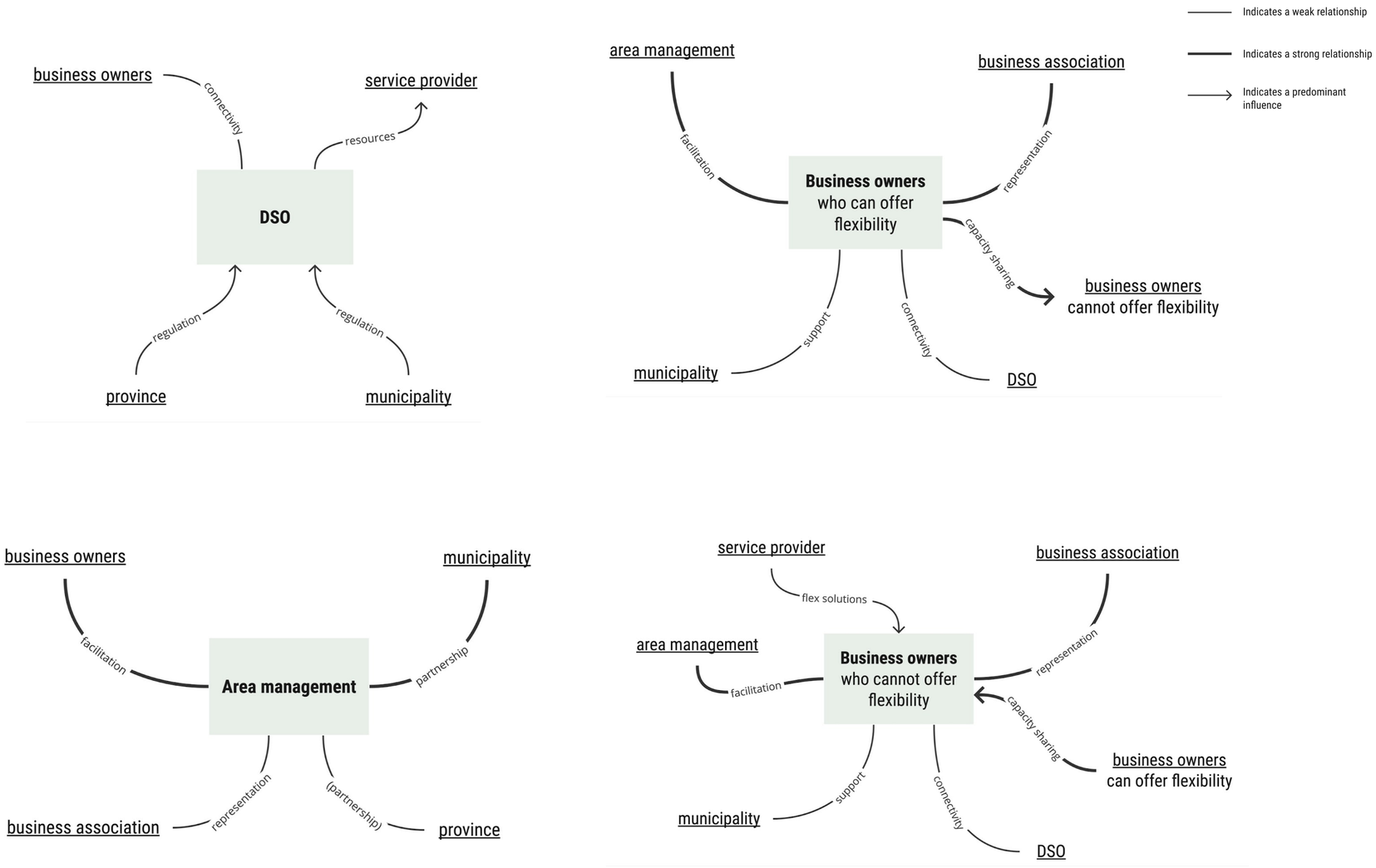


Figure 14 - Actor map per key actor showing the relation between other key actors

Required roles for setting up SEH

To successfully develop a SEH, certain roles are needed, which can be fulfilled by several actors. In collaboration with experts on SEHs a concentric overview was made (see figure 15), showing the organisation of a SEH in its final state, the interactions inside this organisation, and the interplay between roles and actors. This overview is applicable to most situations, however it should be noted that the specific context of each hub may lead to variations in the visual representation and the actors involved. The following roles were identified:

Initiator.

This role is the starting point of any SEH. A party needs to initiate the process of setting up a SEH. This can be done by several actors.

Community builder

The community builder is focussed on engaging the actors and bringing them together. The aim of this role is to find cooperation and alignment between actors. This is often done by someone who knows the local actors well.

Project manager

The project manager is focussed on the planning and speed of the project. They facilitate the process and help in decision making. A neutral party is required, so project manager is not biased with certain interests.

Investors

Process and service investments are needed. The investments in the process are often done by the local government or an area management as business owners find it too risky not knowing beforehand if it will be a success. The investments in services will differ per hub depending on the technical solution which is implemented. These are often done by businesses themselves or by third parties, like banks.

Regulators

The regulators have the power to make decisions and give approvals or rejections based on their authority and expertise. The environmental service of a local government provides permits for potential solutions that need to be implemented in the SEH. Every SEH needs the approval of the DSO, as the DSO is accountable for ensuring a safe and reliable grid.

Consultants

The consultants are important to provide the set-up of SEHs with certain expertise that the local actors are lacking. They can provide a holistic view of all the possibilities and advise in making the optimal decision. Multiple types of consultants are needed, most of the time in the field of finance, legal, governance, and technology.

Conclusion roles

From the concentric overview the conclusion can be made that in order to reach the final state of a SEH, a diverse range of roles is required. However, the fact that many roles can be undertaken by multiple actors can result in a situation where no party assumes any role. This lack of ownership and responsibility in taking up roles can pose a serious challenge in starting a SEH. Since the roles are not explicitly assigned in advance, it can lead to actors failing to fulfil their responsibilities. This raises the question of the what the typical formation process is of SEHs.

General conclusion chapter 2

The energy challenges discussed in this chapter showed there is an urgency to start SEHs. Despite their necessity, the initial stage of SEHs collaboration is facing obstacles.

The overview of actors and their interactions in a SEH shows the complexity of such a collaboration. Many roles are needed to realise a SEH, showing the level of difficulty for the initial stage. Besides, many roles, like organising a SEH is not assigned to one dedicated party, creating problems in the organising ability of setting them up.

To understand the underlying causes of the obstacles responsible for the failing collaborations, empirical data is needed from current SEHs.

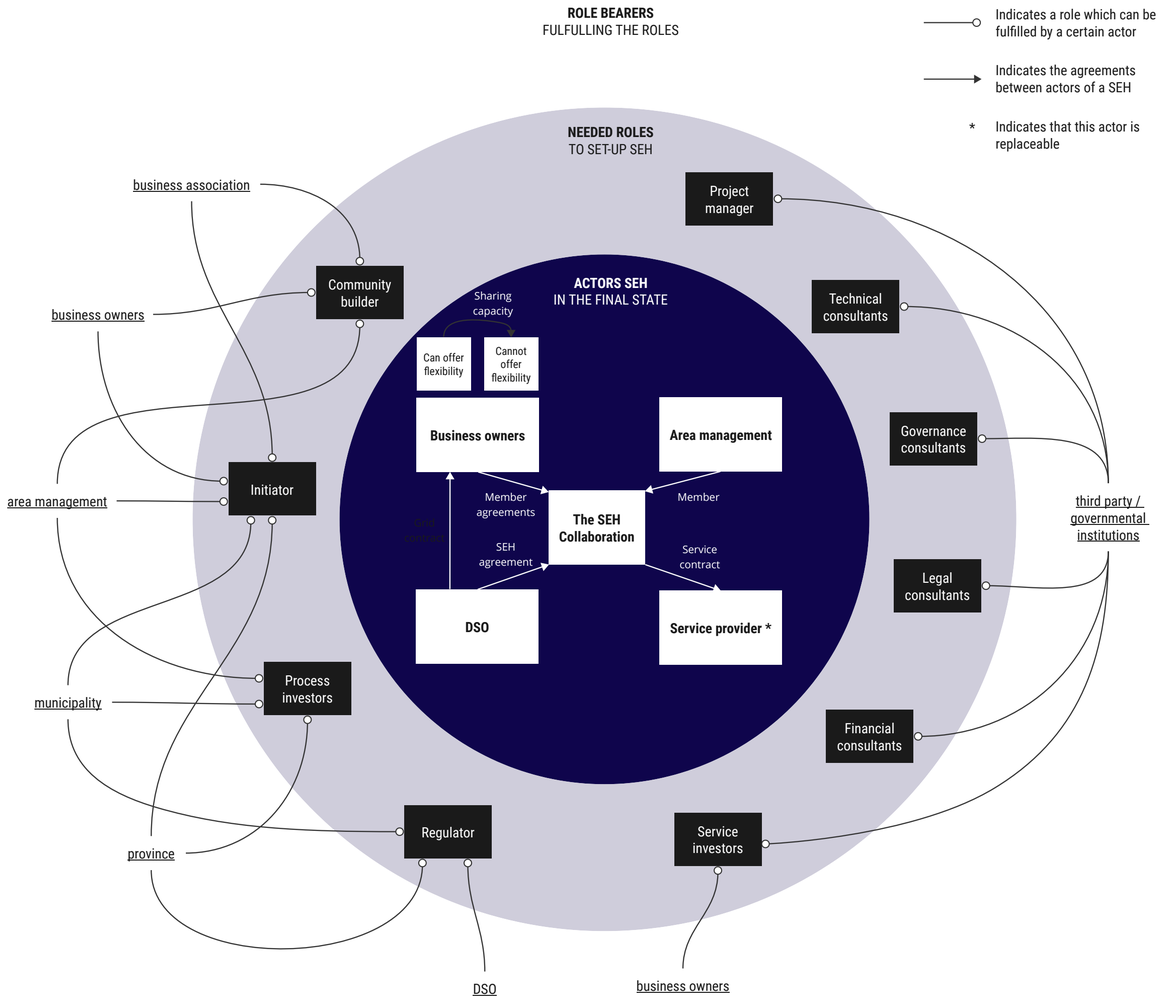


Figure 15 - Visualisation of concentric model of key actors, roles and role bearers

chapter **3**

Analysing Smart Energy Hubs

As SEHs are relatively new and innovative, two framework are examined to use as a reference analysing empirical data of current SEHs. First, a framework for the formation process is presented. Additionally, a framework based on the Strategic Niche Management (SNM) approach to guide the analysis phase is showed, complemented with factors for successful collaborations. The empirical research focused on gathering data specifically related to the formation stage of SEHs. The barriers are mapped on the formation framework. Thereafter, the mindset of actors of how they perceive SEHs, including interests and risks are obtained. With the SNM approach the empirical data is analysed and key success factors are discussed. These lead to key needs for designing strategies to enable collaborative effectiveness.

FRAMEWORKS

Two frameworks

Given the relatively new nature of SEHs in the market, the available literature on the topic is limited. However, it remains crucial to gain a deeper understanding of the underlying processes and factors contributing to their success to develop strategies to enable collaborative effectivity. In order to address these questions, this research draws upon two frameworks as valuable references. Firstly, an exploration of a network formation framework provides guidance on how SEHs can be effectively established. Secondly, a framework is presented to categorise and analyse the key factors that contribute to successful collaborations within SEHs. By utilising these frameworks, this research aims to uncover the complexity of SEH networks and identify the critical elements for their success.

Framework 1: formation process of networks

Understanding the process can ultimately lead to a better understanding of the dynamics and cause of barriers. Due to its relative new character, there is limited literature on the process of setting up SEHs. To better comprehend the underlying process a framework to set up innovation networks is used of InnovationNet (Kratzer et al., 2007). Innovation networks are collaborations of companies with the aim to innovate together in order to secure continuity of their business (Kratzer et al., 2007). Because of the parables of innovation networks with SEH collaborations, the framework of Kratzer et al. is chosen. The framework divides the process into three distinct stages (see figure 16):

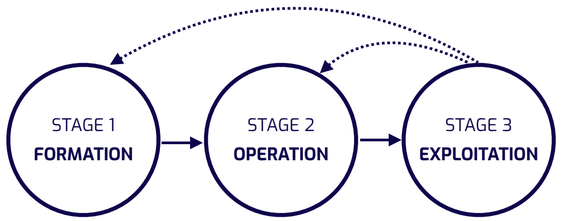


Figure 16 - The three stages of the InnovationNet framework

1. Formations stage focuses on all the issues surrounding the set up of collaboration networks

2. Operations stage deal with all facets of how to run collaboration networks.

3. Exploitations stage investigates all points surrounding goal achievement and learning.

As the scope of this research is on the initial stage of development where collaboration fails, the formation stage will be further highlighted.

The formation of collaboration networks encompasses three main facets that need to be considered:

A. **Partner selection.** The systematic selection of partners, an inevitable requirement at the start, can be done in different ways. In order to select the right partners several criteria or a decision matrix approach can be utilised.

B. **Motive and goal correspondence.** The functioning of networks strongly depends on the motivation and goals correspondence of partners. The multiplex nature of possible motives may create problems because the partners might be pursuing different goals and even contradictory goals. However, goal correspondence does not necessarily mean that partners have exactly the same goals, but these goals should not be conflicting.

C. **Strategic alignment.** It refers to resource alignment, identifying the absent and present resources; relational alignment, having compatible cultures, willingness to adapt, and a long-term orientation; and confidence in partner cooperation and commitment which is essential for successful networks.

The framework developed by Kratzer et al. (2007) serves as a reference for existing SEHs. Therefore, it is interesting to map current SEHs onto this framework to assess their alignment with the reference facets and steps. The formation framework provides a structured approach for categorising the empirical data of the upcoming user research. However, it is important to acknowledge two significant assumptions made by this framework. Firstly, it assumes a willingness among actors to collaborate. Secondly, it assumes the presence of a party that feels responsible for initiating a collaborative network. These assumptions may not always hold true for SEHs. Therefore, in order to effectively utilise this framework, the initiation stage needs to be incorporated (see figure 17). The specific dynamics of this stage will be explored through user research to uncover its underlying steps.

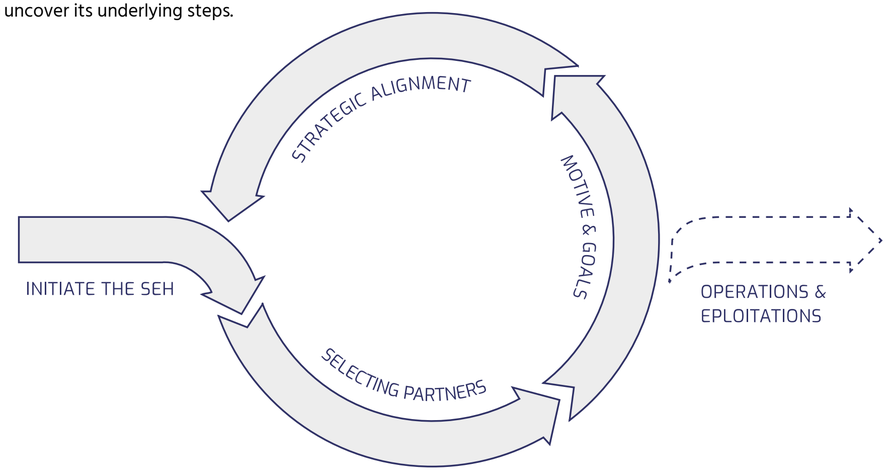


Figure 17 - The formation framework adopted by InnovationNet (Krazter et al., 2007) and adapted with the initiate phase

Framework 2: Strategic Niche Management

In order to understand the barriers faced by current SEHs and define what constitutes success, the Strategic Niche Management (SNM) approach is used as an analytical framework. This framework has proven valuable in analysing the success and failure of introducing innovations (Caniëls & Romijn, 2006). These innovations are referred to as niches. The SNM approach provides guidance and facilitation in the successful development of innovations, consisting of three processes (Schot and Geels, 2008):

- **Aligning expectations and visions.** Expectations play a crucial as they provide guidance for learning processes, attract attention, and legitimise the protection and nurturing of the innovation. In the early stages, the benefits of an innovation may not be evident, and its value needs to be proven despite resistance.
- **Building social networks.** The formation of a new actor network involves creating a supportive constituency, facilitating interactions among relevant actors, and providing the required resources. This process is often necessary in niche development.
- **Articulating the process.** Overcoming barriers and uncertainties associated with the introduction and adoption of an innovation is essential.

