GUIDE FOR INDUSTRIAL SYMBIOSIS FACILITATORS

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Preface

Towards a new natural

TOWARDS A NEW NATURAL

An endless sky, open land, wide forests and troubled seas; Nordic nature is truly unique and grandiose. The changing seasons and dim light bind us together as one people cross borders and imprint our culture and behavior as individuals. Our lives are preconditioned by nature, and maybe because of that, an important inspiration: Natural eco-systems have developed over millions of years allowing a wide diversity of living organisms each with a defined role and function. In nature resource efficiency and diversity prevails, as all things "wasted" is reprocessed within and reabsorbed into their circular community - like when a leaf falls to the ground and re-enters the circle of life as a nutrient for other living organisms.

With inspiration from nature, balance and resilience is to be reached through a circular approach to production and consumption. No doubt, there is an urgent need for the future to be sustainable, and in this respect, industry plays a crucial role in resource consumption, product design and new business models. Process industry needs to take a smart approach, where embracing the green challenge can be turned in to a competitive advantage.

This guide will show you how to use the mindset of Industrial Symbiosis as a tool towards realizing a circular economy. Not as a theory or an idea, but as practical advice as how to get things done, since it is built on a knowledge-based approach. The guide combines experiences and best practice from different cluster organizations in the Baltic countries,

each of them with their own method on how to design and facilitate local partnerships. Generously sharing data, hands-on experiences and knowledge, the partnership behind the guide, will suggest which tools to pick in order to create cross sectoral partnerships – or just to take the very first important baby steps to accelerate the green change.

It is our ambition with this guide to inspire others to get started on the journey towards a new way of thinking business. We aim this to be the new natural where resources are shared and recycled in local partnership.

A new natural without waste.

We are happy to share this guide with you –enjoy

Head of Secretariat, Kalundborg Symbiosis
Lisbeth Randers

CHAPTER 1.0

Introduction

Industrial Symbiosis

The facilitating organisation
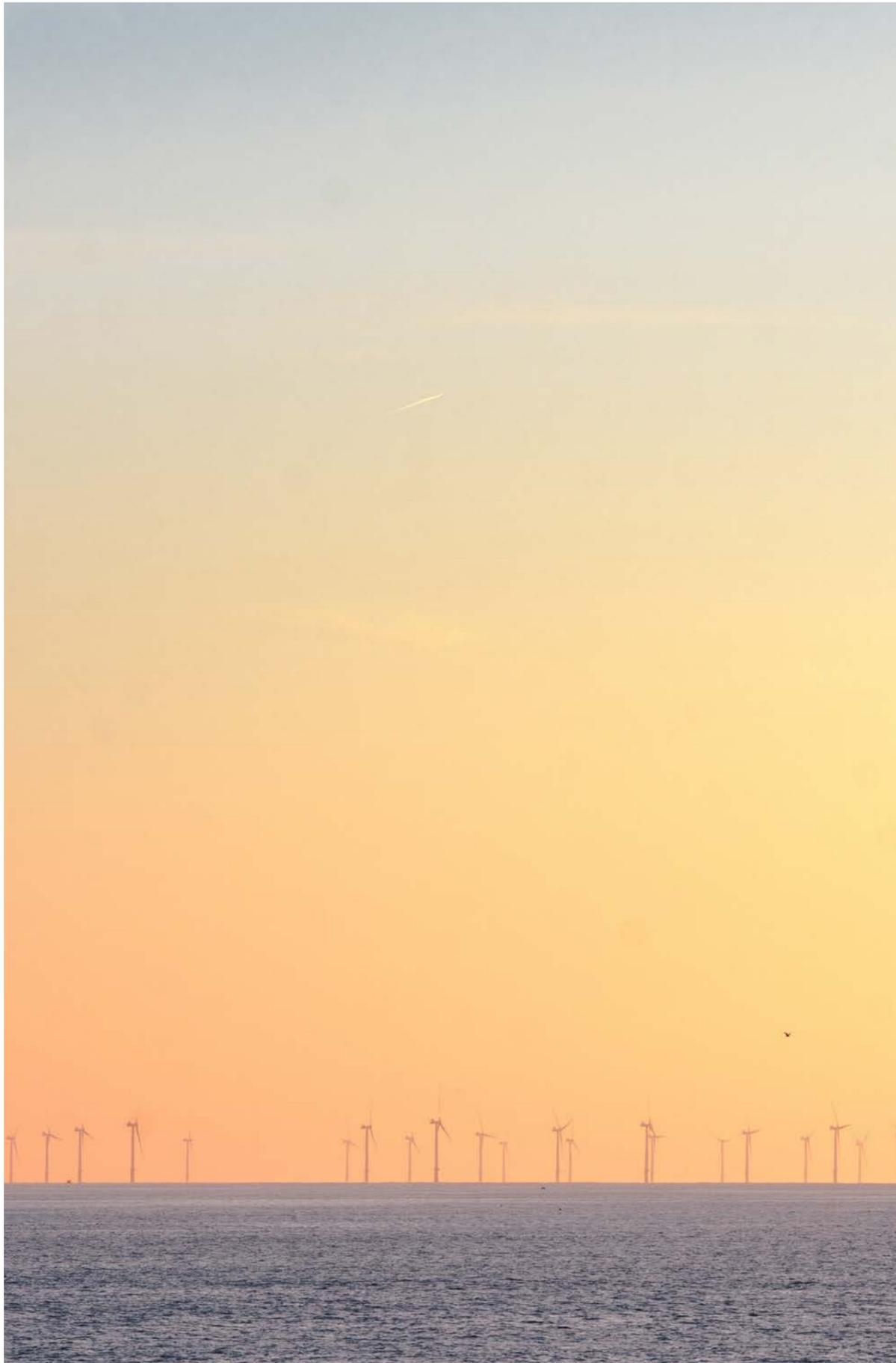
INTRODUCTION

The global economy currently follows a linear model, where raw materials are mined, processed into products, consumed and thereafter become waste. Consequently, global consumption of materials such as biomass, fossil fuels, metals and minerals, is expected to double in the next forty years, while annual waste generation is projected to increase by 70% by 2050[1]. The circular economy offers an alternative to the take-make-waste model, by maintaining the value of products, materials and resources in the economy for as long as possible and minimising the generation of waste[2] .

The process industry is resource and energy intensive, and thereby has a key role to play in the transition towards a circular economy, through sustainable and circular sourcing and cooperating across value chains[3], including both large corporations and small-and medium sized enterprises. This can be achieved through Industrial Symbiosis (IS), a recognised key driver for green growth business opportunities[4]. Taking part in an IS can protect companies against scarcity of resources and volatile prices, helping to create new business opportunities through innovative and efficient ways of producing and consuming[5].

THE INDUSTRIAL SYMBIOSIS

The key principle of IS is the physical exchange of materials, energy and water between two or more companies, turning what is normally seen as waste, into a resource[6]. The companies that collaborate in an IS are often from different sectors[7], but most often from the same geographical area. By replacing input materials with waste, a company can potentially reduce cost of input materials, while the other company reduce waste disposal costs, and potentially even turns their waste into by-products[8].

When two companies exchange resources, they have established a symbiotic exchange between them[9]. A network of several individual symbiotic exchanges, where more than two companies are interconnected around more than one resource, is called an industrial symbiosis network[10], see figure 1.1.

IS is thereby part of the circular economy and allows industry to move away from the linear take-make-dispose system towards circular use of resources. Besides achieving competitive advantages and foster innovation in each company, there are several more economic, social and environmental benefits attached to the collaboration, see figure 1.2.

When companies collaborate about symbiotic exchanges in an IS network, they form a local resilient partnership. As a united network they achieve better resilience towards external and internal developments and are stronger together than each of the individual parts. Such a network is however more complex to establish than the individual symbiotic exchanges and can benefit from a dedicated facilitating organisation, that has the role of an intermediary between the collaborating companies.

Traditional situation:
Each company purchases virgin resources and create waste to waste disposal.

RESOURCES

RESOURCES

WASTE

WASTE

A symbiotic exchange:
The physical exchange of resources between two companies.

WASTE BECOMES RESOURCE

An Industrial Symbiosis Network:
A network of several symbiotic exchanges.

WASTE BECOMES RESOURCE

WASTE BECOMES RESOURCE

WASTE BECOMES RESOURCE

An example from a real-life IS and it's network of symbiotic exchanges, can be seen in part 4: Communicating the results, figure 4.3.

Figure 1.1

IS is thereby part of the circular economy and allows industry to move away from the linear take-make-dispose system towards circular use of resources. Besides achieving competitive advantages and fAster innovation in each company[11], there are several more economic, social and environmental benefits attached to the collaboration[12][13], see figure 1.2.

ENVIRONMENTAL

Reduced extraction of virgin resources

Reduced CO_2 emissions and other greenhouse gases

Reduced waste generation

Reduced emissions from transport

SOCIETAL

Local job creation

Local organisations benefit from a larger customer base

ECONOMIC

Reduced costs for resouces

Reduced costs for waste disposal

Additional income from bi-products

Improved resilience against volatile resource prices

Contribution to sustainability strategy

Talent acquisition

Figure 1.2

When companies collaborate about symbiotic exchanges in an IS network, they form a local resilient partnership. As a united network they achieve better resilience towards external and internal developments and are stronger together than each of the individual parts. Such a network is however more complex to establish than the individual symbiotic exchanges and can benefit from a dedicated facilitating organisation, that has the role of an intermediary between the collaborating companies.

THE FACILITATING ORGANISATION

> ## "
> ## Systems make it possible, people make it happen.
>
> Kalundborg Symbiosis

Despite the multiple benefits associated with being part of an IS for the individual companies, the establishment of symbiotic exchanges or the creation or development of an IS network, does not necessarily happen uncoordinated. Establishing an internal organisation that supports the development of symbiotic exchanges as well as maintains and develops the IS as a network, is therefore key to the long-term success[14].

The facilitating organisation can contribute with technical support, such as help with conducting research and testing and obtaining funding for the development of the symbiotic exchanges. But the development of symbiotic exchanges, as well as a strong and efficient IS network, requires more than technical solutions. Therefore, the facilitating organisation also contributes with social factors such as mutual trust, connection and familiarity between the companies, which is the basis for succeeding with the necessary partnerships between the companies[15]. An important contribution of the facilitating organisation is therefore to set up structures that enable the companies to get familiar with each other and feel inspired

and motivated to develop new symbiotic exchanges[16].

These elements and many more are explored in this guide, which describes how the facilitating organisation may provide support, and thereby enable the establishment of symbiotic exchanges and the IS as a collaborative network, and as such contribute to the transition to a more circular and sustainable industry and society ▪
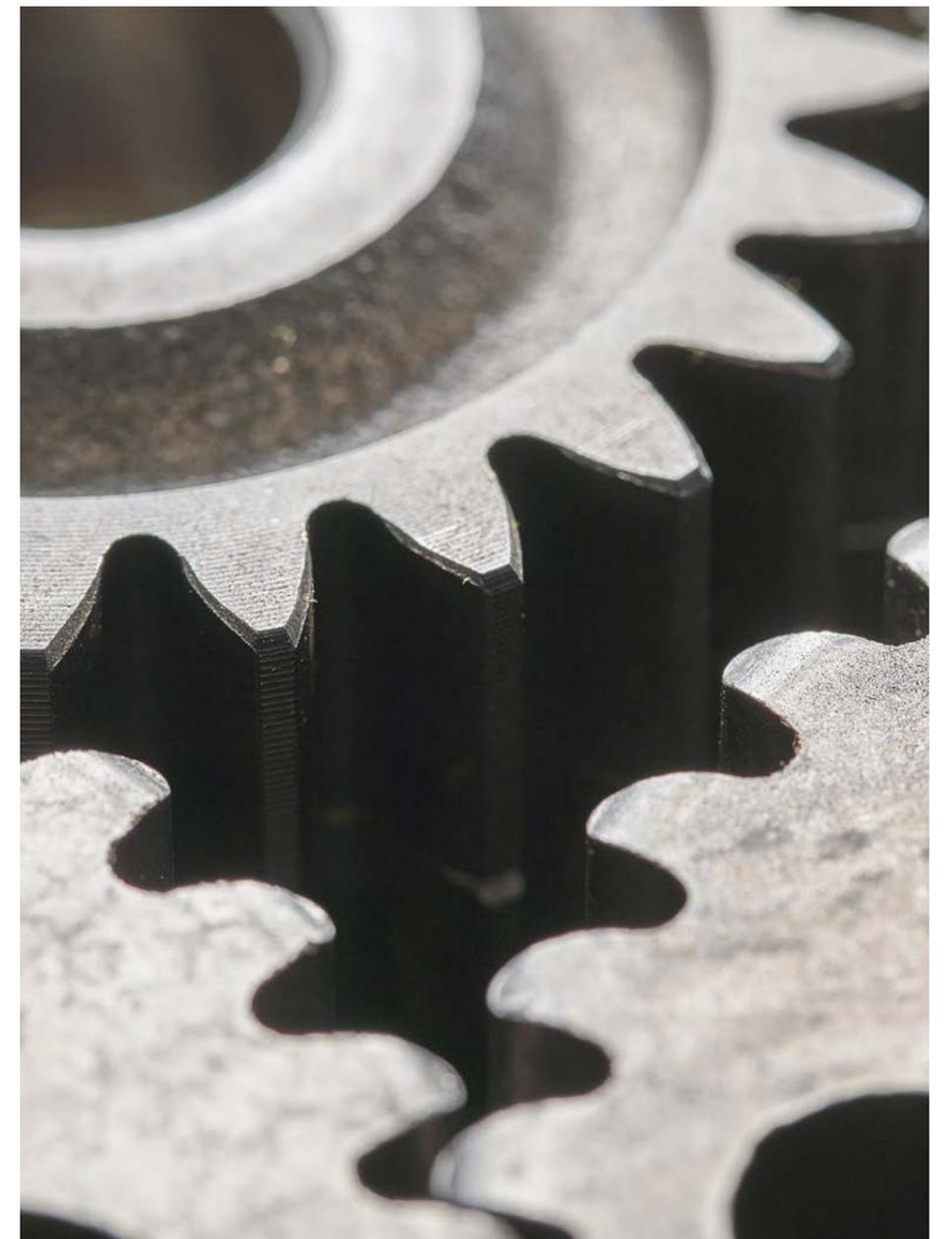
CHAPTER 2.0

This guide

Method and data collection

Reading the guide

Summary of chapter 3
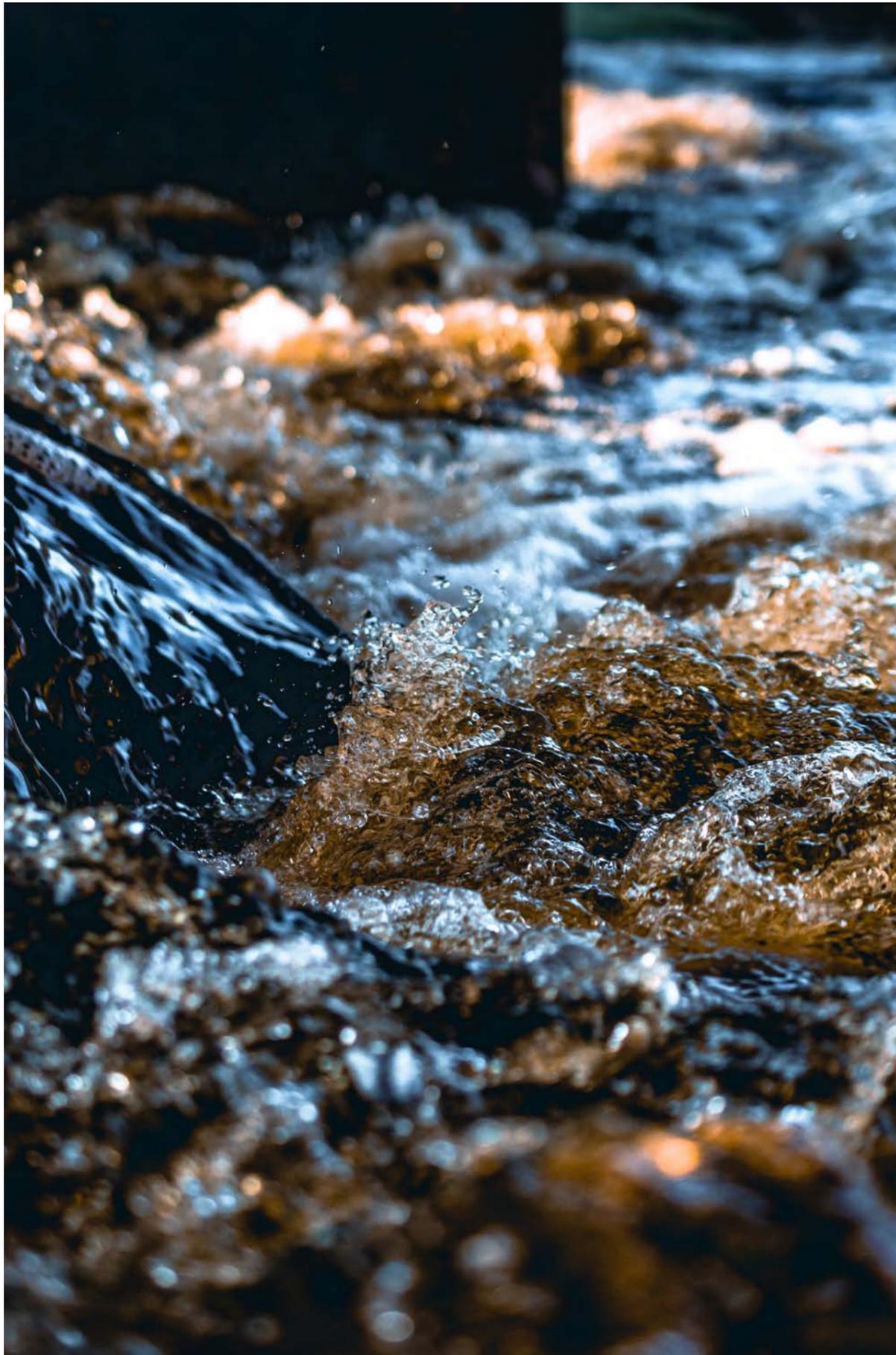
THIS GUIDE

This guide for Industrial Symbiosis facilitators is developed to give guidance to current and future IS facilitators, and explores the facilitator's role in establishing and supporting individual symbiotic exchanges, as well as the development of the IS network of these into a an IS. It is based on insights, hands-on experience, knowledge and best-practices from industrial symbiosis facilitators in the Baltic Sea Region.