These three processes of SNM serve as categories for identifying specific factors that define successful collaborations within SEHs. However, it is important to note that this framework includes both effectiveness and efficiency for successfully developing innovations. During analysis this should be taken into account when identifying key needs. It is crucial to recognise that SNM is not a standalone theory for SEHs but provides a valuable framework to guide research.

Successful factors of collaborations

While the SNM framework provides an overall outline for successful innovation development, this research specifically focuses on effective collaboration. Therefore, a literature review is conducted to identify factors that define successful collaboration networks between organisations. These factors will be used in the analysis of the interviewed SEHs in Chapter 3 to uncover the main barriers and key needs. Additionally, empirical data will complement the list of success factors, resulting in a comprehensive list of factors that influence the successful development of SEHs. The factors in the table (see figure 18) of successful collaborations are based on the works of Brouwer et al. (2016), Shamsuzzoha et al. (2010), Kratzer et al. (2007), and Caniëls and Romijn (2006).

Conclusion two frameworks

Limited research exists on the process of setting up SEHs, making it necessary to use a reference framework. The framework will help to understand and explore the underlying reasons behind barriers. The InnovationNet (Kratzer et al., 2007) framework for the formation process assists in categorising data by presenting the formation process in three steps: partner selection, correspondence of motivation and goals, and strategic alignment. However, this model assumes that initiation is already taken care of, which is not always the case in SEHs. Therefore, an additional step of initiation has been incorporated in the framework.

To evaluate the current SEH cases, the Strategic Niche Management (SNM) framework is utilised. This framework helps in comprehending the barriers by providing insights into what constitutes success in a collaboration. In order to make these frameworks relevant to SEHs, an empirical user research study is conducted to gather data, allowing for a comprehensive mapping of the barriers.

SNM	Success factors	Elaboration
Align expectations & visions	Sharing a concern	Shared and common definition of the problem situation or opportunity.
	Sharing motives and goals	Sharing and aligning motives and goals, documented in writing and formal statements.
	Clarify expectations	Developing clear rules for collaboration (decision-making processes, leadership, responsibilities, sharing resources)
	Long-term orientation	Demand a long-term focus with long-term benefits that justify the investments in the collaboration
Building the network	Strengthen relations	Possess some level of mutual trust, which can be established by working with power differences and recognising conflicts.
	Work across sectors	Recognising that underlying issues and opportunities span across different disciplines and scales, involving multiple stakeholders.
	Involving all actors	Ensuring the involvement of all actors, who are affected by or influencing the situation, from the start. New stakeholders might join or old ones drop out.
	Sheltered spaces for experimentation	Providing initial settings for experimental use of innovation.
	Maintaining momentum	Sustaining continuous development, and continuous learning to support successful collaboration formation.
	Confidence in partner cooperation	Finding balance between control and trust, as these influence the confidence in partner cooperation, which is crucial to justify the risky nature of collaborations.
	Deep commitment	Enabling individuals (champions) at representing organisations to mobilise commitment and resources within their own organisations and networks.
Articulate the process	Supporting learning	Providing a supportive environment with learning processes where actors can educate each other.
	Adaptive planning approach	Incorporating flexibility and adaptability to changing needs while ensuring actors understanding the process approach.
	Facilitating alignment	Engaging a neutral facilitator to manage the formation of collaborations, who is open-minded, flexible, reflective, and capable of learning.

Figure 18 - Table showing the success factors and its elaboration

USER RESEARCH SMART ENERGY HUBS

This user research dives into the findings of the context through interviews with relevant stakeholders. It aims to achieve two objectives. The first objective is to better understand actors' experiences during the SEH formation process, thereby identifying barriers within the different facets of the formation process. If measures were taken by actors to mitigate these barriers, these are noted as well. The second objective is to gain a deeper understanding of actors' perspectives and minset on SEHs, while starting a collaboration. This includes their interests and perceived risks. Full details on the research method, data collection and data analysis can be found in Chapter 1 The Introduction on page 9.

The interviewed SEHs cases and the type of actors can be found in Appendix A.

Key findings of barriers during formation stage

Key findings regarding barriers during the formation stage are essential to understand with the aim to enhance collaborative effectiveness and develop strategies for improvement. These barriers, identified during the interviews, have been mapped and categorised within the formation framework. The following presents a summary of the key findings, discussing the barriers first and then the measures taken to mitigate them. For a more detailed elaboration of all barriers and measures, see Appendix D. A visual representation of the identified barriers can be found on the next page (see figure 18).

Initiate the SEH

The lack of a sense of ownership contributes to the delay or non-initiation of many SEHs, as personal ambitions rather than policy and regulations drive the initiation process. A suitable initiator for SEHs would be the area management, given their existing relationships with businesses and strong sense of responsibility for achieving collective solutions.

Business owners struggle to adopt a collective mindset because they fail to recognise benefits in joining a SEH and primarily focus on the costs of collaboration rather than the potential advantages. For many the value of collaborations remain in-evident, which results in businesses acting individually instead of initiating a collaboration. This was partly due to business owners not being aware of the risks of the energy challenges they will face. Having different perspectives on the situation, which was rooted in experiencing different levels of urgency to act, was another barrier for not participating.

Parties are unaware of the circumstances under which a SEH is the right choice and how much prior knowledge is required before taking action. Therefore they experience a dilemma between conducting a thorough analysis upfront or taking immediate action. This is the result of the lack of expectations of the process of SEH.

To address these challenges, all SEHs strive to promote a shared understanding, highlight successful examples, avoid technical jargon, and emphasise the collective nature of the SEH concept.

Selecting partners

The partner selection process for most SEHs did not encounter significant barriers as it unfolded organically. Typically, an initiator would invite all business owners to join the SEH, and those who were interested would participate. Often this was a dedicated role for a project manager or community builder. Having cooperation of DSO was often a struggle. What should be noted is that this is a time-consuming process to identify all interests and data of actors as these are not transparant and publicly accessible.

Many current SEHs opted to begin with a core group of pioneers forming a steering group to take the initial steps. This approach facilitated quick decision-making and made the process smoother.

Motive & goals

The alignment of motives and goals in SEHs is a time-consuming process, characterised by challenges such as asynchronous ambitions, reluctance to share confidential business information, and potential representatives who may not fully represent their organisation's interests.

Through joint-fact-finding project managers and/or community builders mapped all interests

Strategic alignment

Strategic alignment was not always smooth, involving complexities in sharing resources, power dynamics, different work cultures, the preference for control over trust, and occasional lack of commitment at the top level, resulting in poor participation.

Conclusion of barriers

Barriers are identified at every level of the formation stage of SEHs, with a higher concentration in the initiation and strategic alignment phases. Many barriers stem from actors' perspectives on risks and interests, like the lack of seeing evident value or perceiving a risky investment. Understanding actors' mindset at the start of SEHs is therefore crucial to further explore the causes of the barriers. Uncovering their interests and perceived risks helps later on in the design phase to tailor strategies based on their mindset.

Overview of barriers from interviews

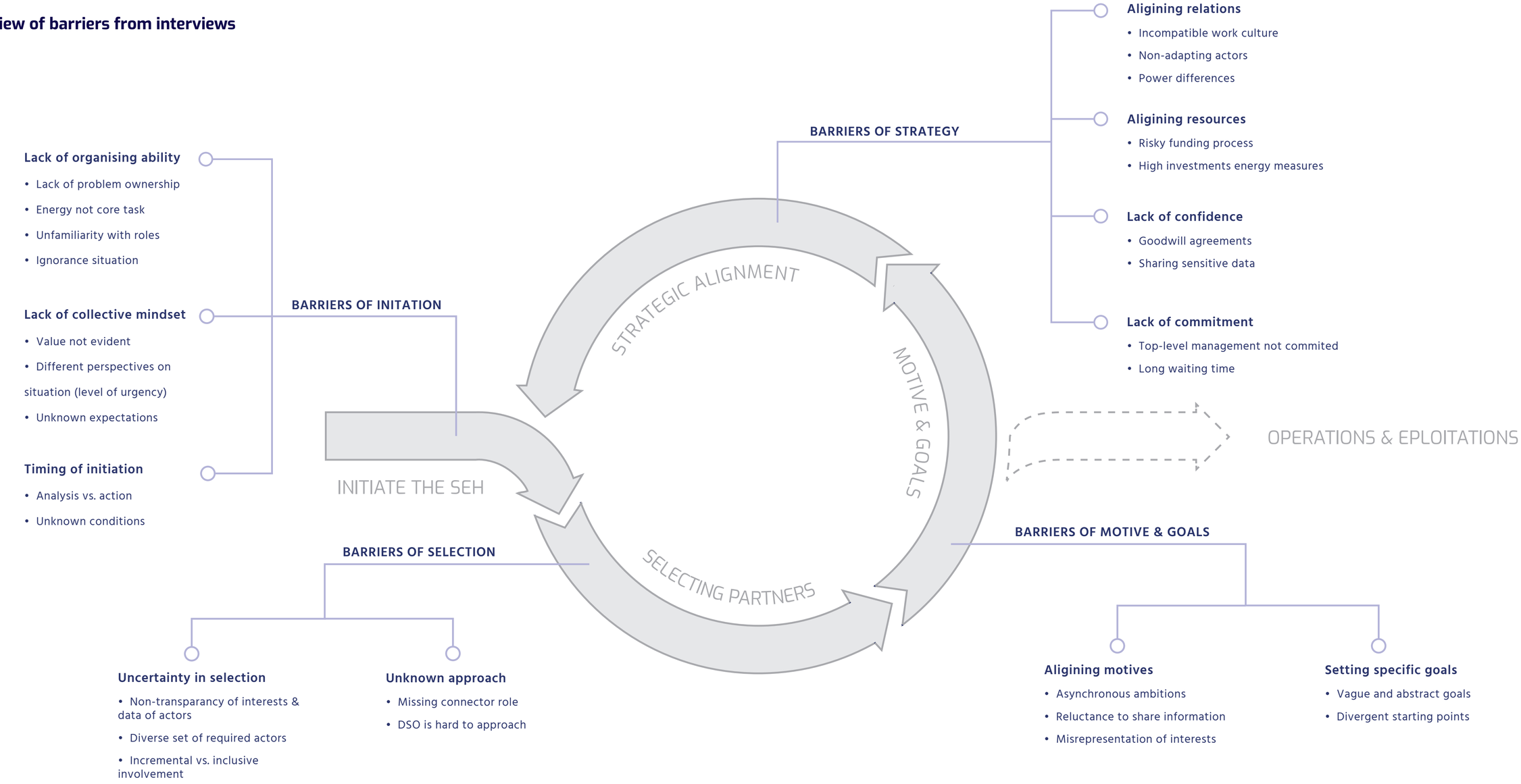


Figure 18 - Visual overview of encountered barriers in formation phase SEH

Key findings actors' mindset at start

The second objective of the user research is to understand the mindset of involved actors at the start of setting up SEHs. With what feeling do they step into the process ? The actors who are in the final state of SEHs are elaborated further below. While other stakeholders were interviewed, their roles and mindset were not explored further as they are not key actors.

Business owners with flexibility (see figure 19)

Business owners with flexibility sometimes lack the sense of urgency to initiate SEHs when they don't face energy-related issues or see potential opportunities. Without this urgency, they may not recognise the value of SEHs and collaboration, leading to a reluctance to participate. Additionally, businesses offering flexibility may perceive SEH participation as a disadvantage since it requires giving up capacity and resources. This perceived lack of value poses a challenge to their engagement in SEH initiatives.

However, introducing a long-term orientation increased the perceived value among some business owners, creating a stronger sense of urgency and willingness to participate.

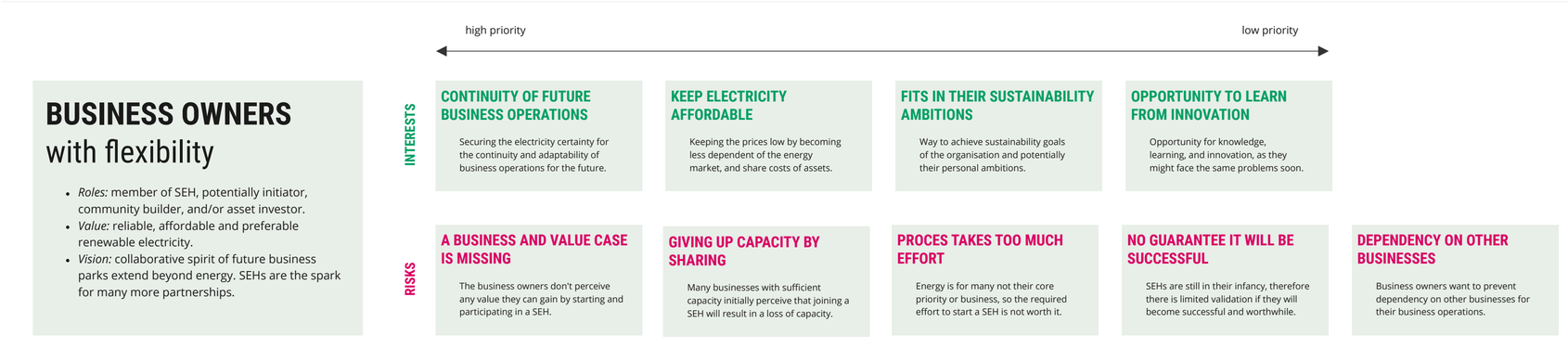


Figure 19 - Mindset of business owners with flexibility

Business owners without flexibility (see figure 20)

Business owners without flexibility often have this sense of urgency to start SEHs due to experiencing problems, conflicts, or perceived opportunities. However, time and guarantee are seen as crucial requirements for these business owners, which are not self-evident in a SEH. Setting up a collaboration is time-consuming, as time is needed for forming relations, having negotiations , etc. Besides, there are almost no proven cases that a SEH will work. They prioritise prompt solutions and reliable outcomes which can prevent them from choosing SEHs.

Overall, the two types of business owners have a relatively negative mindset towards the SEH arising from the perceived risks that outweigh the benefits in their perception. The classification on level of urgency will be more relevant, then on flexibility as this only focusses on congestion problems.

Figure 20 - Mindset of business owners without flexibility

DSO (see figure 21)

DSOs act as gatekeepers for SEHs, as the absence of legislation for SEHs requires their approval for flexibility sharing. This grants them significant power and establishes them as indispensable actors from the start. However, the introduction of SEHs often disrupts the traditional working methods of DSOs, leading to resistance and concerns about grid safety and reliability. Some measures of SEHs are seen as intruding their infrastructure. However their interest of having in addressing congestion often outweigh these concerns.

Area management (see figure 22)

Area management entities, responsible for the development and continuity of business parks, can take on multiple roles within SEHs. Juggling various roles, such as being an initiator, community builder, project manager, and process investor, can be demanding for just one actor. The unfamiliarity with these roles can either deter them from initiating SEHs or create obstacles during the development process. The feeling of responsibility of an area management to start forming a SEH on a business park is closely tied to the quality of area management. Well-functioning organisations with high sustainable ambitions have been instrumental in driving current SEH initiatives forward. Not all business parks have the same level of effective area management, or may not even have an area management at all.