This chapter gives an overview of the data used for the guide, and how it has been gathered and analysed. Following this is a brief description of how the guide should be used and finally a summary of chapter 3 and its parts, which represents the core guidelines.

METHOD AND DATA COLLECTION

The guidance and suggestions presented in this guide, are based on the general findings from data gathered through observation during peer-to-peers and through interviews with selected partners of the BIS project (see description in table 2.1), both amongst governmental - and IS organisations seen in bold in table 2.2 and 2.3. In table 2.4 below, the key aspects of the contributing organisations is outlined. In chapter 4 the organisations are described in more detail. Since the partners differ in terms of country, size, year of establishment, industry focus and organisational structure of facilitating organisation, the conclusions are believed to be useful for facilitating organisations from various countries, at different stages, industries and of different organisational structures. In addition, the content is also backed by theory and academic literature. Most of the claims will therefore not include a reference to a specific partner or

interview, apart from quotes and insights from partners throughout the guide. Although quotes are taken from a specific partner, they are used to highlight an insight only when representative across the partners.

In addition to the interviews, the guide also includes insights from the business- and industry members of the industrial symbiosis organisations, regarding the role of the facilitator. These were gathered through a survey done by Linköping University.

Lastly, the guide draws on literature and academic articles on the concept of IS in general and IS facilitation. Moreover, the guide builds on related and complementary concepts such as ecosystem innovation, organisational management, entrepreneurship, and innovation management.

GOVERNMENTAL AND ACADEMIC PARTNERS:

Symbiosis Center Denmark, Kalundborg Municipality (Denmark)

Ressource City, Næstved Municipality (Denmark)

Trøndelag County Council (Norway)

Swedish Agency for Economy and Regional Growth (Sweden)

Gdansk University of Technology (Poland)

Linköping University (Sweden)

Roskilde University (Denmark)

St. Petersburg State Geological unitary Enterprise "Specialised firm "Mineral" (SC Mineral) (Russia)

Table 2.2

PROJECT BALTIC INDUSTRIAL SYMBIOSIS:

The Baltic Industrial Symbiosis was funded by Interreg Baltic Sea Region and ran from January 2019 to December 2021. The project promoted industrial symbiosis across the Baltic Sea Region, and brought together both industrial symbiosis organisations, governmental organisations, and academia, as seen in table 2.2 and table 2.3. The projected promoted IS by supporting existing practitioners with the following activities: new business models and finance models, the establishment of a new Baltic Sea Region Industrial Symbiosis Council as a platform for dialogue and policy learning, and lastly, peer-to-peer exchanges. During peer-to-peer exchanges, the project partners got the opportunity to learn how colleagues in neighbouring countries facilitate industrial symbiosis development.

Table 2.1

INDUSTRIAL SYMBIOSIS ORGANISATIONS:

Kalundborg Symbiosis (Denmark)

Paper Province (Sweden)

Digipolis (Finland)

Tyreman Group (Russia)

The St. Petersburg house property owners association (Russia)

Table 2.3

INDUSTRIAL SYMBIOSIS FACILITATING ORGANISATION	Digipolis	Kalundborg Symbiosis/ Symbiosis Center Denmark	Paper Province	Ressource City	Gdansk University of Technology	Trøndelag County Council/ Thams Industrial Cluster	Tyreman Group
FOUNDING YEAR FOR INDUSTRIAL SYMBIOSIS FACILITATING ORGANISATION	2012	1996	2003	2015	2017	2018	2018
OWNERSHIP	Public-Private	Association	Private member-based	Public	Public	Association	Private
COUNTRY	Finland	Denmark	Sweden	Denmark	Poland	Norway	Russia

Table 2.4
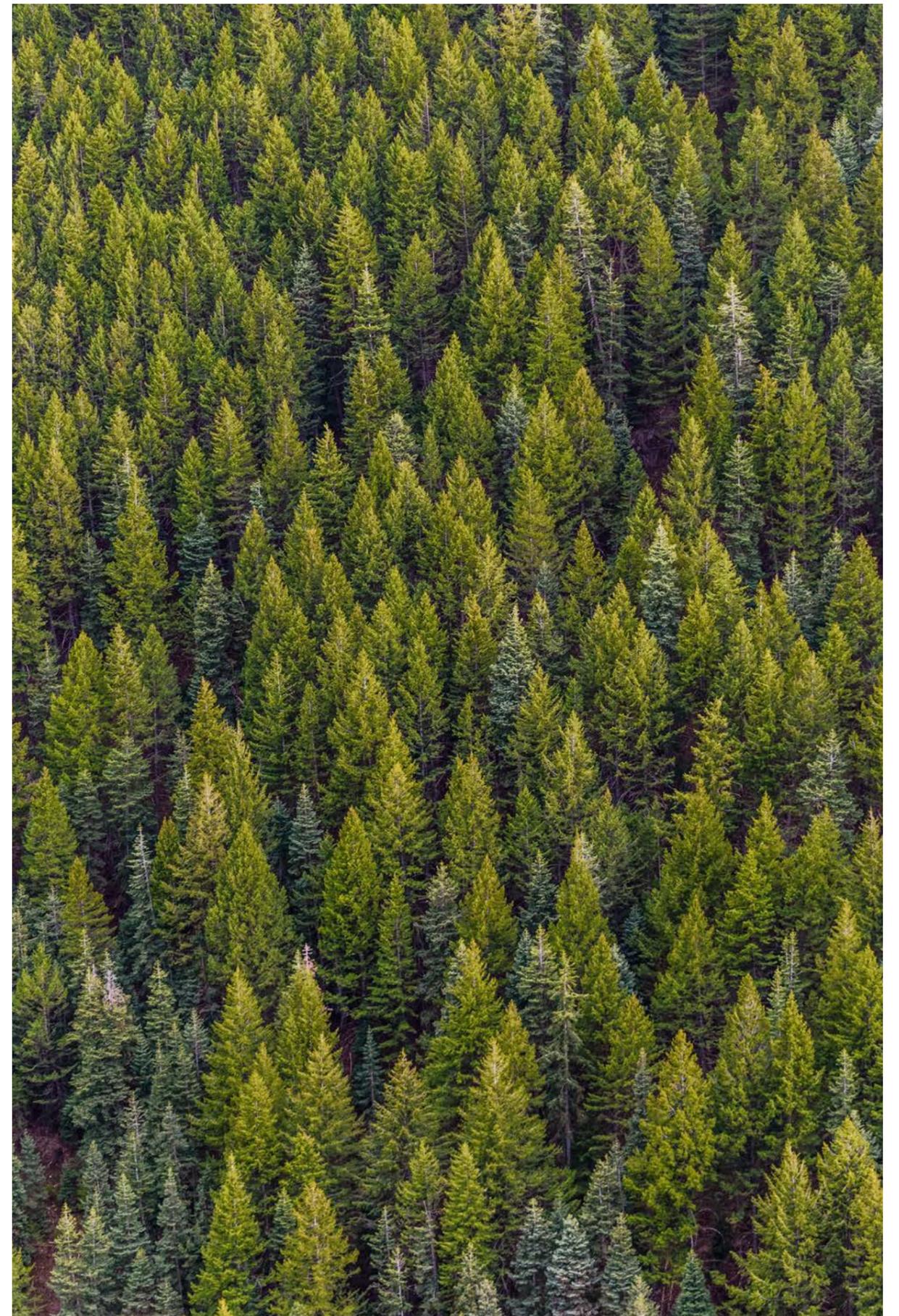
READING THE GUIDE

For whom the guide is useful

The guide is believed useful for all interested in and related to, industry development and the sustainable agenda, although it gives concrete guidance and advice for facilitating IS and as such is particularly relevant for current or future IS facilitators. These can be individuals with a wish to explore the possibility of building a facilitating organisation, from either the public or private sector. The guide accommodates both big and small companies, and all levels of ambition and resources. It can also be valuable for staff members of an already established facilitating organisation, who are looking for inspiration and best-practices from other IS facilitators.

That said, everyone interested and/or relevant to the topic is welcome and encouraged to also take inspiration and learning from the guide. This includes but is not limited to, politicians curious about how a facilitating organisations can best be supported, business networks and associations, and academia. If the reader does not directly affect industry development or IS, but is interested in supporting the sustainable development, a valuable contribution is to share and suggest the guide.

How to read the guide

The guide covers areas that are relevant for facilitators to be familiar with and work with throughout the life of the IS and the facilitating organisation, from the modest beginning, to a solid network of companies and a strong facilitating organisation.

The IS and the IS facilitating organisation go through stages of development, from establishment, finding the first projects, and building a strong network, to identifying and scaling the IS. Similar aspects of facilitation reoccurs throughout all stages.

The process of creating a facilitating organisation and an IS is dynamic and iterative and is supported and fed by the interactions occurring simultaneously between different actors. The life of the IS and the facilitating organisation is therefore not strictly chronological with specific tasks and activities undertaken in a particular way at different stages of maturity. Therefore, many of the same activities repeat themselves for the facilitators throughout. However, the facilitating organisations does not

use equal amounts of time on all activities, always. For example, an IS requires a varying focus on different aspects of facilitation depending on its size, experience, and recognition.