Conclusion actors' mindset

Despite the interests of actors, they perceive multiple risks in starting SEHs. Business owners have predominantly negative mindset towards SEHs, due to the risks. These perceived risks deter them from starting collaborations, as these are linked to forming collaborations. Understanding this mindset is valuable in designing strategies to enable effective collaboration. By addressing actors' concerns and mitigating perceived risks, SEH initiatives can foster a more conducive environment for successful collaboration. Classifying actors based on their level of urgency will be more relevant to this research.

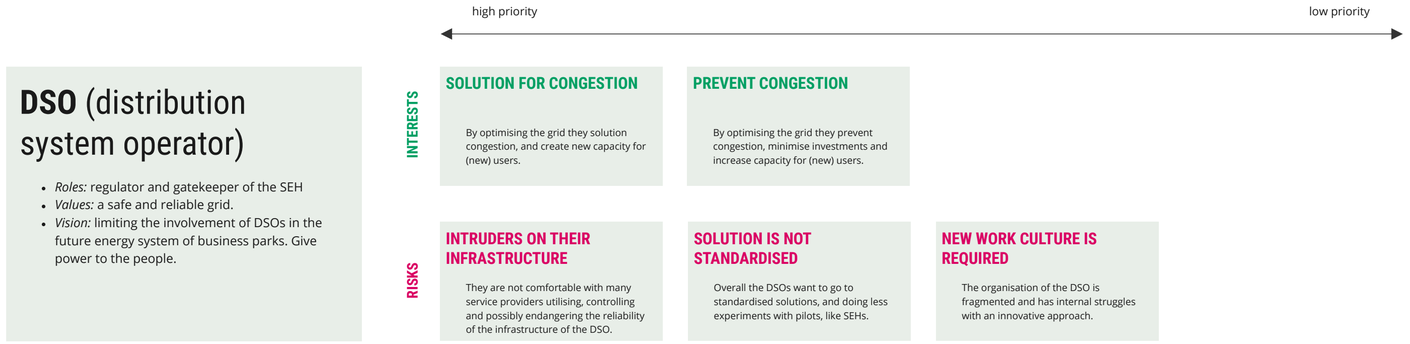


Figure 21 - Mindset of DSO

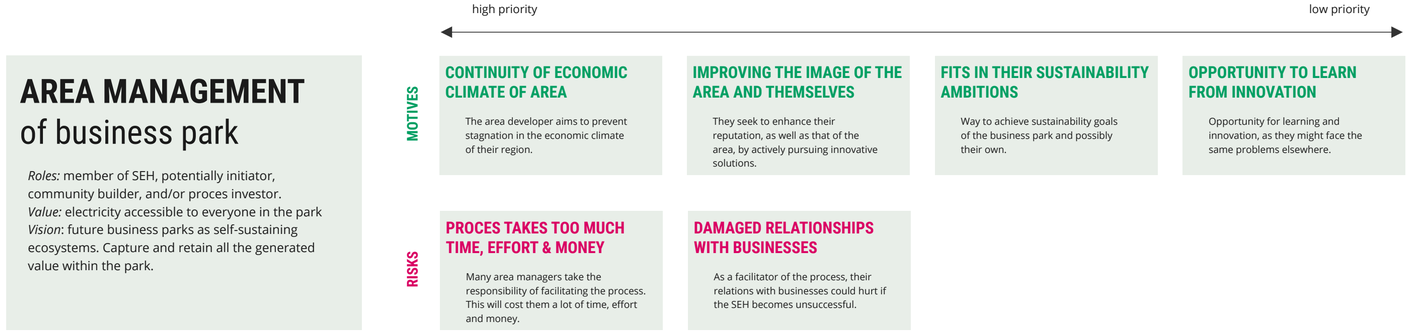


Figure 22 - Mindset of area management

ANALYSIS OF FINDINGS

Analytical framework of SNM

The empirical data from the interviews are analysed with the successful collaboration factors from literature within the SNM approach. This comparison was done by doing a "health check," (adopted from Kratzer et al. 2007) to evaluate the level of alignment between the interviewed SEHs and the established criteria. Through this health check, aspects of the SEHs are categorised based on their level of alignment: high alignment indicating a healthy state, moderate alignment reflecting a level of discomfort, and low alignment indicating a state of fever. Knowing if a factor was met by a SEH, was decided by the researcher based on the knowledge of the interviews. To ensure the validity of the findings, two experts in the field validated the research outcomes, serving as a double-check to confirm the accuracy and completeness of the interpretations. For an overview of this analytical framework see Figure 22.

SNM	Success factors					
Align expectations & visions	Sharing a concern	❒	❒	❒	❒	❒
	Sharing motives and goals	❒	❒	❒	❒	❒
	Clarify expectations	❒	❒	❒	❒	❒
	Long-term orientation	❒	❒	❒	❒	❒
Building the network	Strengthen relations	❒	❒	❒	❒	❒
	Work across sectors	❒	❒	❒	❒	❒
	Involving all actors	❒	❒	❒	❒	❒
	Sheltered spaces for experimentation	❒	❒	❒	❒	❒
	Maintaining momentum	❒	❒	❒	❒	❒
	Confidence in partner cooperation	❒	❒	❒	❒	❒
	Deep commitment	❒	❒	❒	❒	❒
Articulate the process	Supporting learning	❒	❒	❒	❒	❒
	Adaptive planning approach	❒	❒	❒	❒	❒
	Facilitating alignment	❒	❒	❒	❒	❒

Figure 22 - Table showing the visual for analysis of success factors related to the SEH initiatives

Key findings from analysis

In the key findings not all success factors are discussed, but a selection is made on the most important findings of the analysis. From the analysis the table of success factors was complemented with new factors (see figure 23). Some factors were not relevant and crossed out. On the next page, an overview can be found of the key success factors which misaligned most, mapped on the formation framework (see figure 24).

Key success factor: sharing a concern

A large misalignment is found in the factor of "sharing a concern." This is because almost all SEHs experienced initial friction with explaining the situation to business owners. All the interviewed SEHs emerged from congestion issues, which did not initially resonate as a problem which the business owners should solve, according to business owners. However, a shared concern is needed as this is the starting point for setting common goals. What doesn't help is that many actors also don't know what to expect. In the early stages, many SEHs lacked a shared vision that clearly conveyed the situation as a collective problem, its consequences, and how the situation potentially could be improved. However, Schiphol managed to address this by using a shared language that resonated with the businesses, rather than relying on technical terminology.

Key success factor: willingness to collaborate

In addition to the existing criteria, it is important to include the factor of "willingness to collaborate" in the framework. With SEHs it is not always the case that all actors initially want to collaborate, due to the non evident value for them. This was a major barrier at all SEHs, as there is willingness needed to start a collaboration. Many literature about collaboration assumes the partners want to collaborate. With SEHs collaborations are in a position where participation of some parties is necessary while these might not are interested in joining. For some SEHs it helped to show a longer term perspective, stimulating urgency for parties who initially not felt it. Not seeing the value of a SEH is a major contributor to the lacking willingness to collaborate, as the risks outweigh the costs in that case.

Key success factor: supporting learning

As observed from the identified barriers and tensions in the interview findings, there are numerous challenges that each SEH has found its own way to overcome. However, these valuable findings and lessons learned aren't shared or in a limited way. The presence of an experienced project manager who has knowledge of other hubs becomes crucial in this context, yet there is currently a scarcity of project managers with such expertise. Therefore, supporting learning scores low in the analysis. A network of SEHs connected to each other and transferring knowledge is not present everywhere.

Key success factor: sense of problem ownership

Most SEHs had the building of their network well-established. However, a crucial assumption is that there is a supporting party involved in the establishment of SEHs. In the case of all interviewed SEHs, this support was eventually provided, but it was not always readily available in the initial stages. Support is essential as many actors lack the time, knowledge or responsibility to facilitate the organisation. Having a sense of ownership on the collective problem is another factor influencing the successful development. The successful initiation of the SEHs was mostly attributed to an area management or a local government entity that felt the ownership and initiated it.

SNM	Success factors	New success factors
Align expectations & visions	Sharing a concern	Sharing a language.
	Sharing motives and goals	Understanding the context dynamics.
	Clarify expectations	Willingness to share data.
	Long-term orientation	Willingness to collaborate.
Building the network	Strengthen relations	Ownership of collective problem
	Work across sectors	Build on existing networks
	Involving all actors	
	~~Sheltered spaces for experimentation~~	
	Maintaining momentum	
	Confidence in partner cooperation	
	Deep commitment	
Articulate the process	Supporting learning	
	Adaptive planning approach	
	Facilitating alignment	

Figure 23 - Table showing the newly added success factors

Sense of problem ownership

- Required for initiation
- A supporting actor should organise

Willingness to collaborate

- Value of collaborating must be evident
- Stimulating sense of urgency with longer-term orientation

Sharing a concern

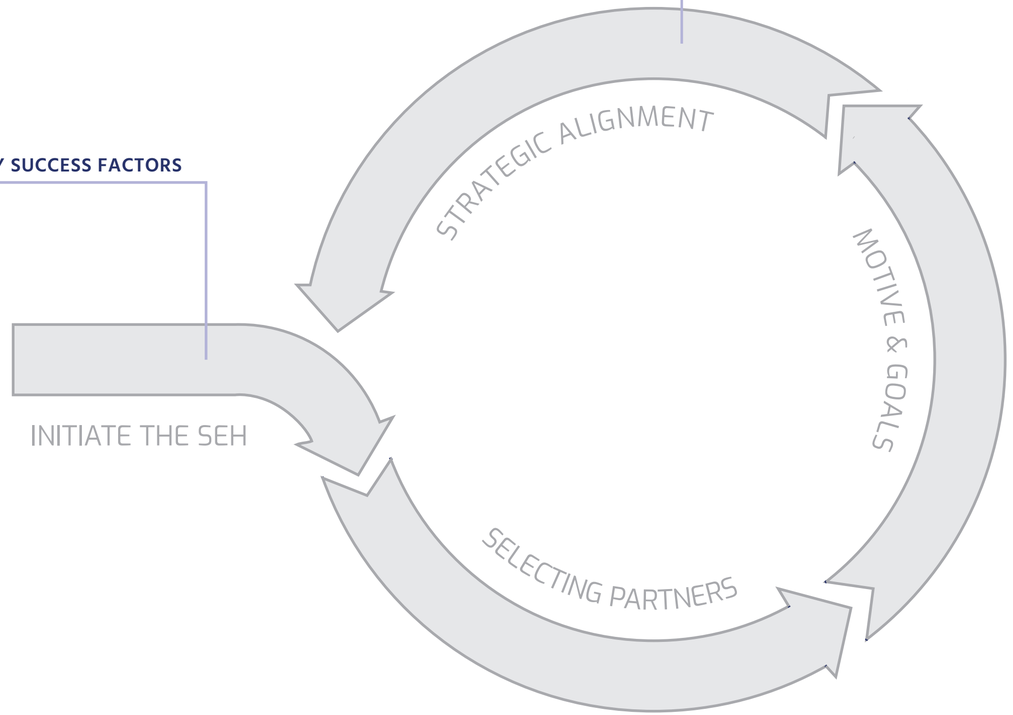
- Creating a shared understanding of problem and a vision
- Unknown conditions

KEY SUCCESS FACTORS

KEY SUCCESS FACTORS

Support learning

- Having a network between SEHs that share valuable learnings about overcoming barriers



OPERATIONS & EPLOITATIONS

Figure 24 - Visual overview showing the key success factors which are unaligned

KEY NEEDS IN SMART ENERGY HUBS

This chapter will be concluded with key needs derived from the analysis of user research and literature. From the analysis four dominant needs have been distilled:

- Need for a shared vision: SEHs require a clear and shared vision that communicates the collective and future understanding of the situation, the consequences on an individual and collective level, and the potential improvements for the current situation. It is essential to foster a sense of ownership among all stakeholders, ensuring that they recognise and address the collective nature of the problem they are trying to solve. This vision could highlight this collective approach and what actors could expect from a SEH and its process.

- Need for support and facilitation: Business owners require support and facilitation from a neutral and independent party to overcome knowledge and time limitations, as well as to foster a collective sense of ownership. The support needs assistance as the amount of roles to support SEHs are often overwhelming for one actor.

- Need for transferring knowledge: The need for transferring knowledge arises from the observation that valuable findings and lessons learned from one context or project are not being shared with others. This lack of knowledge transfer hinders the progress and growth of similar initiatives, as each entity has to independently navigate the challenges and barriers they encounter. A better way to transfer knowledge is needed.

- Need for visualising the value and expectations of collaboration: The need for visualising the value of collaboration arises from the success factor willingness to collaborate and the negative mindset of business owners. Right now for many actors (especially business owners) it remain unknown what the value is from collaborating. Besides, the business owners perceive quite some risks, as they are not sure what to expect. And the sense of urgency can help in making the value more apparent. If the value and expectations are better visualised this might help in increasing the willingness to collaborate.

chapter **4**

From Research to Design

Having established a comprehensive understanding of the existing network, its challenges, and the identified needs, we now start the journey of reframing the design challenge and exploring the solution space. Building upon the insights gained from understanding the SEH network and unravelling its barriers and needs, the foundation is laid for uncovering new possibilities. Some of the opportunities are tested in a real life setting through a co-creation. This will form the justification for choosing one design.

REFRAME

Choice justification of chosen needs

Through the comprehensive analysis in the previous chapter, valuable insights were gained that led to dominant needs. Among the identified needs, two needs are chosen to continue with.

The first chosen need is the transfer of knowledge. This need holds significant importance in the early stages of SEHs, as many current initiatives are reinventing the wheel. By transferring knowledge, organisations can leverage the experiences and insights of others, avoiding unnecessary mistakes and fostering collaboration. This collective learning process leads to more effective outcomes and supports the establishment of better expectations about the SEH process, ultimately increasing the willingness to collaborate.

The second chosen need is visualising the value of collaborating. The willingness to collaborate is essential for initiating collaborations, however businesses are perceiving too many risks. By visualising the value of collaboration, this feeling of risk can be lowered, encouraging business owners to actively engage in collaborations. This need aligns with the researcher's expertise in visual design.

The other needs of a shared vision and support and facilitation were not chosen, as addressing these needs would require more of a policy change rather than a design solution. While important, these aspects are better suited for policy and organisational interventions rather than within the scope of this design project.

Design challenge

To address the chosen needs, the design challenge is defined as follows:

How can we visualise the value of collaboration and effectively transfer this information among actors?

In order to guide the design process and make informed decisions for the final concept, requirements for the concept are derived from knowledge management theory. Based on the principles of successful knowledge management (Davenport & Prusak, 1998; Intezari et al., 2017) the following concept requirement are created:

1. The concept should create an infrastructure to share knowledge
2. The concept should foster a knowledge-intensive culture
3. The concept should visualise the knowledge

Solution space of visualising value

In the solution space for making value visible, various ideas have been explored, including digital dashboards, serious gaming, user scenarios, and infographics (see figure 25). Prototypes have been created which helped in understanding and further specifying the narrative that needs to be conveyed to business owners. The story should start with the why, showcasing the urgency, moving to the what, demonstrating the different possibilities, and concluding with the how, illustrating the approach.

By addressing the chosen needs and embracing the design challenge, the project aims to create visual tools and approaches that effectively communicate the value of collaboration and facilitate the transfer of knowledge among actors. This will contribute to a better understanding of SEHs and foster a collaborative environment for successful implementation.