The structure of this guide emphasises the equal importance of the recurring facilitating activities, and the parts of chapters 3 are intended to be read as deep dives into equally important topics that reoccur and are relevant from starting to scaling the IS and the IS facilitating organisation. The reader does not have to read the guide chronologically but can choose to read specific parts of this guide depending on interest.

1. THE IDEA OF CREATING AN INDUSTRIAL SYMBIOSIS

2. ESTABLISH THE FACILITATING ORGANISATION

3. CREATE SYMBIOTIC EXCHANGES

4. ENSURE CONSISTENT DRIVE IN NETWORK

Maturity of the IS network

The facilitating organisation's tasks

Find the arguments necessary to take the idea towards realisation, by getting internal support, support from the local companies and attracting funding for the facilitating organisation.

Establish the facilitating organisation, by building an identity, deciding on a business model, considering the necessary skillset and qualifications, and making an internal strategy.

Create symbiotic exchanges between local companies, by facilitating the emergence of ideas, and supporting the realisation with matchmaking, research, and funding.

Ensure the internal drive of the IS network by building a strong culture. Communicate the results and collaborate with external partners to ensure consistent development of the facilitating organisation and the IS

Figure 2.2

OVERVIEW OF CHAPTER 3

The next chapter of the guide, chapter 3, is about building a facilitating organisation and facilitating IS. The chapter is divided into 4 parts. Throughout the guide, there is a distinction between the IS and the facilitating organisation and some parts of the chapter are more focused on one or the other. Part 1 & 2 of chapter 3 are particularly focused on the facilitating organisation. Part 3 & 4 focus more on the IS, and how the facilitating organisation can make the IS thrive. All parts are written using the facilitating organisation as point of reference.

Part 1: Pre-emergence

Many IS facilitating organisations have started because someone has a personal ambition to create and/or facilitate an IS. Since most aspiring IS facilitators are already employees of another organisation, either private or public, this signifies the importance of building the arguments that secures the internal support for spending the necessary time and resources to put the idea into reality. This part offers guidance for where to look for those arguments, and how to use them to get the internal support, as well as support from the local business environment and funding.

Part 2: The facilitating organisation

When the necessary support has been given to establish an organisation that develops and facilitates IS, it is important to consider what role, purpose, organisational set-up, and strategy the facilitating organisation will have. This part goes through how these aspects will affect the development of the IS and the facilitating organisation. The choices made when establishing the organisation ties both to how it will be able to support the development of the IS, as well as financially securing its own survival.

Part 3: Symbiotic exchanges

At its core, an IS is a network of companies that collaborate around the exchange of resources. Constant innovation is the building block for the survival of the IS to keep a relevant and attract attention to new companies and the external world are important factors of securing innovation. This part elaborates on how a resource exchange is developed, and the role of the facilitator throughout the process, including identifying the issue, finding a solution, and supporting the implementation. Finally, part 3 elaborates on the effect of successful resource exchanges on the general drive of the IS through the creation of an embedded network.

Part 4: Ensuring the drive

The constant emergence of symbiotic exchanges is in many ways a result of the underlying drive of the IS, meaning the internalised motivation amongst the members to improve and strengthen the IS. This part focuses on how the facilitating organisation can create this drive, by building a strong culture, which includes building a common story, ensuring successful collaborations, giving the IS a direction by creating a common strategy, communicate the results, and engage in external partnerships. Through contact with other relevant organisations, politicians, media and communities, the facilitating organisation can get inspiration and learn from others, generate external attention and recognition, and consequently get better at facilitating as well as keeping the IS and the IS facilitating organisation motivated ∎

CHAPTER 3
FACILITATING INDUSTRIAL SYMBIOSIS
PART 1

Pre-emergence

Finding arguments

Getting support

PRE-EMERGENCE

This part focuses on the early beginning of establishing an IS facilitating organisation. Many IS facilitating organisations have started because an individual is driven by the topic and has a personal ambition to make an IS happen in their local region.

"

After several years of hard work, our organisation started to gain a lot of positive attention. So, don't give up!

Michael Elgaard, Ressource City

When observing already established IS's it might look like a daunting task to initiate a similar initiative. Although a full grown IS looks complicated and complex, getting it off the ground is not rocket science. Every IS is different depending on country, region and industry, and there is no single recipe to start an IS, but this part will provide inspiration and ideas on how to do it. As you will experience, the process is characterized by trial and error, and requires that you as the facilitator have an entrepreneurial mindset, a proactive attitude, patience in the process, work hard, believe in the idea, and, have a pinch of luck.

Regardless of how personally motivated you are to make an IS happen, the process will take time and require money and resources. Further, when the project develops, and external stakeholders are involved, the work becomes more time-consuming, and the facilitator is increasingly expected to be structured and responsible for continuous progress. This part therefore goes through how to get the required support from the organisation that you are currently a part of, by building up the winning argument, as seen in figure 1.1. Throughout this guide, your current organisation is referred to as the mother organisation, which is further explained in table 1.1.
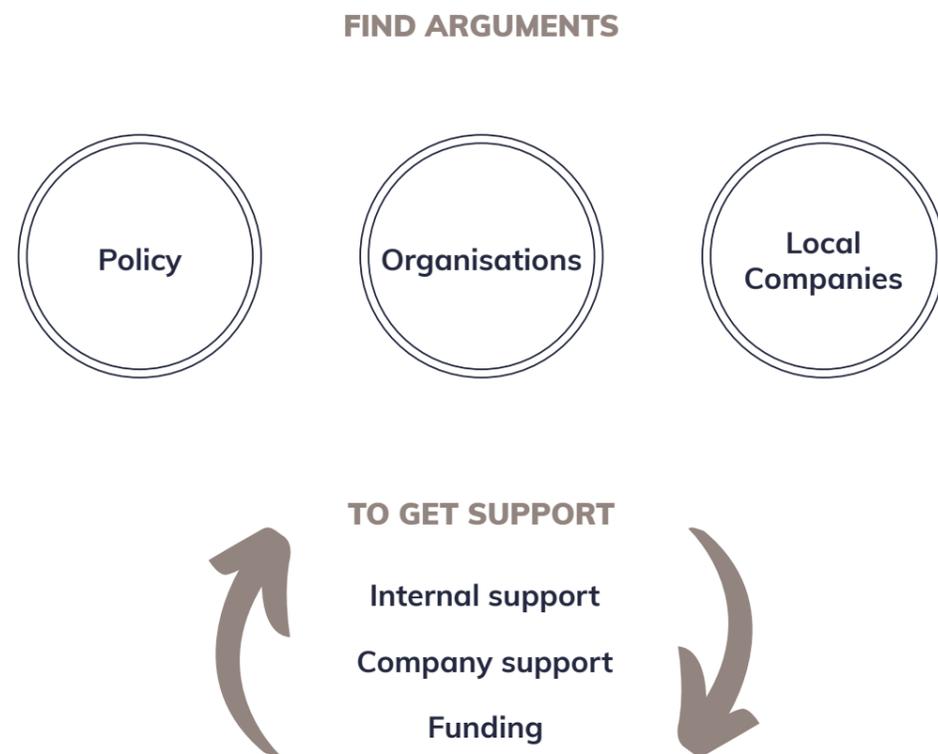
A winning argument normally consists of a combination of policy developments, trends in the local business environment and the mother organisation's strategy. In addition to obtaining the internal support, it is also useful for getting the support from the local business environment, and funding. The three types of support are interlinked and mutually reinforcing; obtaining support for local companies increases the likelihood of getting both internal support and funding, and similarly getting internal support will allow you to put in the time necessary to get funding. This initial work will give you valuable knowledge and arguments that you can also use later when campaigning for IS.

Since the topic might not yet be an area of focus in your mother organisation, you are most likely looking into the potential for IS on top of your regular tasks. During this phase it is important that you manage to uphold your motivation and belief in the process, as this phase might take long.

FIND ARGUMENTS

Figure 1.1

THE FACILITATING ORGANISATION AND THE MOTHER ORGANISATION

Throughout the guide, the facilitating organisation and the mother organisation are used as terms.

The facilitating organisation refers to the organisation that develops and facilitates IS. The facilitating organisation can be its own legal organisation such as an association, or it can be an internal project entity in an existing organisation.

If the organisation is established as an internal project entity in an existing organisation, the existing organisation is referred to as the mother organisation.