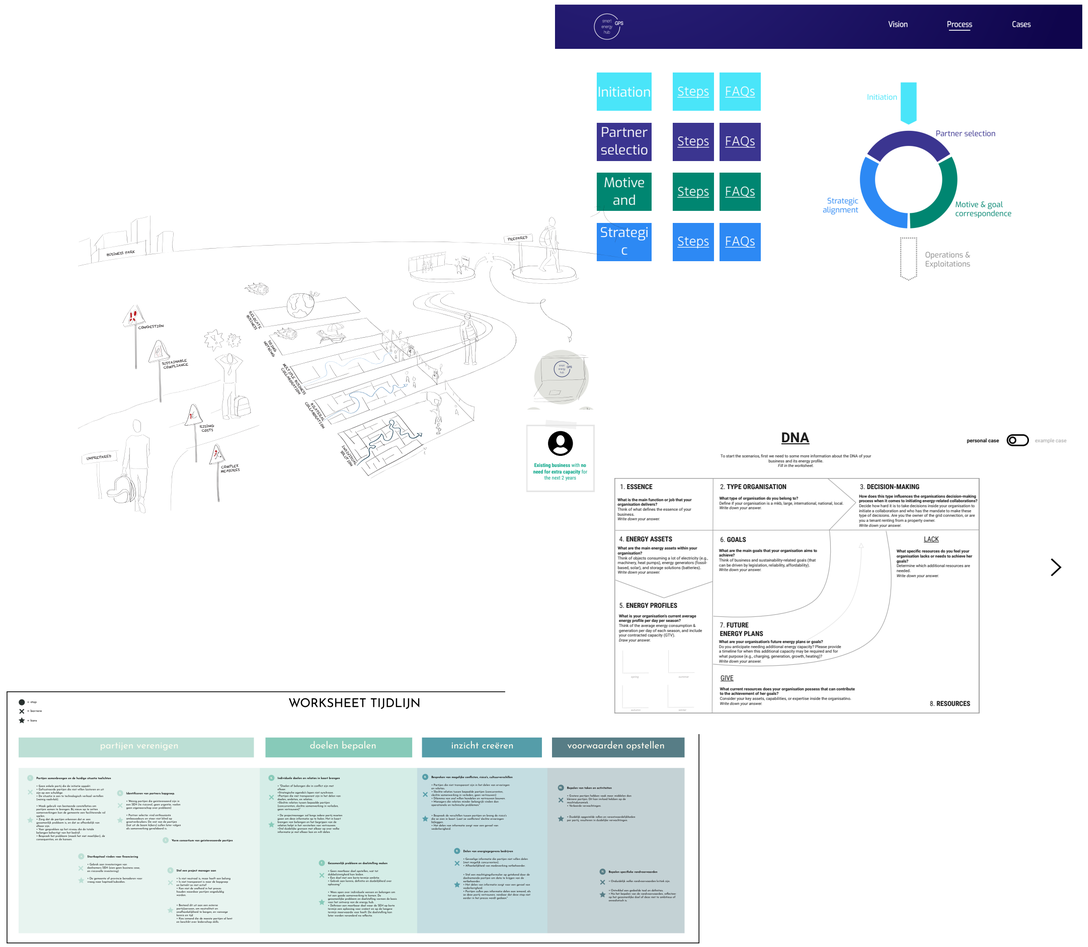


Figure 25 - Several ways of visualising the knowledge of formation process

CHOICE CONCEPT

Validation at co-session

To validate the effectiveness of visualising knowledge and assess the viability of a social infrastructure, a co-creation session was organised with nine participants (see figure 26). The session consisted of two parts, focusing on transferring knowledge and testing a fictional case. During the co-creation session it was found out that a visual infographic leaded to fruitful discussions, which was promising for using visual knowledge. Besides, other actors who were not involved in the development of SEHs were invited as well. These persons contributed to the discussions with new perspectives and showing other parallels with other industries. This shows that a knowledge intensive culture shouldn't just involve actors from the field of SEHs. Lastly, the actors were eager to meet again, showing the willingness to actively share knowledge.

Choice final concept

The chosen design for the project is based on the three concept requirements. For each of the requirements a part of the concept is explained.

The chosen design concept is based on the three concept requirements derived from knowledge management theory. Firstly, building a knowledge infrastructure is addressed through the development of a digital website. The website allows for easy access and adaptability to information and easily can be implemented as a widespread promotion means to increase awareness of SEHs. Secondly, a social infrastructure in the form of a Community of Practice (CoP) is established to foster knowledge sharing and collaboration among actors involved in SEHs, as a digital platform on its own wouldn't be sufficient. Lastly, making knowledge visible is achieved through the creation of scenarios that provide practical options and guidance for businesses, enhancing their understanding and willingness to collaborate.

Figure 26 - Photos from the co-creation session in Amsterdam

chapter **5**

The Final Concept

This chapter presents the final design of the Smart Energy Hub GPS, which has been selected as the most promising opportunity to be further conceptualised. The GPS serves as a valuable tool to support actors in the successful development of SEHs using knowledge management practises and visualising the value of collaboration. To understand the design of the Smart Energy Hub GPS, the design goal, the context of the tool, value and its infrastructure are discussed. Making the value visual is presented with an infographic and an interactive guide.

THE SMART ENERGY HUB **GPS**

A guide for identifying your position & determining your direction.

The Smart Energy Hub GPS is a guide designed to address the needs of visualising the value and expectations of collaboration while support learning by transferring knowledge. This innovative solution serves as a flexible and adaptive knowledge database, providing users with valuable insights and practical tools to navigate the complexities of the SEH formation process (see figure 27).

The guide was evaluated and developed in collaboration with SEH experts through a research-by-design approach to ensure a user-centric perspective. Furthermore, the information of the guide is fuelled by the empirical data gathered through interviews.

Goal of the guide

The guide is structured into three components: challenges, strategies, and approach, each carefully developed to facilitate informed decision-making. The goal of the GPS is to stimulate the willingness to collaborate among business owners by making the urgency and value of SEHs tangible and accessible. By visualising the challenges, strategies, and approach in an engaging and informative manner, the guide aims to inspire action and provide the necessary tools and information for business owners to confidently start their sustainability journey.

Context of the guide

The GPS is intended for anyone interested in SEHs, with a particular focus on business owners. It has been specifically designed to meet the needs of business owners with a certain interest to explore collective opportunities, but struggle to grasp the value and urgency of collaboration in the realm of sustainable energy solutions.

The components of the guide

The Smart Energy Hub GPS guide incorporates three components: challenges to show urgency, strategies to provide operational perspective, and approach to guide the decision-making process.

These components are based on written scenarios by the Delft Design Guide (2014) that provide a narrative structure from the perspective of a certain persona following a sequence of actions. The guide starts with a decision tree to uncover which type of actor the viewer is, inspired on using a persona as perspective. The strategies show the range of actions tailored to the urgency of the actor.

Figure 27 - Visualisation of concept

Value of GPS

Aligning with the needs of business owners. The Smart Energy Hub GPS is specifically designed to bridge the gap between business owners' needs and the world of energy-related collaborations. By offering a comprehensive overview of energy challenges and providing tailored strategies, the GPS aligns with the needs of business owners who may lack awareness of the urgency and value of participating in energy-related collaborations. It aims to address their need for better expectations, ensuring they are well-prepared to start on collaborative efforts.

Offering a structured collective approach. The effectiveness of the GPS is not solely dependent on business owners' immediate willingness to collaborate. Instead, it serves as an empowering tool that equips them with the knowledge and understanding necessary to make informed decisions about engaging in energy collaborations. By offering a structured and collective approach, the GPS guides users through each step of the collaboration process, highlighting potential barriers and facilitating a smooth journey towards collaborative success

Raising awareness around collaborative efforts. Beyond its immediate impact on business owners, the GPS also serves as a catalyst for raising awareness about SEHs and the importance of collaboration in addressing energy challenges. It underscores the significance of collaborative efforts and encourages stakeholders to come together, fostering a culture of collaboration and collective problem-solving.

The impact of the design is evaluated through pre- and post-assessments of participants' willingness to collaborate. By measuring the change in participants' attitudes and intentions towards joining or setting up collaborations, the effectiveness of the scenarios and the overall design of the GPS guide can be evaluated.

The infrastructure

The concept of the Smart Energy Hub GPS includes both technological and social infrastructures to support knowledge sharing and collaboration among stakeholders., see figure 28 for the visual overview of the GPS.

The technological infrastructure involves the development of a digital guide where knowledge is visualised and shared. This website serves as the platform for the Smart Energy Hub GPS guide, providing users with access to valuable insights and information related to energy challenges and strategies.

To make knowledge visible and accessible, two visual means are used: an infographic and an interactive guide. The infographic shows the narrative for a business owner in one view, while the interactive digital guide offers a more detailed exploration of challenges, strategies, and approaches tailored to the viewer's context.

In addition to the technological infrastructure, a social infrastructure in the form of a Community of Practice (CoP) is established to facilitate knowledge sharing and maintenance of the GPS guide. A CoP is a group of actors dedicated to sharing and creating knowledge (Kratzer et al., 2007). To support the CoP, two potential organisations, Oost NL and Programma Verduurzaming Bedrijventerreinen (PVB), have been identified. These organisations have existing networks and resources in business parks that can contribute to the success of the CoP.

Dedicated community managers play a critical role in effectively managing the CoP. These managers are responsible for identifying relevant SEH-related knowledge, translating it into practical forms, updating the website, monitoring learnings, and organising events to facilitate knowledge sharing. Their active involvement is essential in promoting participation and engagement within the CoP. The supporting organisations need to start this network of community managers. PVB has confirmed in an interview they are capable and willing to do this.

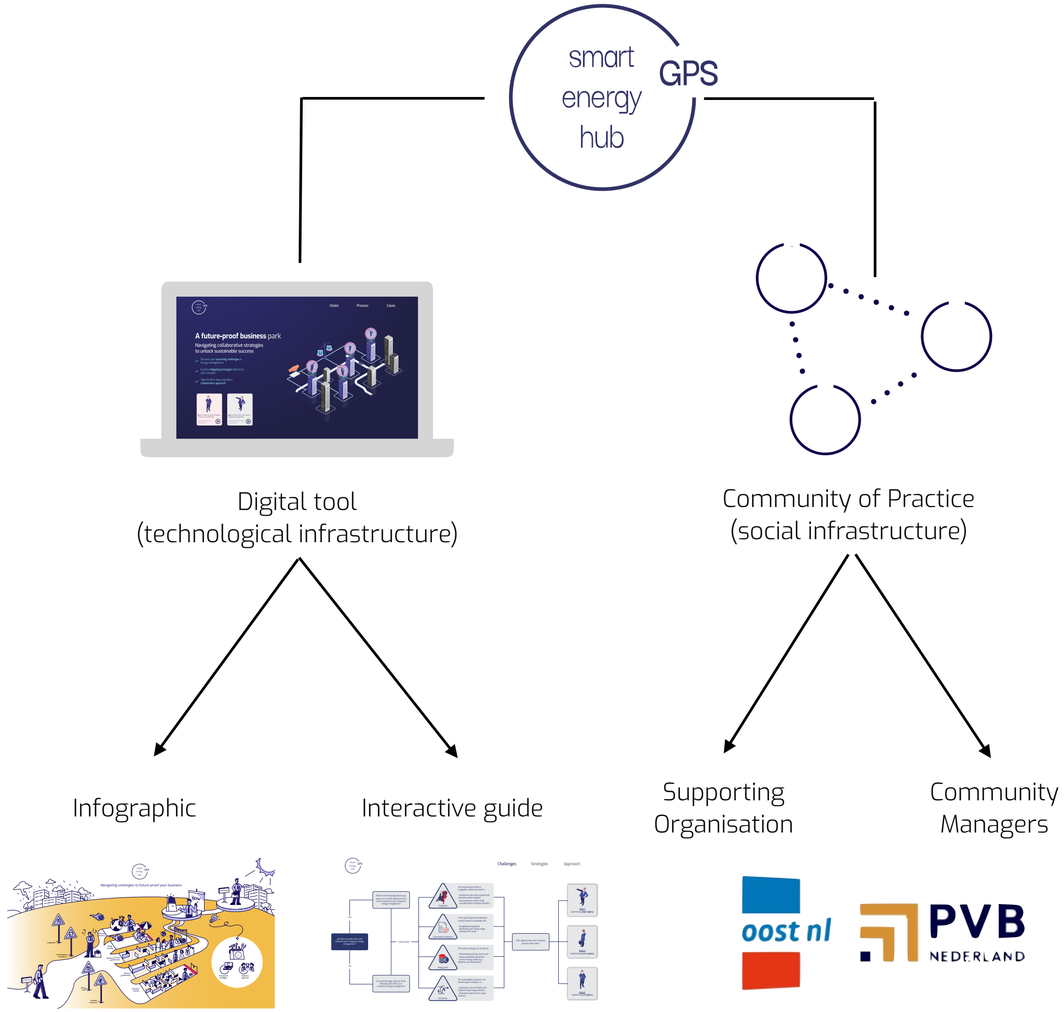


Figure 28 - Visualisation of overview component of GPS concept

MAKING KNOWLEDGE VISIBLE: INFOGRAPHIC

Infographic scenarios

The Smart Energy Hub GPS provides valuable insights into energy challenges and strategies, but due to its detailed nature, it requires multiple screens to explore. To address this, an infographic (see Figure 29) has been created to present the story and value of collaborations in a single view, aiming to stimulate the willingness to collaborate. The infographic illustrates the journey of a business owner, starting from being unprepared to becoming prepared in terms of energy challenges.

Throughout this journey, the business owner encounters various energy-related challenges that prompt them to question what they can do to address them. The infographic depicts these challenges and presents five strategies as different roads, each accompanied by visual representations of their value and associated risks.

Among the five strategies, three offer solutions to the challenges with varying levels of complexity (see the mazes). However, particular emphasis is placed on the two collective strategies, which roads are continuing further. To guide the business owner in executing these collective approaches, the Smart Energy Hub GPS equips them with the necessary tools to take the initial steps.

The infographic serves as a concise and visually engaging resource, providing an overview of the collaborative journey towards energy transformation. It highlights the importance of collaboration and empowers business owners to take action and contribute to the development of Smart Energy Hubs.

Figure 29 - An infographic of the challenges and strategies of the GPS

MAKING KNOWLEDGE VISIBLE: THE GUIDE

In the Smart Energy Hub GPS the components, namely challenges, strategies, and approach, are visualised. Their content is based on the findings of the literature review and interviews. Each of the components and its visual will be elaborated. On

Challenges: Decision tree to uncover type of actor

The first component, the challenges, begins with a decision tree tool. This tool aims to raise awareness among viewers about the energy challenges they may face, even if they are currently unaware of them. These energy challenges are based on the findings of what triggers the start of a SEH (see page 12). By presenting a series of questions, the decision tree helps viewers identify their level of urgency. Based on insights from interviews, three types of actors with different levels of urgency are identified.

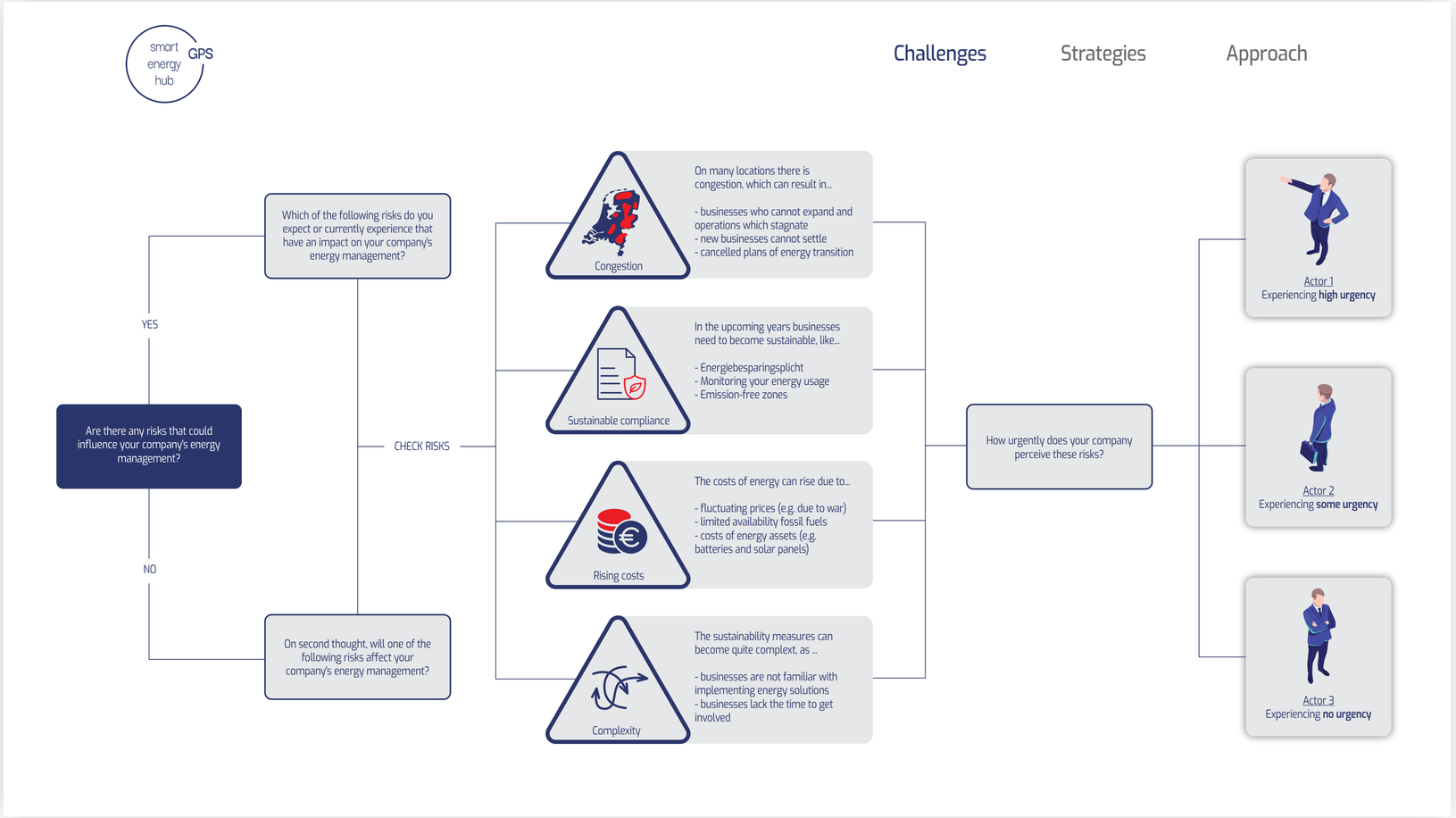


Figure 30 - Decision tree in GPS

Strategies: comparing actions to understand value

The second component focuses on comparing strategies to understand their value and associated risks. Once viewers have identified their type of actor, they are presented with a range of strategies tailored to their specific level of urgency. These strategies are developed through a combination of interview findings and expert input. They offer different approaches to tackling the energy challenges. Each strategy is accompanied by a clear description of its advantages (value) and disadvantages (risks), providing viewers with the necessary information to make an informed decision. The values and risks of the strategies will differ based on the level of urgency of the actors, as the context is different of an actor with an urgent problem compared to one who hasn't. These values and risks are based on the interests and risks from actors (see page 24).

Figure 31 - Strategies with values and risks in GPS

Knowing the first steps of approach

The third component highlights the first steps in approaching collaboration, particularly for the strategies A and B that involve collaboration. The other strategies are not further elaborated, as this is not within the scope of this project. The approach provides viewers with a roadmap of the formation process, outlining the various stages and the roles involved. By exploring each phase and the corresponding roles, viewers gain a deeper understanding of the steps required to address the energy challenges collectively, and who they need to do this. Additionally, the approach highlights potential barriers that may arise, equipping viewers with the knowledge to anticipate and overcome obstacles.

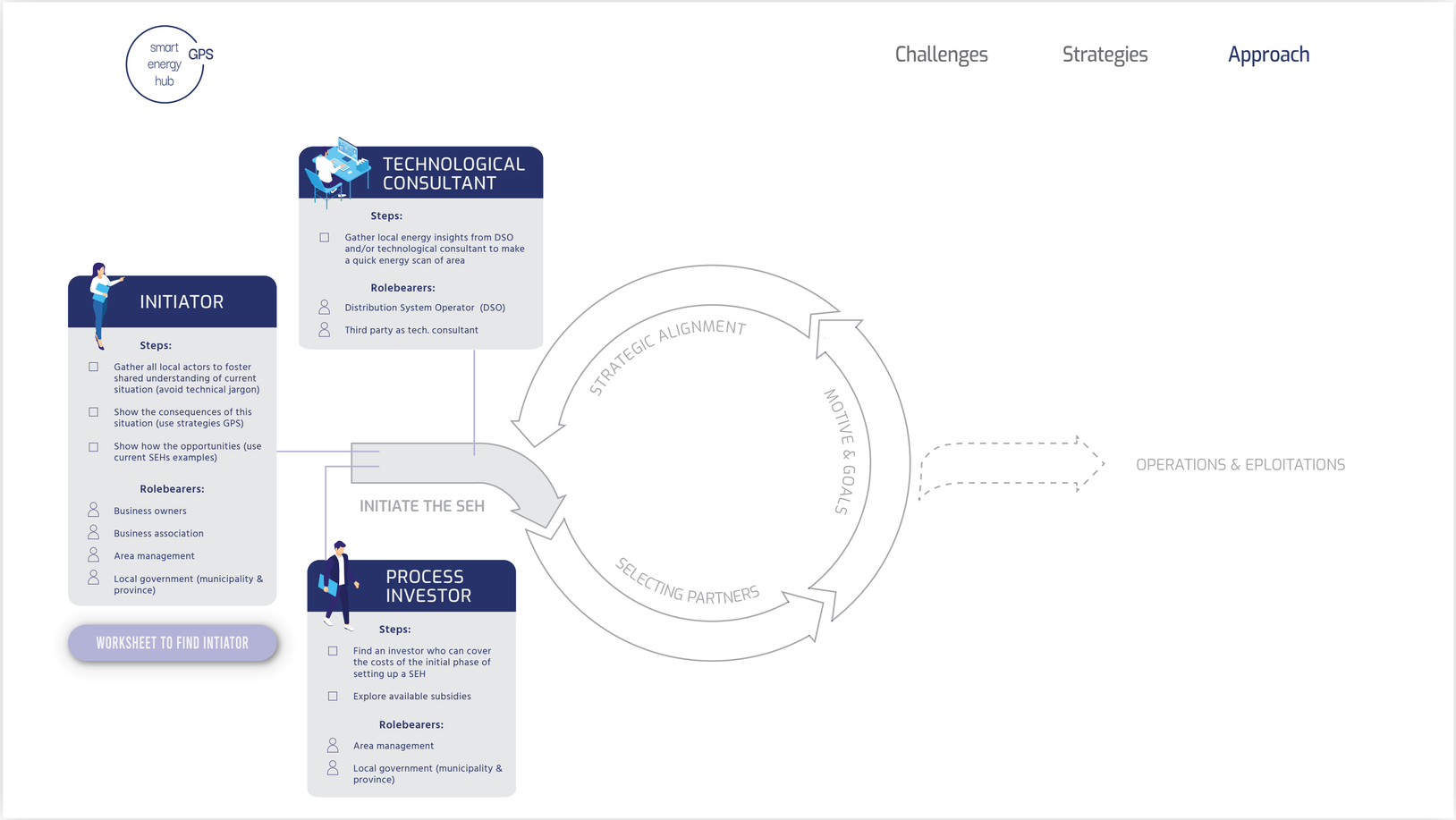
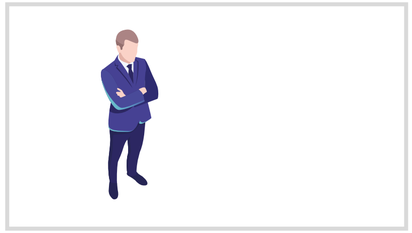


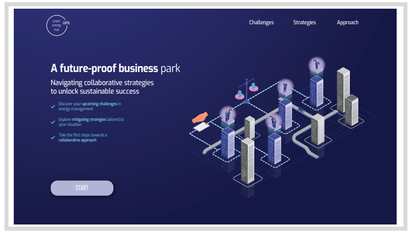
Figure 32 - Approach showing first steps and needed roles in GPS

User scenario

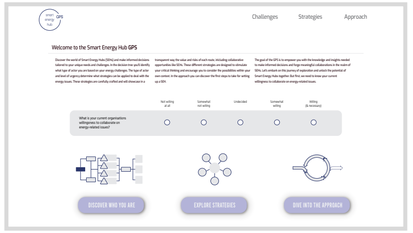
A user scenario is made to explain the use of the GPS guide. The scenario shows how a business owner is exploring the concept through multiple screens. To view the details of all screens of the GPS guide, an interactive guide of the concept can be downloaded on the TU Delft repository website.



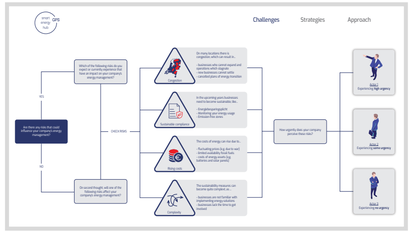
Hello, meet Bas! Bas is a business owner facing some energy problems. He doesn't know what to do, but he has heard of the Smart Energy Hub GPS, which could help him navigating through his challenges.



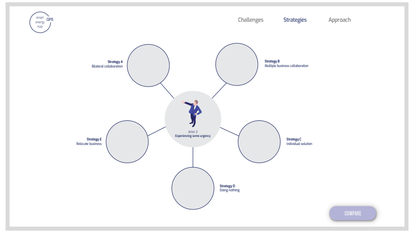
He opens the GPS home website & clicks on start.



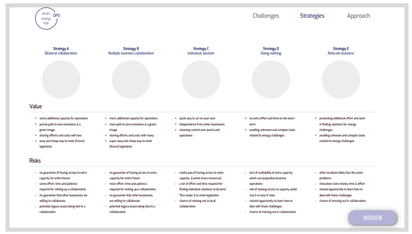
Before Bas starts with the guide, he answers the question about willingness to collaborate with a 'not sure'. Now, he starts with the guide.



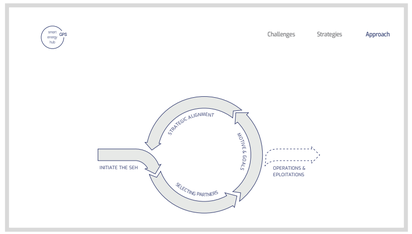
This brings Bas to a decision tree to uncover what type of actor Bas. He didn't know there were so many energy challenges! He clicks on being an actor with medium urgency.



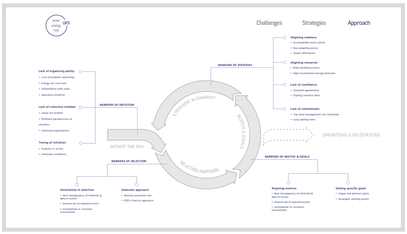
He sees tailored strategies to deal with his urgent challenges. However he wants more details about the value and risks of each strategy. He clicks on compare.



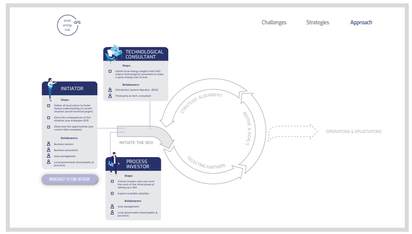
For each strategy he can compare the value and risks to make an informed decision. He chooses for a bilateral collaboration.



This brings Bas to the approach. He sees the overall framework for a collaborative approach. He is eager to know the specific barriers on each phase.



All the barriers which can pop up during setting up a collaboration are presented. He wishes to know how he can mitigate these barriers.



By clicking on each phase on the visual Bas sees per phase the needed roles, the actors who should fulfil these roles, and the mitigating steps for the barriers.

Bas is now fully prepared to tackle his energy challenges and knows the first steps for collaboration!

STRATEGY TO IMPLEMENT

The implementation strategy for the Smart Energy Hub GPS focuses on seamlessly integrating the guide into existing processes and workflows of SEH development. This strategy includes several key practices to ensure successful adoption and utilisation of the guide, which are based on the findings of this research. The best practices to implement the concept are:

1. **Promoting the GPS guide at well-known and relevant organisations:** Make use of established organisations who are committed to make business park sustainable, such as Rijksdienst voor Ondernemend Nederland (RVO) and Programma Verduurzaming Bedrijventerreinen (PVB), to raise awareness about SEHs and share the GPS guide with their networks. PVB has already confirmed their commitment to publishing the guide on their website.

2. **Strengthening urgency among actors:** Emphasise the sense of urgency through showcasing the GPS decision tree, highlighting the importance of Smart Energy Hubs and their role in addressing energy challenges.

3. **Training the trainers:** Identify and empower ambassadors on business parks, who already feel responsible and accountable for the interests of an area, such as area developers and local government authorities. Leverage their expertise and influence to drive the development of the GPS in their respective area. The supporting organisation of the GPS and its community managers need to become responsible for identifying these ambassadors, to further expand the supporting network.

4. **Create a compelling story of the GPS guide:** Develop compelling narratives and storytelling techniques to engage business owners in the guide. A narrative can help actors to connect with the vision, better understand the value, and inspire action towards implementing SEHs. The infographic is an example of doing this.

By implementing these practices, the goal is to create an environment that supports the successful adoption and implementation of the Smart Energy Hub GPS guide.

“The guide becomes very engaging and interesting by incorporating the perspective of a business owner. When the Smart Energy Hub GPS guide is available in Dutch, we are eager to share it with our network.”

- Christa de Ruyter (PVB Nederland)

chapter **6**

Concluding The Project

In this final chapter, the key findings and insights from the research project are reflected on and summarised. The validity and generalisability of the research and results are discussed, the encountered limitations during the research process are addressed, and the recommendations for future research is provided.

A final conclusion is provided and this research is ended with a personal reflection.

DISCUSSION

Discussing the results

In this study, the focus was on exploring the formation of Smart Energy Hub networks to enable effective collaboration in the energy industry. The research emphasised the importance of user research and understanding the needs and perspectives of various stakeholders involved in Smart Energy Hubs (SEHs). Through interviews and user research, valuable insights were gained regarding the barriers, challenges, and mindset of actors in SEHs, which helped shape the design strategy for the Smart Energy Hub GPS guide.

The integration of frameworks, such as the InnovationNet framework and the Strategic Niche Management (SNM) framework, provided a systematic and structured approach to the research, enhancing its validity. These frameworks assisted in categorising data, gaining a better understanding of barriers, and identifying success factors in SEH collaborations. The empirical user research further enriched the understanding of these barriers and contributed to a comprehensive mapping of challenges in SEH formation, creating two frameworks relevant within the SEH context.

The findings of this research project provide a valuable case study for stakeholders interested in establishing Smart Energy Hub networks, stressing the significance of effective collaboration between businesses, energy companies, and governmental institutions in addressing energy challenges. The visualisation of knowledge through the GPS guide, including visual infographics and scenarios, offers stakeholders the means to make informed decisions and manage risks associated with SEH participation and strategy.

When reviewing the concept highlights the duality of online platforms and physical meetings in facilitating collaboration should be highlighted. While the online platform may not directly impact collaboration, it indirectly strives to clarify the value and expectations, assuming it will improve the willingness to collaborate. This assumption needs to be tested, and will be further elaborated on in the recommendations. Therefore it remains a dilemma if online tools can foster physical relations. The current assessment of willingness is provided in the concept as a question at the start.