Table 1.1
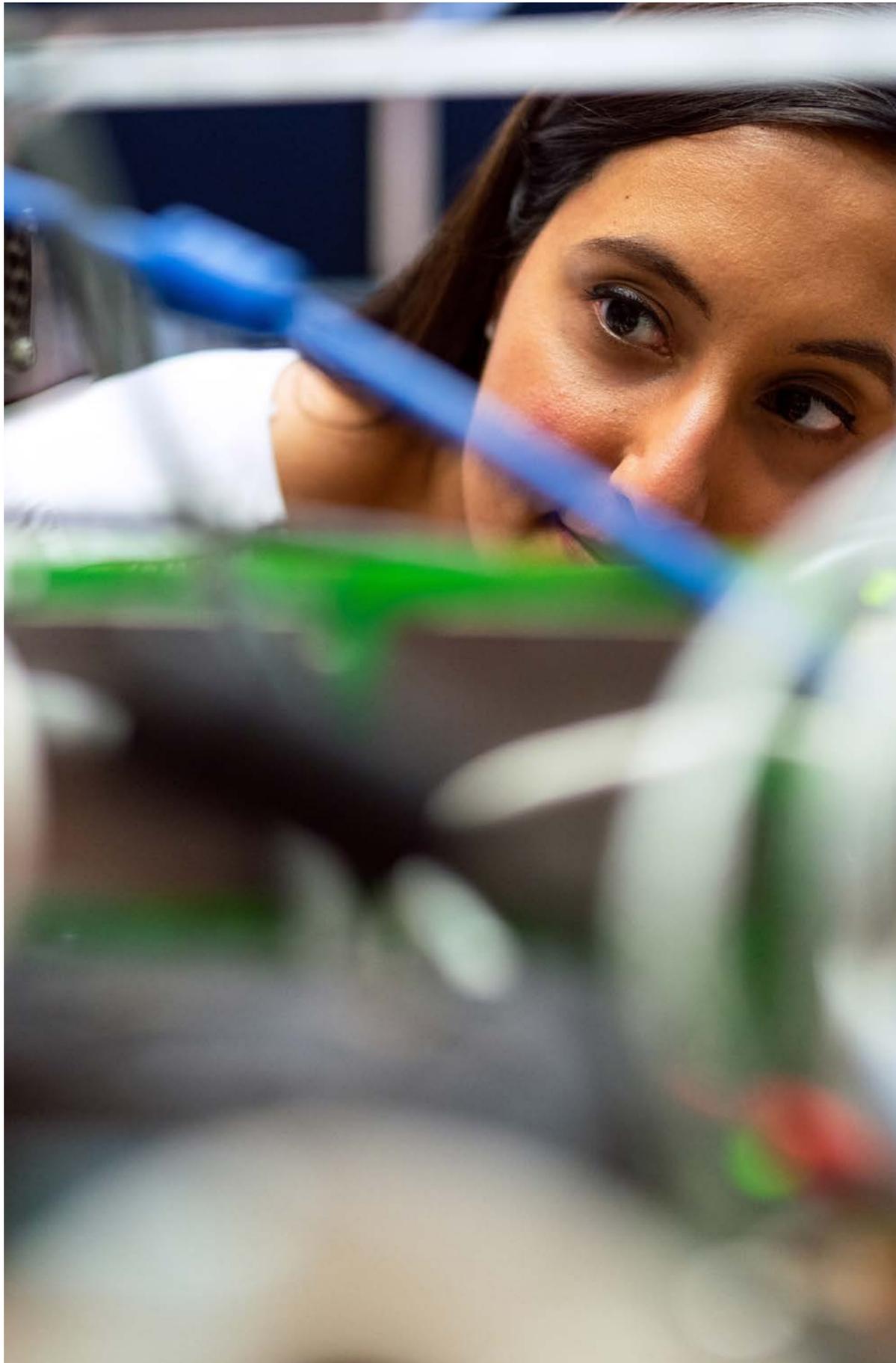
FINDING ARGUMENTS

Arguments can come from policies that back up the need to work with IS and/or knowledge of your local business environment and potentials. Which will be your "best" arguments depend on your position, organisation, reality, and context. A general approach could be to do a broad scan for arguments, since they can come from different places, and the strongest case is often built up of a variety of arguments. Having an open mind, eyes and ears for what is happening in your local area and the public debate is therefore crucial in the beginning. Also, throughout the life of the IS, there will be a need to keep looking for arguments, as both organisational and financial support never ceases to be necessary.

Policy arguments

Policy targets or strategies, as well as legislative changes can represent a window of opportunity. Below are areas of inspiration:

> Looking into national but also EU policies focusing on circular economy, climate, energy, resource consumption and green business development can help you advocate for why IS is relevant and should be prioritized. For instance, IS could start because of national policies such as tax incentives, regarding energy consumption and reducing climate change or changing waste policies.
> Policies and legislations about city development plans or infrastructure construction that include a focus on sustainability or circularity, which you can leverage to argue for further resource sharing.
> Local strategies and ambitions including local funding possibilities. For someone in the public sector, working with IS can arguably be a way to fulfil policy goals. Further, you can argue that prioritising IS can give local companies a competitive advantage, provide an innovative business environment, preserve and create local jobs, reduce negative environmental impacts and increase the attractiveness of the city and region (see chapter 1, figure 1.2).
> International developments to build your arguments, by arguing that these changes need to be prepared for in your local context. For instance, international media attention around climate change and resource scarcity, can point to coming changes.

Organisations to network with or join

Already established organisations that facilitate IS can provide inspiration, motivation, and successful examples of IS. Moreover, they can contribute with learnings and experience of how to develop local IS and they might become valuable partners for support and collaboration now and throughout the life of the organisation and development of the IS. These organisations do not have to be in your local community but could be national or even international organisations.

Other potentially valuable organisations are organisations that focus on IS, sustainability and circular economy, such as industry clusters, business networks or incubators. By joining or networking with these organisations, the facilitator can gain multiple benefits, such as increased knowledge of the topic, knowledge of upcoming projects and funding opportunities, and introductions to relevant stakeholders and organisations.

INSIGHTS FROM A BIS PARTNER

"

BIS is like a stepping stone for us, and gives us the opportunity to learn from the other partners in the BIS project. We believe that this will help us to promote the idea of industrial symbiosis in our region in the most effective way.

Nikita Lomagin, Tyreman Group

The Russian partner, Tyreman Group, is part of several local organisations and networks, such as the Cleantech Cluster in St. Petersburg and a local business incubator. These organisations have proven valuable as a source of scouting project possibilities, gain access to local companies, and get relevant tools and information.

It was through the Cleantech Cluster that Tyreman Group got to know about the possibility of applying for the BIS project, which has been an important enabler for them to start facilitating IS. In the initial phase, when the IS is still at the idea-level, getting access to funding and support contributes significantly to the first steps of taking it into reality.

Additionally, these organisations have been a platform to get in touch with local companies, through which they were introduced to the first companies. At this point, they have already established the first symbiotic exchange between two companies, whom they were introduced through the local organisation.

The local business ecosystem

The local companies are the essential partners in the IS as they will be the ones collaborating about symbiotic exchanges. It is therefore vital to get an overview of the local ecosystem to be able to identify and attract companies to the IS. This includes looking for sprouts of existing company collaborations, preferably but not exclusively around resources, as well as understanding the local companies' opportunities and challenges. A way to identify potential companies and cases, is through local business associations and networks. The local newspaper can be a good source of such associations, activities and events with a potential for making relevant contacts, and local company cases that can serve as a starting point. Informal channels such as family, community, or civic organisations, can also prove valuable, as many crucial conversations, decisions, and connections, are made in informal settings. Keep eyes and ears open and talk to people in your network about what you are working on. This way, you are more likely to meet someone with similar interests or useful insights or come across a company or leader that can open doors.

Lastly, it is important to point out that at this point in the process of creating an IS, the success of your efforts also depend on luck and timing. Meeting the right person at the right time, being backed by timely policy changes or other events, can make all the difference.

"

There are many things you can do to identify local companies, but sometimes you simply need to be lucky.

Per-Erik Sørås, Thams Industrial Cluster

Sprouts

The concept of IS might be new to you, however, there could already be sprouts of IS taking place in the local business environment such as existing resource collaborations or resource collaborations in development, but not yet orchestrated. In the literature it is commonly found that *"a period of initial self-organization occurs before IS discovery"* [1].This "self-organisation" is essentially what you should structure and facilitate to support the growth of the IS. IS requires companies from various industries and several IS have consequently grown successfully in areas where there is already established industry[2]. Existing resource collaborations could potentially be found through for example utility stations that already have resource collaborations with local companies. Building on the sprouts of existing local collaborations allows you to take part in and strengthen an already existing relationship, which makes it easier to get support and attract more companies to join. Further, it shows that the concept has been through the market test, which signalises that it has a proven potential. Lastly it provides a history, which you can use to develop a common identity for the IS.

Depending on your mother organisation there are different sources of connections and resources that you can draw on when exploring the local business environment. These are laid out in table 1.2.

PRIVATE MOTHER ORGANISATION	PUBLIC MOTHER ORGANISATION	ACADEMIC MOTHER ORGANISATION
If you are from the private sector, you might have connections to local companies, business clusters or networks where you can gain knowledge of potential local collaborations.	If you are from a public institution you might represent or have a connection to the local professional business body, access to the unit for environmental control and waste in companies from the municipality, or knowledge of future local development plans.	If you are from an academic institution, you might have knowledge and experience from relevant research projects, access to networks and the possibility of conducting new projects as a legitimate actor in the field.

Table 1.2

Opportunities and challenges

Another way to look for business arguments for establishing an IS is by identifying local challenges such a fragmented industry and a lack of arenas for company collaboration. These types of challenges could be turned into opportunities through a facilitating organisation and an IS partnership.

Another approach is to look for companies with sustainability priorities, goals and/or strategies, or companies that deal with significant resource inputs and outputs. These are likely to have a positive mindset towards IS and potential for getting guidance and help with resource optimisation or achieving sustainability goals.

GETTING SUPPORT

When the arguments from policies and/or the local business ecosystem have been gathered, it is time to use the arguments to obtain the necessary support. Internal organisational support is often the prerequisite to get the opportunity to apply for financial support. However, as figure 1.1 shows, these two types of support are self-enforcing in the long term. The first organisational support leads to funding, which allows you to explore the project, and consequently gives you more experience and track record. This then often leads to strengthened organisational support.