The identified success factors for collaborations have strongly influenced the determination of key needs and the subsequent design direction. However, it is important to question the necessity of all these success factors for Smart Energy Hubs (SEHs). Given the limitations in sample size and time of the current research, further validation of these factors with a larger number of SEHs is warranted. It is crucial to consider these limitations when evaluating the findings of this research.

Limitations

The following limitations should be taken into consideration when interpreting the findings and implications of the research:

- Limited sample size of business owners interviewed: While the focus of the design is on business owners, the interviews conducted included only three business owners. To supplement the information about business owners, insights were gathered from other actors closely associated with them, such as community builders and project managers. However, not having direct input from a larger number of business owners is a limitation as it may restrict the depth and diversity of perspectives in the design process.

- Context-dependent nature of SEHs: The study involved interviews with only five cases of SEHs, making it challenging to generalise the findings to the broader context of the Netherlands. SEHs vary significantly depending on the specific context of the business park and the surrounding organisations. Factors such as industry relationships and competition among businesses can heavily influence collaboration outcomes. Therefore, the findings should be interpreted within the specific context of the studied cases.

- Single researcher bias: Conducting the research with only one researcher introduces the potential for bias in data collection and analysis. The researcher's perspective and interpretation may influence the way data is collected and analysed, potentially leading to an incomplete or skewed understanding of the research topic. It is crucial to acknowledge that certain insights may have resonated more with the researcher, inadvertently shaping the design process in a specific direction. The involvement of multiple researchers could have provided a more diverse range of perspectives.

DISCUSSION

Recommendations

The recommendations of this project are categorised on three topics: recommendations for future research, for the concept, and for the municipality.

Recommendations for future research:

- Explore research possibilities for collaboration on other themes. While the current guide is specifically tailored to energy-related collaborations, future research projects can investigate the potential for generalising the guide's framework to apply to other thematic areas on business parks such as water management or biodiversity conservation. By adapting the guide's structure of challenges, strategies, and approach, collaborations on different themes can be facilitated, broadening its applicability and impact.
- Conduct a Social Network Analysis (SNA). Due to time constraints, this research project could not include a comprehensive SNA. However, future studies can dive further into the analysis of actors and their relationships within the SEH collaborations. SNA can provide insights into the network dynamics, mapping networks over the formation stages to identify any changes and in roles and responsibilities, and which networks lack in certain roles. By identifying any gaps in networks and understanding the overall network structure, more opportunities for optimising collaboration can be identified and addressed.
- Research efficiency and collaboration in later stages. It is recommended to explore the efficiency of SEH collaborations in the later stages, during the operations and exploitation phases, when SEHs are more mature. Understanding the challenges and opportunities in the later stages will provide valuable insights for enhancing the efficiency and streamlining the process.

Recommendations for the concept:

- Conduct pilot sessions with actors and businesses owners. Hosting pilot sessions can serve as a testing ground to assess the effectiveness of the guide. Creating two pilots where one is settled in a context where there is no need for energy collaborations and one context where there is a need, can help to further specify the exact needs to increase the willingness. Additionally, pilot sessions can explore how the design elements of the guide influence the sense of urgency among actors, allowing for refinement of specific components.
- Test the impact of each guide component. To further validate the guide's effectiveness, it is recommended to conduct tests specifically focused on assessing the impact of each component (challenges, strategies, and approach) on the willingness to collaborate. This will provide empirical evidence of the guide's value and enable continuous improvement based on user feedback.
- Enhance the usability of the GPS. Continuously test and improve the usability of the Smart Energy Hub GPS guide to ensure that it is user-friendly and accessible to a wide range of stakeholders. Incorporating user feedback and conducting usability testing provides opportunities to identify any potential usability issues and implement necessary refinements to enhance the user experience.

Recommendations for the municipality of Amsterdam:

- Establish a dedicated collaboration team in the municipality of Amsterdam. To facilitate and support the formation of collaborations between businesses in general, it is advisable to establish a follow-up team within the municipality of Amsterdam. This team can focus on coordinating and fostering collaboration across various thematic areas, such as heat, biodiversity, and more. By dedicating resources and expertise to collaboration efforts, the municipality can enhance the effectiveness of SEH initiatives and drive sustainable development.

CONCLUSION

Final conclusion

This research project has explored the challenges and opportunities associated with setting up Smart Energy Hub networks in business parks in the Netherlands. The complexity of SEH collaborations and their multitude of roles showed the importance of gathering empirical data to map barriers and understand the underlying causes through the mindset of the actors. With limited literature available on SEHs, reference frameworks from InnovationNet and the Strategic Niche Management approach, were used to categorise and comprehend the data, providing insights into the formation process and success factors of SEH collaborations.

The analysis revealed barriers at every level of the formation stage, with particular concentration in the initiation and strategic alignment phases. Based on the comprehensive analysis, two dominant needs from these two phases were identified: the transfer of knowledge and visualising the value of collaboration. The transfer of knowledge is crucial in the early stages of SEHs to avoid reinventing the wheel and foster collective learning. Additionally, visualising the value of collaboration showcases the benefits and potential outcomes of collaboration, where the feeling of risk can be mitigated, encouraging business owners to participate more actively.

The Smart Energy Hub GPS guide, developed as a result of this research, holds substantial value for stakeholders involved in SEHs. By presenting a clear overview of energy challenges and offering tailored strategies, the guide aims to align with the needs of business owners who may be unaware of the urgency and value of energy-related collaborations. It assists them in having better expectations, making informed decisions, and overcoming potential barriers during the formation process.

By understanding the barriers and needs of actors involved in SEH collaborations, this project provides a foundation for future research and design interventions in similar contexts.

PERSONAL REFLECTION

Reflection on my graduation journey

During this project I wanted to learn and challenge myself in understanding collaborations better. As a designer, I have gained valuable insights into the dynamics of multi-stakeholder collaborations. I have come to understand the significance of building relationships for effective collaborations, as well as the fragility of these relationships when missteps occur. Language has proven to be a crucial aspect, where I had to change my way of talking depending on the type of actor. Finding a common language among diverse actors remains a challenge, but it has been a rewarding experience to learn to speak the languages of different actors and bridge the gap between the social and technical aspects of the energy world. Many individuals were inspired by the alternative way of discussing the same problem, presenting a fresh perspective.

The timing of my research aligned perfectly with the interesting developments in congestion and the energy transition, which have turned the energy world upside down. At times, I found it challenging to define the boundaries of what was relevant to my research and what was not. As a non-expert in the field, my goal was to bring a new perspective, but I often found myself deeply immersed in the energy domain, sometimes forgetting to apply my skills as a designer. Taking a step back to evaluate and understand the significance of my findings would have been beneficial. Utilising my visualisation skills earlier could have facilitated a better understanding of the complex problem both for myself and others.

Throughout this project, I realised that self-assessment was difficult for me. Without the validation and feedback from others, the progress of my project stagnated. I find it easier to provide strategic perspectives and review the work of others, but when it comes to evaluating my own progress, I struggled. Mirroring this strategic mindset for my own project has proven difficult. Therefore a project on my own for a longer period of time is not well-suited for me.

One aspect I acknowledge as an area for improvement is embracing a more chaotic process. As someone who seeks structure and order, accepting chaos and unexpected changes can be challenging. Especially in a multi-stakeholder collaboration where a lot of players have influence on the field, resulted in a more chaotic process than that I was used to. To better prepare for such situations, I should document my assumptions and consider alternative responses when things will not go as planned for a next time.

In my role as a project manager, handling a multi-stakeholder project proved to be highly interesting and, at times, challenging, particularly when dealing with sensitive and confidential information. As a student, people were more open to sharing with me than they might have been with one another. I have formed strong connections during this process, which I still maintain.

Sadly, there was no dedicated team in the municipality on this topic. It was just me and my coach. This had influence on the quality of the project as I there was no prior knowledge from the municipality and it limited the amount of people who I could discuss the project with.

Overall, I have been effective in reaching out to and connecting with people throughout my thesis journey. Maintaining these connections has been crucial, as they have provided ongoing support and valuable insights.

In conclusion, my thesis experience as a designer and project manager has been a good learning opportunity. It has highlighted the importance of relationship-building, effective communication, and the need for self-reflection. Embracing chaos, seeking validation from within, and leveraging my visualisation skills earlier are areas for growth. This journey has provided valuable connections and a deeper understanding of collaborative processes, ultimately contributing to my personal and professional development.

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Appendices

A. Interviewees user research & explorative interviews & events

B. Project brief

C. Interview guide

D. Elaboration on barriers

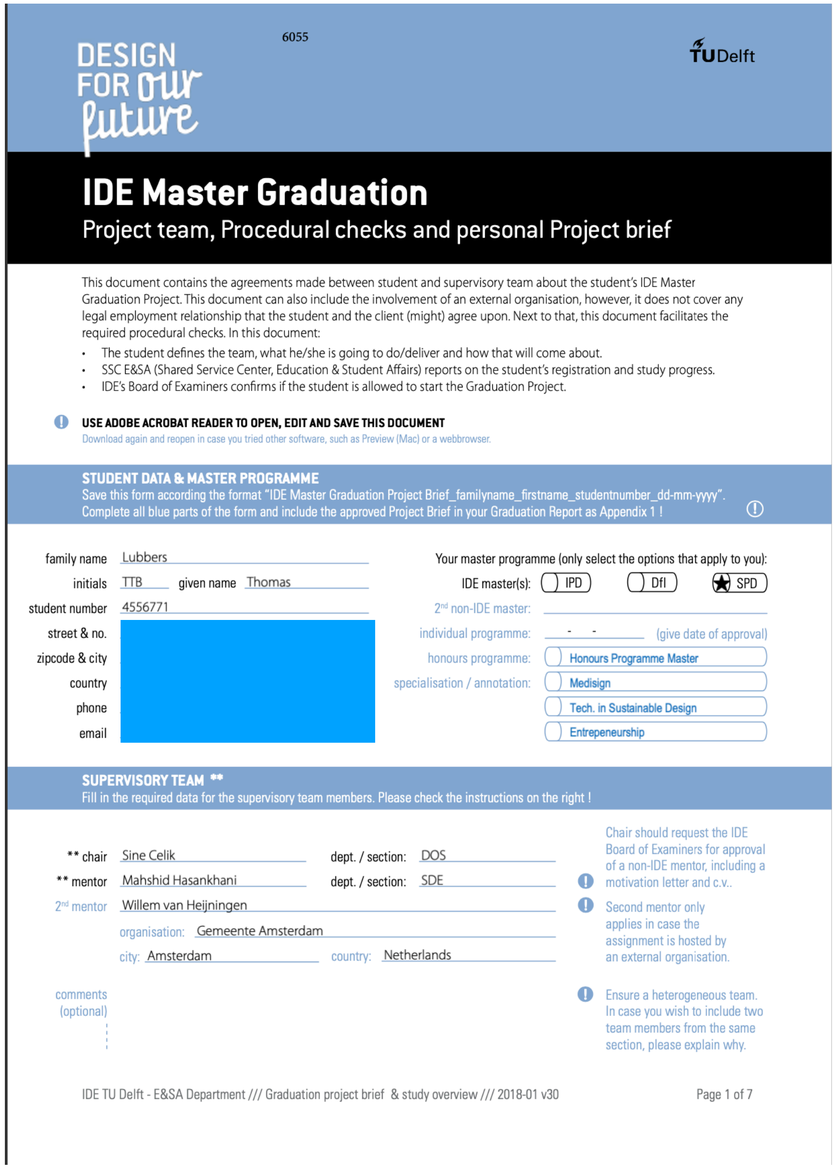
A: INTERVIEWS

SEH	Type of actor	Company / Institution	No.
Schiphol Trade Park	Area management	SADC	1
	Service provider	Joulz	2
	Business owner	Segro	3
	Service provider	Spectral	4
Havengebied Amsterdam	Business owner	ChocolateMakers	5
	Business owner	Global Port Equipment	6
	DSO	Liander	7
	Area management & Project Manager	Port of Amsterdam & CC Value	8
De Mars	Project Manager	GreenFieldCities	9
InnoFase	Project Manager	1STROOM	10
Harderwijk	Project Manager	Transitiemakers	11
	Project Manager	Transitiemakers	12
Centraal station Amsterdam	Municipality	Gemeente Amsterdam	13

Expert	Company	No.
SEH expert	ROCC	1
Collaboration expert	Samenwerkings code	2
Project manager expert	P2	3
Engagement expert	Tertium	4
Technological expert	Liander	5
Facilitator expert	HIER opgewekt	6
Technological expert	Firan	7
Policy expert	AMS institute	8
Policy expert	TU Delft	9
Entrepreneurial expert	GooiOpGroen	10
Cooperation expert	EcoStroom	11
Innovation expert DSO	Alliander	12

SEH	Type of actor	No.
RVO LEO working sessions	Utrecht	1
Formation conversations oterdijk station (ProRail, NS, GVB, VRA, Gemeente	Amsterdam	2
EZK	Amersfoort	3
Change.Inc Netcongestie webinar	Amsterdam	4
Kennistafel Smart Energy Hubs Stevin	Utrecht	5
PVB webinar	Online	6
Webinar Kiemt	Online	7
UNIC citylab	Online	8
Transform Hackathon	Utrecht	9

B: PROJECT BRIEF



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DESIGN FOR our future

TU Delft

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT
Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME
Save this form according the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 !

family name: Lubbers
initials: TTB given name: Thomas
student number: 4556771
street & no.:
zipcode & city:
country:
phone:
email:

Your master programme (only select the options that apply to you):
IDE master(s): ( ) IPD ( ) DfI (★) SPD
2nd non-IDE master:
individual programme: - - (give date of approval)
honours programme: ( ) Honours Programme Master
specialisation / annotation: ( ) Medisign ( ) Tech. in Sustainable Design ( ) Entrepeneurship

SUPERVISORY TEAM **
Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair: Sine Celik dept. / section: DOS
** mentor: Mahshid Hasankhani dept. / section: SDE
2nd mentor: Willem van Heijningen
organisation: Gemeente Amsterdam
city: Amsterdam country: Netherlands

comments (optional)

Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

Second mentor only applies in case the assignment is hosted by an external organisation.

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

IDE TU Delft - E&SA Department /// Graduation project brief & study overview /// 2018-01 v30 Page 1 of 7

B: PROJECT BRIEF

TU Delft

Procedural Checks - IDE Master Graduation

APPROVAL PROJECT BRIEF
To be filled in by the chair of the supervisory team.

chair Sine Celik date 17 - 01 - 2023 signature

CHECK STUDY PROGRESS
To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: ____ EC
Of which, taking the conditional requirements into account, can be part of the exam programme ____ EC
List of electives obtained before the third semester without approval of the BoE

YES all 1st year master courses passed
NO missing 1st year master courses are:

name date - - signature

FORMAL APPROVAL GRADUATION PROJECT
To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **.
Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: APPROVED NOT APPROVED
Procedure: APPROVED NOT APPROVED
comments

name date - - signature

TU Delft

Personal Project Brief - IDE Master Graduation

Design for setting up energy hub collaborations project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 28 - 11 - 2022 17 - 05 - 2023 end date

INTRODUCTION **
Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

CONTEXT:
Congestion on the grid
The electricity demand is rising each year (CBS, 2020). At the same time, the climate goals state that more electricity needs to be generated by renewable sources. This transition from predictable production of electricity (gas and coal plants) to production with a more intermittent character (solar and wind park), leads to more peak moments in the grid (TNO, 2022). Unfortunately, the capacity of the current grid is not enough to handle the rising demand and peak moments in multiple areas in the Netherlands. We speak of grid congestion in those areas (RVO, 2022), see figure 1 for a simplified representation of the energy system. DSOs (Distribution System operator) are forced to cancel new requests for accessing power on the grid, including new wind and solar parks. The DSOs are doing their best to shore up the grid, but it takes a lot of time (RVO, 2022). To prevent a delay of the transition to renewables, we need to take a look at how we can use the current grid smarter.