Organisational support

Internal support is first and foremost for you to be allowed to spend more of your time on exploring and developing the idea into a project. This could be in the form of an internal decision to allocate time and budget for you to investigate further and/or apply for external project funding. This support is crucial because your next step is to engage stakeholders and therefore you need to be able to commit to the project.

Company support

External support from local stakeholders is important for your own motivation, as well as starting the momentum by giving the project legitimacy which then increases the chances of attracting more companies to the network. Since engaging in an IS is not business as usual, most companies need to be convinced. However, the dynamic resembles the domino effect, where the hardest part is to get the first company to join, and then others are likely to follow. This can happen rather organically, by convincing more and more companies. As with most, "seeing is believing", and an effective way of convincing the local companies, for whom the green transition might seem far away, is to practically show the benefits and examples of successful IS's. For this, building on existing IS's is powerful. Even as an aspiring IS facilitator, you are welcome to reach out to established facilitating organisations and hear if there are any possibilities of visiting together with some local companies or otherwise learn from their experiences.

Showing the concept visually from the very beginning is especially convincing. Even before any resource exchanges have been established, the facilitating organisation should prioritise developing visuals. This can for instance be of the companies in the region, an overview of the resources

leaving or entering the region, or the flow of job creations (see part 3, identifying the problem). What is important is to visually communicate what is currently happening in the area and use this as leverage to develop symbiotic exchanges. Oftentimes, universities are capable of supporting such overviews. In addition, having convinced an influential actor in the local community to support the facilitating organisation and concept of IS can spearhead the development of the network. Such an actor, called a champion, is able to provide trust in the project, engage its own network and attract broader public attention, providing prestige and spreading the word. The term is elaborated in table 1.3.

WHO IS A CHAMPION?

The champion is not merely the first company buying into the idea, but also a vocal supporter who is willing to put time and resources into making the IS happen. Ways of supporting are through joining the IS facilitating organisation´s advisory board, spreading the idea in its own network and speaking out about the benefits of IS. Champions are important because they are able to establish connections between different projects and stakeholders, and develop support through a bottom-up approach between organisations, enabling social relationships by bringing people together, and advocate the vision of industrial ecology and IS.

The champion can, but does not have to, be from a local company offering a large pool of material flows as IS potential. More importantly is that the champion and the business is known and respected in the local business environment and preferably has a certain size. A champion is a leader that stands out in initiatives and possesses deep understanding of the local society and culture, and preferably has a track record of industrial innovation.

HOW DO YOU GET A CHAMPION?

Throughout your analysis of the local business environment you might have found companies that are engaged in collaboration and show a positive mindset towards the benefits of an IS partnership. They could be interested in the idea because of their large resource consumption, or an ambitious sustainability strategy. You can also look for potential champions in sustainability, or projects that your organisation have taken part in in the past, can potentially provide contacts to build on. In the very beginning, the point is not to ask for formal connection or participation in the project, any support is beneficial.

Table 1.3

Financial support

Even though there are strong business incentives for IS, any change requires investment, and the companies are not necessarily ready to take on financing the facilitating organisation. At this point in the process, it is therefore important to secure financial support to allow you and potentially more people, to continue pursuing the ambition of an IS.

Getting public project funding is the most common way for IS facilitators to get the organisation up and running, attract partner businesses, and subsequently create the first IS collaborations. Based on these initial collaborations, the facilitating organisation can continue to apply for funding for more innovation projects, and so on.

HOW TO GET FUNDING

The most common source of funding is public funding programmes. They can be from the EU, national, regional or local programmes and bodies. The same arguments that secured you the internal support, can also be used to obtain funding. For instance, arguing how IS helps fulfill national policies, supported by your already thorough knowledge of the business environment and engagement from local companies, can serve as arguments to secure funding.

Funded projects often signify that you become part of a project consortium, which again increases your network, knowledge, motivation, and legitimacy. Building on and strengthening the connection with other organisations and IS facilitators gives you the possibility to create partnerships with whom you can potentially identify new innovation projects and apply for new funding.

By the end of this process, the organisational, company, and financial support allow you to start looking at how you would like your organisation to work and contribute to the development of an IS in your local area. How you establish your facilitating organisation is elaborated in part 2: Establishing the facilitating organisation ■

CHAPTER 3
FACILITATING INDUSTRIAL SYMBIOSIS
PART 2

The Facilitating Organisation

Building an identity

Choosing a business Model

Facilitating several stakeholders

The facilitator's skillset

Making a strategy
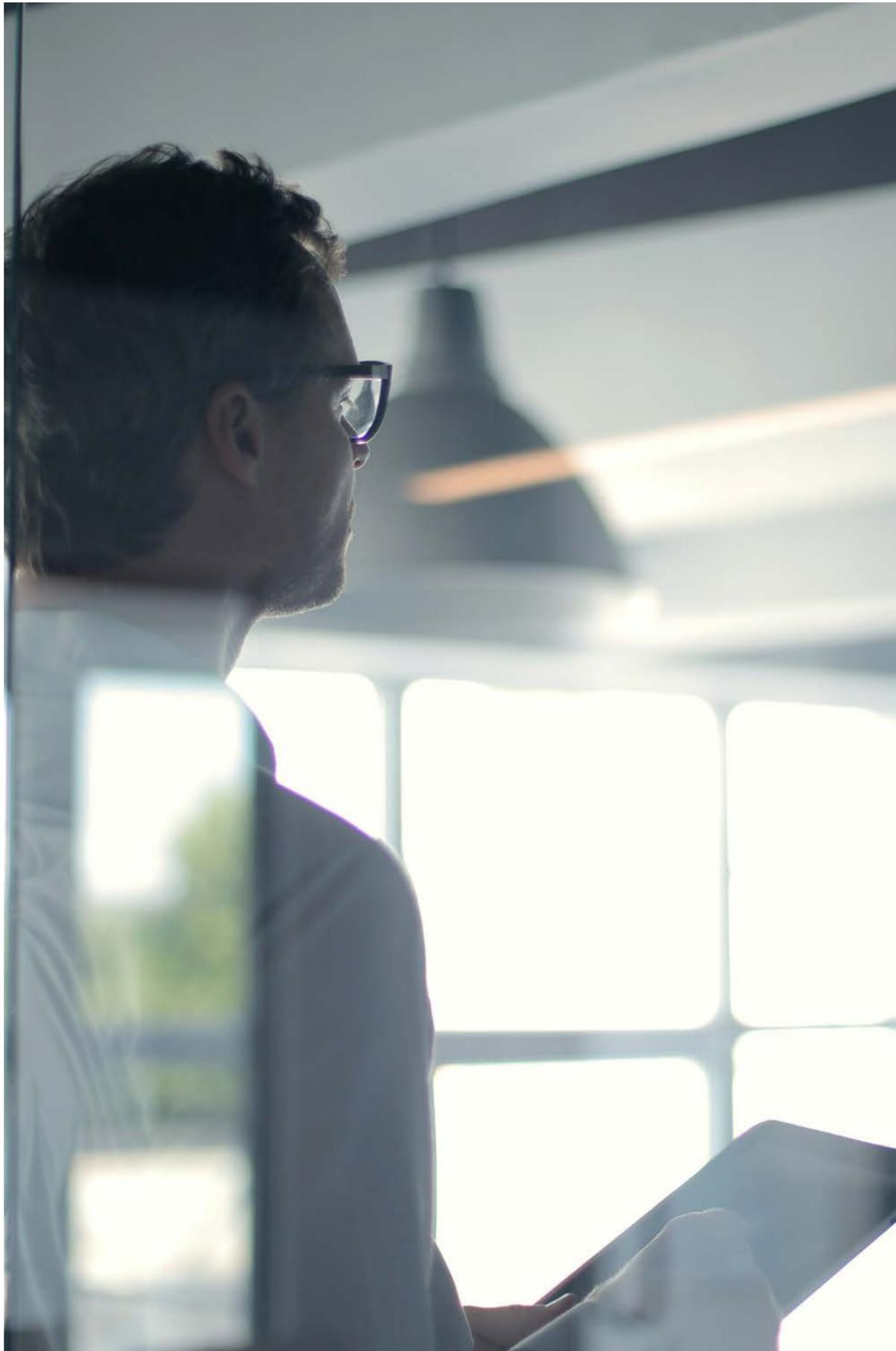
THE FACILITATING ORGANISATION

This part goes through various steps of establishing an IS facilitating organisation. What comes first in real life and how to structure the facilitating organisation, is dependent on the specific local and cultural context and room for manoeuvre in the mother organisation.

"

There is a massive call for realising the sustainability potential in industrial symbiosis, but if you don't have a project organisation to lead and coordinate the projects around symbiotic exchanges, it will not work.

Lisbeth Randers, Kalundborg Symbiosis

Building on the pre-emergence phase (see part 1), a decision has been made to dedicate time and resources to establish an IS facilitating organisation. Next is then to consider and specify the role, purpose, and organisational set-up of the facilitating organisation, as well as identify the necessary skillset. These aspects are often mutually dependent and overlapping, as seen in figure 2.1.

**Identity**

STRATEGY

Skillset

Business Model
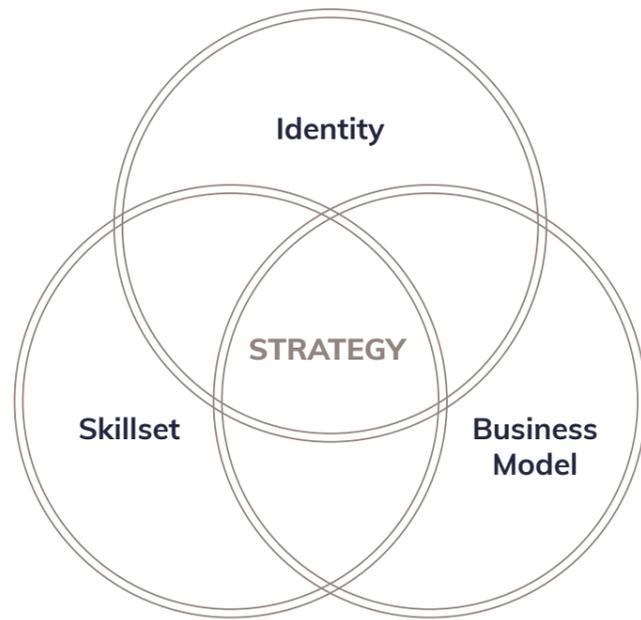
Figure 2.1
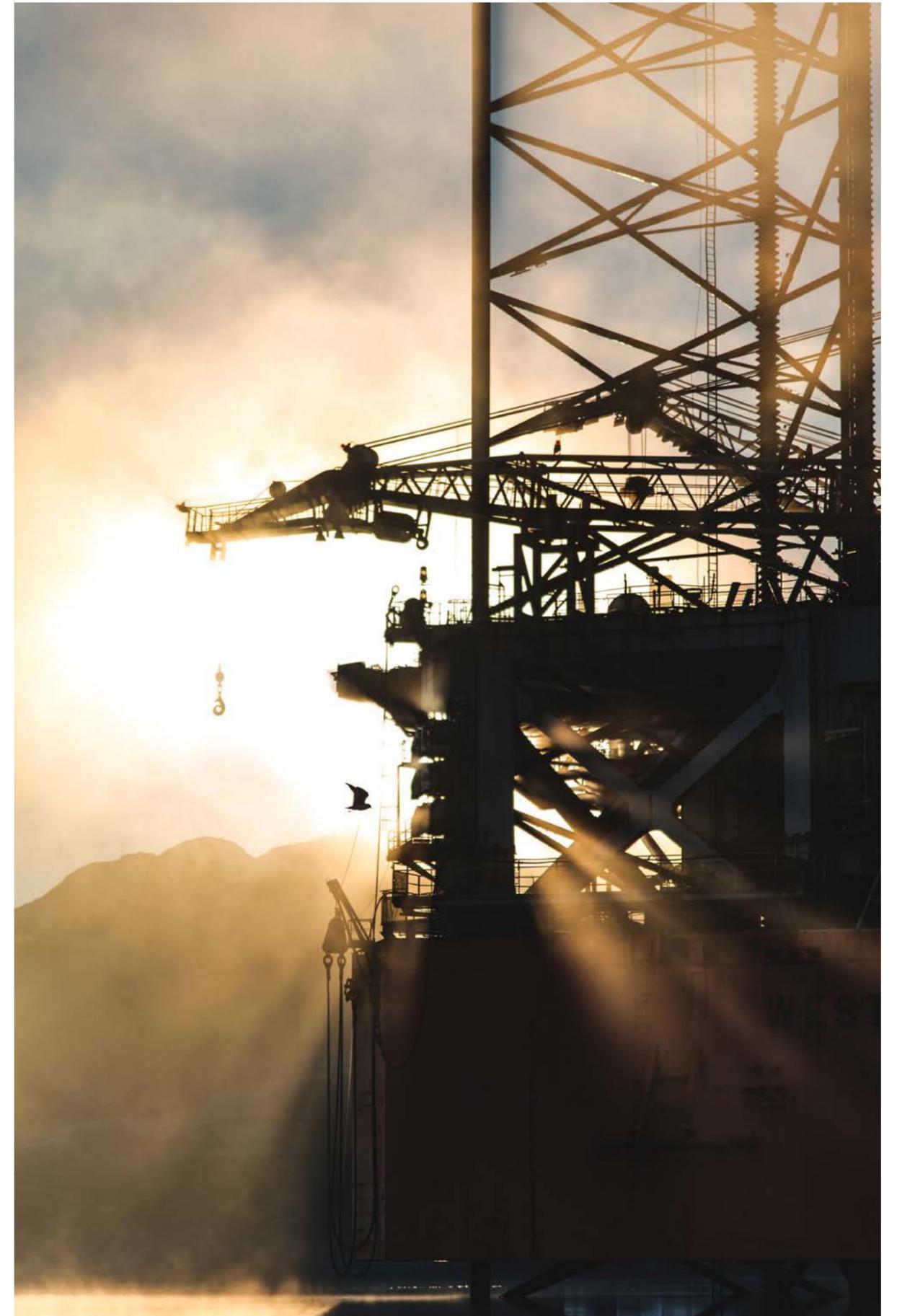
BUILDING AN IDENTITY

As with every organisation, a crucial part of the development is to create an identity, both to align internal expectations and communication and to be able to communicate and sell the idea of IS effectively to external potential partners and companies.

When building the identity of the organisation it is important to consider and define what the purpose of the organisation is, meaning; why the organisation exists, the mission statement, what the organisation offers, how it differentiates itself from other similar organisations, and to consider which stakeholders to focus on.

The topics mentioned in this part should be revisited throughout the lifetime of the facilitating organisation so that the organisation constantly remains relevant for companies, partners and is aligned internally. There is no timeline for when to revisit the topic. This could be done as part of updating the strategy of the organisation or it could be revisited due to new project possibilities, changes in society or other.

"

When you build the facilitating organisation it's important to know what you are offering, because to be able to sell something you need to know what to sell.

Per-Erik Sørås, Thams Industrial Cluster

Mission

The mission is a simple and clear statement that defines the organisation's purpose of existing, what it aims to achieve and how it aims to achieve it. It is therefore a useful tool to structure the direction of the organisation, and can simultaneously be used for external and internal communication.

Most IS facilitating organisations are, at least in the beginning, focused on the mission that secured them the financial and organisational support. The mission is therefore often aligned with the priorities and goals of the mother organisation. This could for instance be to use IS to support and strengthen local business development, create local jobs or to fulfill sustainability policies.

INSIGHTS FROM A BIS PARTNER

The mission of Thams Industrial Cluster is to strengthen the competitiveness of the local companies by facilitating and inspiring the green transition, and more specifically the transition to a circular economy. Overarchingly, the aim is to establish an IS where the members can be supported in innovation and the establishment of new collaborations.

The mission to create an IS derived from Trøndelag County Council due to an ambition to be connected closer to the local companies and to bridge local business opportunities with environmental concerns. The process of choosing the exact mission was however influenced by the need to differentiate themselves from other similar organisations. For instance, there was already a "business association" in the region, with a focus on industrial and regional development, including infrastructure and how the municipality can support industry development through other services. The initiators of Thams Industrial Cluster identified a gap and potential to differentiate themselves by focusing more on individual companies and company collaboration through IS.

CHOOSING A BUSINESS MODEL

The choice of business model and how the facilitating organisation is structured depend on whether it is a project entity as part of a public or private mother organisation or is established as an entirely new organisation.

In most countries, there are significant legal differences between public and private institutions, both in terms of which business models are available and which activities that are allowed to be offered. Depending on the legal association with the mother organisation, the facilitating organisation must follow the legal room for manoeuvre that the mother organisation complies with. In this case, the mother organisation has a direct effect on the available business model and how the facilitating organisation can secure funding, both for itself, and for the projects around IS. The organisation might change the structure later, however in the beginning the important thing is starting out.

"

There is no need to figure out the perfect organisational constellation from the beginning, as you will have to continuously adapt it to the changing reality.

Lisbeth Randers, Kalundborg Symbiosis

Type of organisation

When deciding on the business model it should also be decided how the facilitating organisation should be registered, or if it even should be. If the facilitating organisation starts as an internal project entity as part of a mother organisation, it might not be necessary to register it. Again, the choice of legal organisation is connected to the mother organisation as well as the financial expectations of the facilitating organisation.

There are different benefits and possibilities in terms of funding opportunities depending on whether the organisation is a public institution, private organisation, or business association. Discussing the possibilities provides an overview of the barriers and benefits of each. It is worth noting, that the possibilities of organisational structure might differ depending on the available legal set-up in your country.

Kalundborg Symbiosis started out organically and rather anonymously, and in the beginning did not have a facilitating organisation. However, in the beginning of the 90's, the attention around the industrial symbiosis had grown to a level where the companies could no longer facilitate it on their own. Consequently, the Kalundborg Symbiosis Center was established, under the auspices of Kalundborg Municipality.

From then on, the Kalundborg Symbiosis Center, later named Symbiosis Center Denmark, acted as a facilitating organisation that took care of visitors to Kalundborg Symbiosis, answered inquiries, and gave presentations both nationally and internationally. It was both responsible for the external communication and had the role as the secretariat for Kalundborg Symbiosis' board of directors. Having a public facilitating organisation which through base funding could make it possible to initiate, fundraise and facilitate projects, as well as to be responsible for external and internal communication, enabled the acceleration of the development of Kalundborg Symbiosis. In addition, being a part of a mother organisation, Kalundborg Municipality, allowed the facilitators to draw on competencies and structures, such as accounting and IT.