Local use in energy hub
By using electricity more locally, it reduces the traffic on higher-level grid (Firan, 2022). An energy hub covers an area where electricity is distributed as efficiently as possible, by using the grid and available infrastructure in a smart way (see figure 2). By bringing all the data and information together about electricity generation, storage and consumption, a local match can be made between demand and supply. Using the grid in a smart way can be achieved by using smart technology (linking solar and wind production with smart meters) and software (distribute and manage the energy locally). When supply meets demand in one area, the impact on the total grid can be minimised (Enexis, 2021).

STAKEHOLDERS:
For the involved stakeholders of an energy hub, I want to know what their perspective is. What are their interests, concerns and goals, and what kind of conflicts, risks, influences, barriers are rising when the developed/are developing an energy hub? An overview of the involved stakeholders: Coordinator, Inhabitants, Aggregator, Advisor, DSO, Government, the collaboration itself.

OPPORTUNITIES:
Energy crisis causes extra urgency at stakeholders (government, consumers, companies)
Parties in an area want to become more independent of energy supplier, because of affordability, sustainability and accessibility to electricity.
Technology and software to manage electricity in a more smarter way is available.
New energy law makes it possible as a consumer to act in energy market, and you can share electricity with your neighbours.

LIMITITATIONS:
Laws and regulations for setting up organisation
Limited knowledge about energy by parties in an area
Renewables have an irregular character and are dependent on the weather
Ownership and collaboration with other parties can be uncomfortable and can result in resistance
Representation of all parties in an area is complex.

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B: PROJECT BRIEF

Personal Project Brief - IDE Master Graduation

TU Delft

introduction (continued): space for images

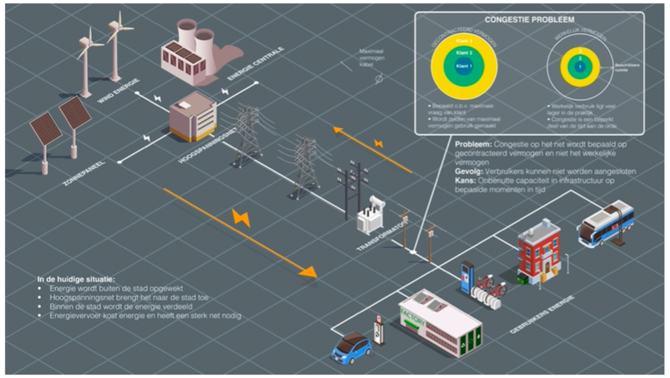


image / figure 1: Current system experiences net congestion

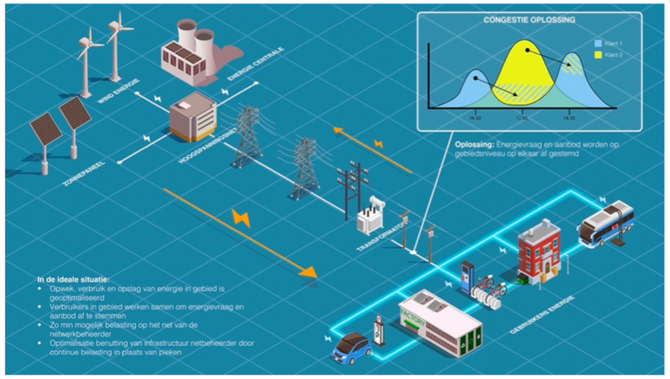


image / figure 2: New energy system with energy hubs (blue)

Personal Project Brief - IDE Master Graduation

TU Delft

PROBLEM DEFINITION **
Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

PROBLEM
Multiple energy hubs are now tested and realised in practice. The technology to manage and distribute electricity in a smart way is not the bottleneck (Simonsen, 2022). However, struggles arise around the organisation of such a hub. For my research I will focus on stations, as there is a case running at this moment at Sloterdijk. This raises the question:

RESEARCH QUESTION
How to set up an energy hub collaboration at a station?

SUB QUESTIONS
What ways of communication will be helpful in the early stages of an energy hub?
What are the interest and concerns of the stakeholders?
What is the trajectory of an energy hub and how can the early stage be improved and smoothed?
What are the general guidelines for an energyhub on a central level, so the wheel will not be re-invented?

ASSIGNMENT **
State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

RESULT
General framework/roadmap based on design interventions to optimise the early stage of setting up an energy hub collaboration

STEPS
1. Identify the current energy system, its boundary conditions, concrete examples of problems in the system, roles of stakeholders.
2. Analyse multiple case studies of current energy hubs (SADC, Oost NL) by creating a timeline with key moments/decisions, conflicts of stakeholders.
4. Scope the research on one or two conflicts/barriers and design interventions on how to tackle these for one stakeholder.
5. Based on the insights of the interventions a general roadmap/ framework can be made for setting up and implementing a new collaboration form for an energy hub at a station

B: PROJECT BRIEF

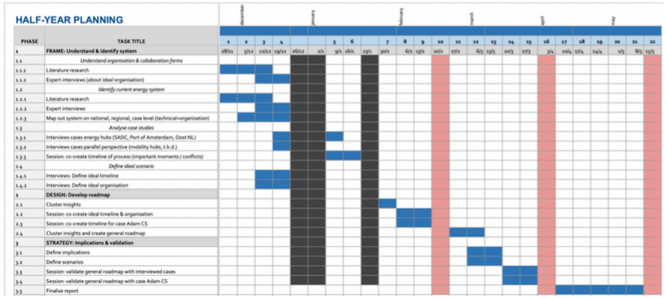
Personal Project Brief - IDE Master Graduation

TU Delft

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 28 - 11 - 2022 — 17 - 5 - 2023 end date



Planning is three parts: Frame, Design, Strategy

FRAME
Understand and identify system
- Organisation and collaboration forms
- Current energy system
- Analyse case studies

DESIGN
- Scope research
- Design interventions for early stage
- Co-create general roadmap for stations

STRATEGY
Implications and validation
- Define implications of roadmap
- Validate and implement on case

Initials & Name TTB Lubbers Student number 4556771

Title of Project Design for setting up energy hub collaborations

Personal Project Brief - IDE Master Graduation

TU Delft

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

We live in a period of time which could be the tipping point for a climate disaster. In order to prevent this pivotal moment we need to do a lot. Clean energy is a way to reduce emissions by using renewable sources, like solar and wind. Unfortunately, many solar and wind projects in the Netherlands are now delayed, because of congestion on the grid. The urgency is high to take action with our energy grid, but still many questions remain unanswered. That is why I want to contribute to the energy transition with this graduation project.

With this subject I would like to challenge myself. During this energy crisis I experienced how far away I actually am from the energy I use daily. I take electricity for granted, which is not so obvious anymore. Why is that? How does that system work? When I dove deeper in the energy system I found out that we face huge and complex problems regarding the energy transition. As a layman I hope I can bring a new perspective to this complex challenge, which can push the transition in the right direction, and at the same time enrich my knowledge of the energy sector for personal development. As a designer, I want to continue the talking and start testing with experiments (which is lacking right now). I need to connect the stakeholders and let them form a strong collaboration.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

Initials & Name TTB Lubbers Student number 4556771

Title of Project Design for setting up energy hub collaborations

C: INTERVIEW GUIDE

Interview setup

CONTEXT

Introductie

Mag ik gesprek opnemen?

Kan je het constent form invullen?

Ik wil het graag hebben over de (smart) energiehub. Dit interview is gefocust op het traject wat jullie lopen/gelopen hebben bij FIXME, ingezoomd op de samenwerking.

Wie ben je, en wat is je rol binnen FIXME?

Het vraagstuk

Wat is het vraagstuk waar jullie voor stonden/staan omtrent elektriciteit?

Wat voor soort vraagstuk was dit? Technisch, juridisch, organisatorisch, procesmatig, meerdere?

Het traject

Wat is jullie aanpak om het vraagstuk op te lossen?

Kan je het traject opdelen in verschillende fasen? Geef ze een naam op de tijdlijn.

Hoe lang duurt de samenwerking? Wat is de levensduur? Geef aan op de tijdlijn.

Gesprekken

Hoe zijn gesprekken gelopen met partijen?

Welke argumenten zijn het sterkst om partijen te overtuigen om mee te doen?

Door welke argumenten waren ze verrast?

Uitdagingen

Voor welke vragen/beslissingen sta je, die je graag aan een orakel zou willen stellen?

Welke barrières staan er in de weg van deze beslissingen? (Ook als je geen last hebt van juridische en financiële belemmeringen. Wetboek en budget zijn gul).

Wat zijn de beperkingen waar je mee te maken hebt?

Welke hulpmiddelen zijn beschikbaar of nodig om het vraagstuk op te lossen? Wat missen jullie voor jullie aanpak?

Ziet iedereen (inclusief jullie zelf) de noodzaak om te samenwerken? Is het zowel willen als moeten? Voor wie wel of niet?

VERKENNING

Context energiehub

Omschrijf wat voor jou een energiehub is en inhoudt. Teken het.

Welke (soorten) partijen/stakeholders spelen een rol in de energiehub?

Wat zijn de belangen van de partijen?

Welke doelen (SMART) stellen de partijen zichzelf op om hun belangen te bereiken?

Welke zorgen hebben partijen? Wat zien ze als risico's?

Wat levert het ze op? Individuele opbrengst en gezamenlijke opbrengst.

Wat moeten de partijen er in investeren?

Relaties stakeholders

Kan je voorbeelden noemen van hoe stakeholders in het verleden omgingen met elkaar?

Hoe komen de doelen en belangen van de verschillende stakeholders overeen of in conflict met elkaar?

Wat voor invloed heeft de machtsdynamiek tussen stakeholders invloed op het beslissingsproces?

Hoe heeft het perspectief van stakeholders op elkaar invloed op de relaties en samenwerking?

Inrichting samenwerking

Wat heb je geleerd van eerdere samenwerkingen en wat zou je nu anders doen?

Hoe zie jij een succesvolle en effectieve samenwerking voor je?

Hoe verandert de samenwerking in de toekomst?

Afronding

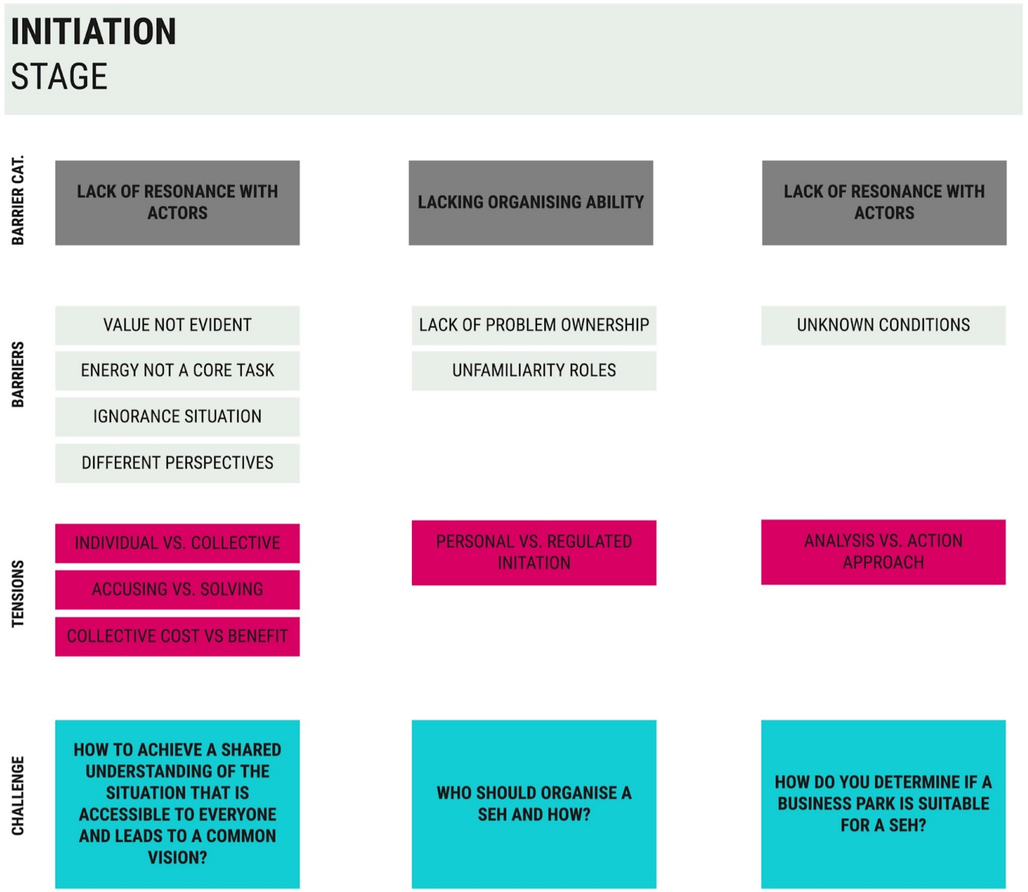
Heb jij vragen naar aanleiding van dit gesprek?

Tips of aanbevelingen voor wat ik over het hoofd heb gezien tijdens het interview?

Raad je mensen aan die mij verder kunnen helpen?

Wil je betrokken blijven met updates?

D: ELABORATION BARRIERS



Initiation stage

Elaboration on the barriers:

Value is not evident: Due to the novelty of SEHs, many business owners are unaware of the value they can derive from participating in a SEH. There is a lack of validated business cases or value cases, and few successful SEH examples.

Energy not a core task: Energy is not a core task for many business owners, resulting in a lack of engagement when the SEH story is presented in a technical manner. Additionally, energy is not a high priority for many business owners.

Ignorance situation: Many actors fail to recognise that the energy challenge is a national and collective problem that cannot be solved by the DSO alone. The awareness of a new energy approach has not fully permeated, as everyone was accustomed to the old system.

Different perspectives: Each party views the situation differently due to varying backgrounds, ambitions, and priorities. The initial SEH story does not always align with these perspectives.

Lack of ownership to initiate: Many parties do not feel ownership of the collective problem and may not recognize it as a shared issue. Consequently, there is a lack of initiative, community building, and facilitation for SEH. These roles are essential for starting a SEH. Parties tend to point fingers at the DSO, municipality, and area developer as the solution providers, and they may become emotional when informed that they need to work together to find a solution.

Unfamiliarity with roles and responsibilities: Collaboration in SEHs is new for many actors. Parties such as the municipality and area developer are unsure of their support role and how to fulfill their responsibilities.

Unknown SEH conditions: Parties are unaware of the circumstances under which a SEH is the right choice and how much prior knowledge is required before taking action.

Elaboration on the tensions:

Individual vs. collective mindset: Businesses tend to prioritise their individual interests rather than considering the collective benefits. They support a collective mindset as long as it does not compromise their organisational interests.

Accusing vs. solving behaviour: Some actors become emotional and refuse to accept responsibility for finding solutions.

Collaboration as a cost vs. benefit: Actors differ in their perception of collaboration, with some focusing only on associated costs while others emphasize the benefits gained.

Personal ambition vs. regulated initiation. The initiation of SEHs currently relies on the personal ambitions of actors rather than being supported by policy and regulations.

Analysis vs. action. There is a dilemma between conducting a thorough analysis upfront or taking immediate action.

Current approach to deal challenge of shared understanding:

All SEHs: All SEHs facilitated gatherings of businesses and stakeholders to foster a shared understanding. Some hubs allowed business owners time to reach a collective comprehension without relying solely on one party to deliver the message. They needed to emphasise that the electricity grid belongs to everyone, not just the DSO.

Port of Amsterdam & STP: For businesses that are sceptical about the value, they showcased other business parks where SEHs have been implemented and demonstrated that the current situation is soon a problem for everyone. Besides, they presented a scenario showing the consequences of pursuing individual solutions, highlighting the higher costs and challenges in obtaining permits. This helped in convincing stakeholders of the need for a collaborative solution.

Port of Amsterdam: At PoA they tried to avoid technical and complex jargon when discussing the problem. To explain congestion, they simplified the explanation: certain days of the year pose a problem, and a SEH aims to address those days. They emphasised the goal of achieving a synchronised energy system, as electricity and energy usage affect everyone.

SEH Schiphol Trade Park: SADC initially approached individual parties to understand their perspectives before conducting a collective meeting. The meeting outlined: 1. The current situation, 2. The consequences of this situation, and 3. How can we do better?. This approach provides parties with a clear picture of the benefits a SEH can bring.

Current approach to deal with who should organise challenge:

All SEHs: All SEHs: There are several roles needed: an initiator, community builder, project manager, investor(s). A neutral party or parties are necessary to manage, connect and coordinate all aspects of the SEH. This entity should have an active role as a project manager and/or community builder. Businesses often lack sufficient knowledge and time to do this themselves. An area developer often feels the most responsible for an entire area and has connections with many businesses. They are an ideal candidate to initiate, finance and organise the SEH, potentially in collaboration with an independent party. Government institutions can provide support by initiating and financing the initial stages of the process, but don't need to facilitate it.

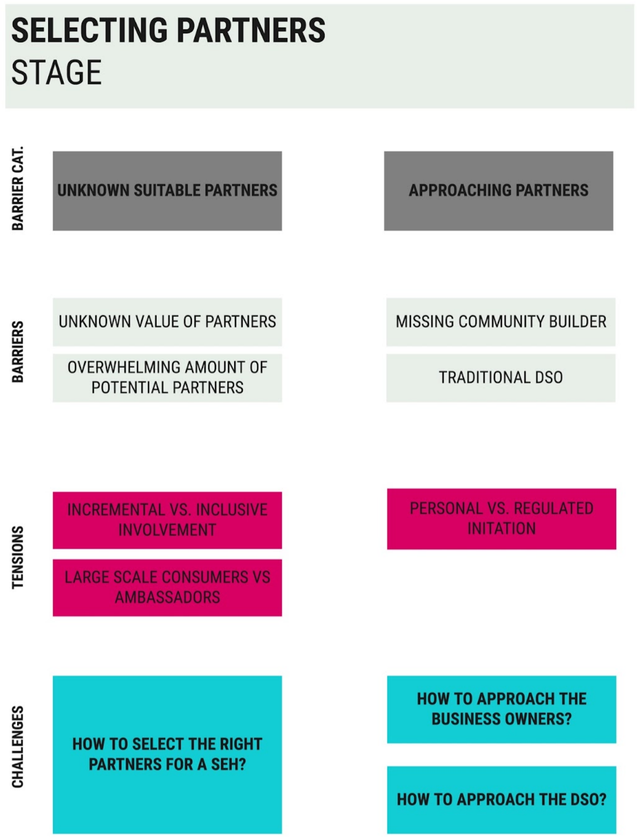
Current approach to deal with challenge of suitable places for SEHs:

SEH Ecub: Two key factors need to be identified: physical and social characteristics. Physical characteristics involve assessing buildings, energy profiles, the surrounding environment, and types of businesses. Social characteristics focus on the level of organization within the park, interrelationships and dynamics, and policies.

SEH Central Station: It was observed that obtaining data from parties is often difficult without having had preliminary discussions with them. Sitting at the table creates more willingness to share information.

SEH Port of Amsterdam: A quick scan is essential. More detailed energy scans can be conducted later. Feasibility studies often take too long to complete.

D: ELABORATION BARRIERS



Selecting partners stage

Barrier category: Unknown suitable partners.

Specific barriers:

Unknown potential value actors.

Overwhelming amount of potential partners.

Tension: Incremental vs. Inclusive involvement. Choosing between involving all parties from the beginning or starting with a core steering group and gradually expanding involvement.

Tension: Large-scale consumers vs. Ambassadors. Balancing the need for impactful and widespread actors in collaboration with the potential of leading by example and inspiring others.

Challenge: How to select the right partners for a SEH?

Approach:

SEH ecub: Avoid solely focusing on large consumers that are perceived as necessary. Identify ambassadors or pioneers through stakeholder analysis. A too large group becomes unmanageable.

STP: Choose pioneers, as when one party follows, others tend to follow suit. The domino effect.

Port of Amsterdam: Urgency is crucial among partners, and their openness to collaboration. Without it, they may resist the process and be unwilling to participate. Generate a sense of urgency among certain parties. Start with a small number of partners, then allow others to join. Identify the right individuals within organisations responsible for establishing the collaboration.

Station: Top-level commitment is essential. Without it, collaboration will not materialise as the mandate from top-level is necessary to initiate inter-organizational cooperation.

Barrier category: Unknown approach to approaching partners.

Specific barriers:

Lack of a community builder. Some SEHs initially lacked a community builder, making it difficult for companies to get involved.

DSO's lack of openness. However, DSO plays an essential role. They often have a traditional way of working, and the organisation itself is fragmented.

Challenge: How to approach the parties?

Approach:

STP: Business associations or park management can act as points of contact. It is crucial to know the parties and establish mutual familiarity.

Transitiemakers: A community builder can assist in this regard.

Challenge: How to engage the grid operator?

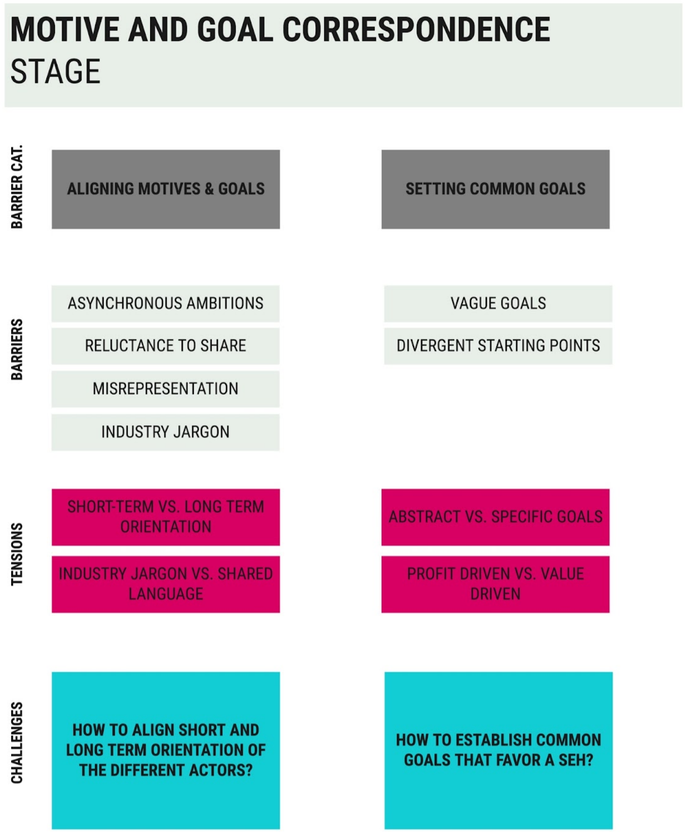
Approach:

Liander: Before encountering the DSO, they prefer you are: 1. Organised in a collective (steering) group, 2. Data authorization form ready for data sharing. The innovation team of grid operators allows for efficient communication.

STP: The province and municipality can exert political pressure on the grid operator. E-Assets serve as backup, although they are rarely needed. They primarily provide reassurance to the grid operator.

PoA: The SEH and DSO agree that the development is a pilot, providing the DSO with more flexibility. The DSO becomes part of the SEH and, therefore, part of the solution (eliminating the blame game). The SEH and DSO jointly define the bandwidth within which balance can be maintained; the safety of the grid is a priority for everyone (DSO and companies). This collaboration provides comfort to the DSO.

D: ELABORATION BARRIERS



Motive and goal stage

Barrier category: Aligning Motives and Goals is Challenging

Specific barriers:

Asynchronous ambitions and objectives: Each company has its own agenda, resulting in different timelines. This leads to disagreements among parties regarding whether to prioritise short-term or long-term goals and vision. The disparity in urgency among parties contributes to this challenge.

Reluctance to share among competitors: Due to potential competition in the same area, not every party is willing to share extensive information.

Representatives unaware of overall organisational interests: When representatives fail to advocate for the comprehensive interests of their organisations, it creates complications during alignment.

Use of industry jargon: Many companies communicate using their own technical language, causing confusion and misunderstandings among other parties.

Tension: Short-term vs. Long-term Orientation

Actors hold different perspectives on the primary purpose of a smart energy hub, whether it should focus on short-term benefits or long-term sustainability.

Tension: Jargon vs. Shared Language

Due to diverse perspectives and concerns, actors often struggle to understand or connect with a story when it is expressed in unfamiliar or technical language.

Challenge: How to align the orientation of different actors?

Approach:

Martijn: Joint fact-finding can help identify common ground between interests.

Station: Developing a shared vision can facilitate a longer-term orientation.

Schiphol Trade Park: A long-term ambition resonated with both companies experiencing urgency and those without. A short-term ambition appealed only to the parties with urgency. Maintain a focus on long-term goals to appeal to all parties.

All SEHs: Ensuring that everyone has a vested interest. Mapping out all interests through the active role of a project manager or community builder.

Barrier category: Establishing Goals is Challenging

Specific barriers:

Vague goals: Many goals set during the process remain abstract, leading to confusion and reduced participation among parties.

Divergent starting points for SEHs: Different perspectives among parties result in a potential divergence regarding the precise foundation of the smart energy hub.

Tension: Abstract vs. Specific Goals

The common goal can vary from being high-level and accessible to being more specific, emphasising clarity and commitment.

Tension: Profit-driven vs. Value-driven

Actors hold contrasting perspectives and priorities regarding the primary purpose of the SEH, whether it is driven by profit or value.

Challenge: How to establish common goals?

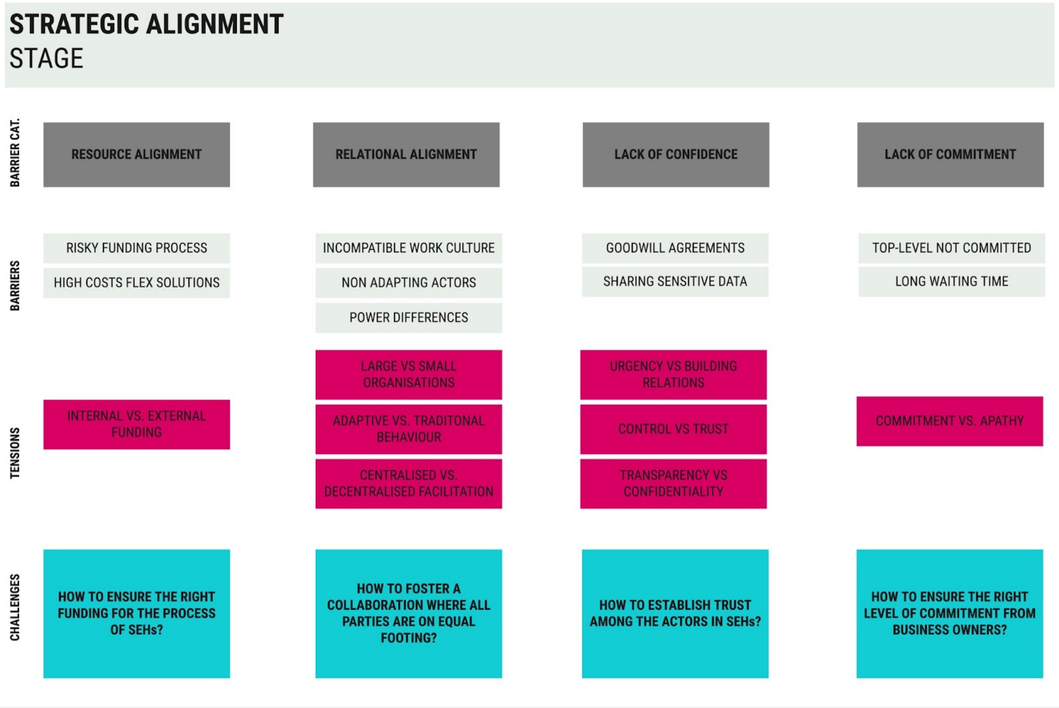
Approach:

PoA: Foster collaboration among parties to create a fair system where the value generated within the area remains within the area.

STP: Parties were not motivated by financial gain, as the business case is yet to be proven. Focus on highlighting potential savings instead.

ecub: Identify the key interests of the leading group.

D: ELABORATION BARRIERS



Strategic alignment stage

Barrier category: Resource alignment

Specific barriers:

Risky investment in the initial phase of the process. Due to the lack of guarantees for successful SEH collaboration, many parties are reluctant to invest their own funds in the process costs.

High investments in flexibility solutions. Some assets and solutions require significant financial investments, often borne by the business owners.

Tension:

Internal vs. External funding. The extent to which financial resources should come from internal partners or externalactors.

Challenge:

How to ensure the right funding for the process and the SEH itself?

Approach:

All hubs: Process investments in initial costs covered by government agencies or developers. Costs of flexibility solutions are the responsibility of the business owners.

STP: Ideally, assets are jointly procured.

Barrier category: Relational alignment

Specific barriers:

Incompatible methods of working in private-public partnerships. Many companies perceive authorities to be slow in taking action and desire faster responses. This is particularly evident with the DSO, which is essential.

Non-adapting actors. Some actors do not change as the SEH evolves.

Power differences. Power disparities arise due to varying sizes and capabilities of companies within a business park.

Tensions:

Large vs. Small organizations. Larger organizations may have more resources, resulting in power differences with smaller organizations.

Adaptive vs. Traditional behavior. The willingness to adapt as collaboration requirements change or stick to old habits.

Centralized vs. Decentralized facilitation. The distribution of decision-making power across the SEH organization.

Challenge:

How to foster a collaboration where all parties are on equal footing?

Approach:

STP: At Schiphol Trade Park, we have a board consisting of representatives from companies with capacity, companies without capacity, and SADC. This ensures equal representation of everyone's interests, regardless of company size or group size.

PoA: The leading group should have more influence in the process, beyond the project manager and facilitator.

Barrier category: Lack of Confidence

Specific barriers:

Agreements based on goodwill. Some agreements are perceived as too lenient and non-binding by business owners, posing risks.

Sharing sensitive data. Companies find it challenging to share data as it may contain sensitive information.

Tensions:

Urgency vs. Building relations. The speed of actions impacts the time actors have to build relationships with each other.

Control vs. Trust. Trust and control have a complementary relationship, meaning that more trust leads to less control, and vice versa. Both are needed to establish confidence.

Transparency vs. Confidentiality. Each business has a balance between shared data and confidentiality, especially in the presence of competitors.

Challenge:

How to establish trust among the actors in the SEH?

Approach:

All hubs: Engage an independent, neutral party to handle data exchange. Establish a legal entity with agreements and sanctions.

Barrier category: Lack of Commitment

Specific barriers:

Top-level not fully committed at the start. If the top-level management participates in the SEH but lacks full commitment, it can lead to challenges.

Long waiting for results. Some SEH solutions take a significant amount of time, leading to impatience among business owners.

Tensions:

Commitment vs. Apathy. If top-level management lacks full commitment and engagement, it can influence development and result in a misrepresentation of interests.

Challenge:

How to ensure the right level of commitment from business owners?

Approach:

All SEHs: Draft contracts with requirements to document parties' commitment.

Innofase: Start with low-threshold, easy-to-implement actions. The key is to keep companies engaged by addressing low-hanging fruit.

Station: Engage in discussions at the executive level. They understand the organization's interests and have the authority to