On the other hand, there were also some drawbacks from being part of a public institution. With the increased recognition and attention, the distinction between the Kalundborg Symbiosis and the facilitating organisation, Symbiosis Center Denmark, became confusing for many external actors. Further, being a public facilitating organisation limited the possibilities of applying for public funding. And when the funding was given, the facilitating organisation was subject to double auditing control, both from the funding institution and regulations around public institutions. Lastly, as the aim was to be closer to the companies, it made sense to be directly associated with companies, and not just facilitate the collaboration from another unit.

For these reasons, Kalundborg Symbiosis decided to restructure itself as a private association from January 2020.

These changes of the facilitating organisation of Kalundborg Symbiosis, shows how different types of organisations can answer to different needs of the IS, and that the organisational set-up can be revised throughout the life of the IS.

Funding

The facilitator's role of fundraising is twofold. It is both responsible for covering the base funding for its own operations, as well as assisting companies in applying for funding for the development and testing of new symbiotic exchanges. The two funding purposes are explained below.

1. Financially securing the facilitating organisation

In the beginning the most important finance to secure is the finance to cover the facilitating organisation. This is the most important since the facilitating organisation is the prerequisite to begin to facilitate an IS. One way of seeking finance is through national and international funding programmes. These programmes most likely require a level of co-financing either in cash or hours and therefore the organisation also has a need for a base funding. For this, some facilitating organisations start out by charging a fee from their member companies, whereas others can offer their services for free because the mother organisation covers the base funding. This relates back to the type of organisation that has been chosen for the facilitating organisation, since a public institution is often not allowed to charge members a fee.

2. Attracting funding to develop the IS

Funding is necessary when developing IS because it allows for the development and testing of potential symbiotic exchanges. This in turn provides innovation, branding and ensures a continuous competitive edge to the local IS and associated companies. National and international projects that the facilitating organisation can initiate or participate in could include funding for developing and testing symbiotic exchanges, which in turn continuously develops and strengthens the IS.

FACILITATING SEVERAL STAKEHOLDERS

"

Our most important stakeholders are the local companies, but we also want to be able to pass on a sustainable planet to future generations.

Evdokia Lomagina, Tyreman Group

The facilitating organisation has several stakeholders. Based on the definition of IS; "Physical exchanges of materials, energy, water, and by-products among diversified clusters of firms"[1], a naturally important stakeholder group are the broad range of companies in the local area. This includes both large, small- and medium sized companies, from different industries. Managing companies from such a broad range can be challenging, as different companies have different resources, realities and ambitions, but succeeding in including all of them is the key role of the facilitator and is what will contribute to innovative solutions and collaborations between companies that do not normally engage with each other.

Looking more in detail however, there are some considerations worth mentioning in terms of types of companies to target for successful IS development. An advantage, at least in the beginning, could be to look for companies that already have an interest in a focus on sustainability, or that has received relevant societal attention, as it can ease the persuasion phase and increase the chance that they will join the network[2]. Further, recruiting companies with somewhat similar worldview makes it easier to create a shared story and vision, and thus a stronger organisational culture and drive. This aspect will be further elaborated in part 4. Further, small-and medium sized enterprises are often in more need of a facilitating organisation, as they do not have the necessary in-house resources to work with projects that are outside of their core business activity, whereas large enterprises are more likely to have the internal capacity to dedicate time and resources to new projects. The main point is to focus on companies with potential, who are willing and able to contribute positively to the network. In the beginning however, the most important thing is to convince the first companies to join, to start the momentum for the facilitating organisation and for the creation of an IS.

Another important stakeholder is of course the mother organisation, that provides a base funding, for the facilitating organisation, as well as its associated stakeholders. The facilitating organisation must actively involve key decision makers from the mother organisation in determining the strategic direction of the facilitating organisation and the facilitating organisation should strive to make itself relevant and provide value to the mother organisation.

Besides these stakeholders, the facilitating organisation also has the role of gathering and distributing relevant knowledge to its network as well as communicating about IS through various media to stakeholders outside the network. Therefore, the facilitating organisation must always be updated on news going on internally between companies in the network and externally, both nationally and internationally. The role as the intermediary with the outside world will be further elaborated on in part 4: Ensuring the drive

To attract funding, create the network around the IS and to be able to realise and grow the IS, the facilitating organisation is responsible for interacting with and connecting academia, the public sector, private sector and civil society. This is also known as the quadruple helix, shown in figure 2.2.

Therefore, just as important as it is to involve companies there are also several external stakeholders that need to be involved as the IS develops. Engaging actively with all stakeholders in the quadruple helix maintains the relevance of the facilitating organisation and the IS as well as scaling both. The stakeholders are a key part of growing the organisation and the IS as they can contribute with funding, knowledge, marketing platforms, partners etc. Managing all the stakeholders is therefore a constant part of the facilitators daily work.
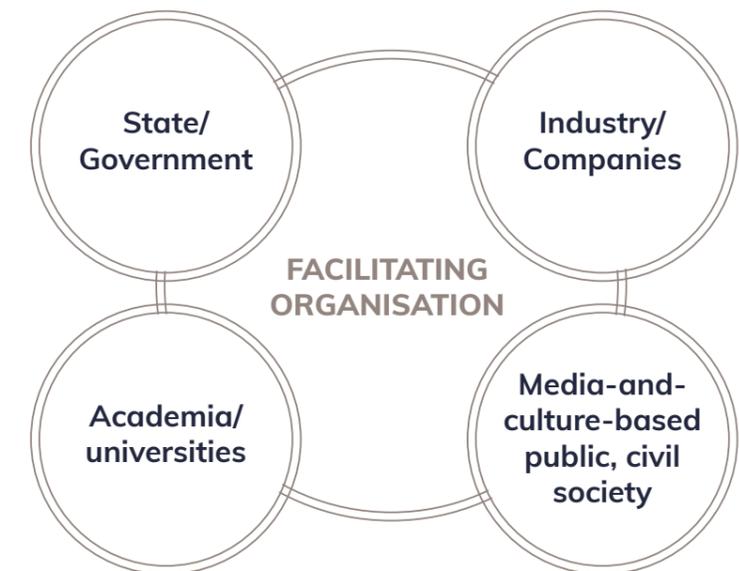

Figure 2.2

Digipolis, in Finland, is a technology center with a broad range of stakeholders. It is started by and owned primarily by the city of Kemi, as well as the cities of Simo and Tervola, and the University of Oulu. It is leading the industrial circular economy innovation platform in the Kemi-Tornio region, which is one of the key projects in the circularity roadmap for Finland, as well as being the leader of all eco industrial parks in Finland. Lastly, it is a founding member of the Nordic Industrial Symbiosis Network, and its network as a facilitating organisation spans worldwide.

Consequently, the facilitating organisation is operating on both local, regional, national, Nordic, European and international level, and across the quadruple helix. Coming back to the definition of an IS written in chapter 1, an IS is mainly about collaborations between local companies, and the main task of the facilitating organisation is about enabling collaboration and innovation between these companies. Additionally, establishing and supporting an IS is often also a direct consequence of local and regional policies. This means that the facilitating organisation needs to carefully manoeuvre the interests of its core stakeholders and other interessees and networks.

THE FACILITATOR'S SKILLSET

In general, the facilitation of IS is highly dependent on the human and personal characteristics of the facilitators. The role is varied, and spans from adopting an entrepreneurial approach to inspire and facilitate innovation, as well as to represent a stable and trustworthy management that upholds progress, by creating and maintaining trust and relations between companies.

Personality and Mindset

Regarding the value of having an entrepreneurial mindset, it is important to point out that being an entrepreneur is not necessarily a personality trait, or something one is born with. Rather, it is a style of management aimed at pursuing opportunities and drive change[3]. For instance, entrepreneurs are not content with leaving the world as they found it, but instead are focused on bringing people, money, ideas and resources together to build new organisations or change existing ones. Relating to the IS facilitator this characteristic comes across in the need to start or be a part of an IS facilitating organisation and establishing an IS, with the aim of combining business and environment. Further, the entrepreneur is always looking for the opportunity to do something differently and better, innovating in order to create new value, in this case looking for resource optimisation and opportunities for collaboration. Lastly, entrepreneurs have an eye for all aspects of the organisation, and how they all play a part in the overall mission. This is particularly necessary in the beginning of the facilitating organisation and in the beginning of facilitating the IS, especially if the facilitator is alone and therefore responsible for several positions.

In general, most facilitators are sociable, outgoing and enjoy connecting with people. This often comes with, or leads to, having a large network, which is crucial to be able to build the IS network and engage with various stakeholders. The knowledge of and familiarity with the local business ecosystem helps the facilitator identify, promote, encourage and engage companies to join the network. To be able to get most value out of the network, the facilitator should be perceived as trustworthy, and having a previous connection with the companies will be helpful in this regard.

When approaching new companies, the facilitator should think of him/herself as a salesperson, see table 2.1.

HOW TO BE A SALESPERSON

According to research, a good salesperson has both empathy and ego-drive. Empathy is the ability to put oneself in the shoes of someone else. Neurologically, it happens when the two parts of the brain work together; the emotional center perceives the feelings of others and the cognitive center tries to understand why they feel that way and how to help them. With empathy the salesperson understands the customer's situation (in this case the customer could be a company that the facilitator wants to persuade to be part of the IS) from the company's perspective and its potential and challenges. Consequently, the seller can change the approach to the customer according to the personal feedback that he/she gets. This enables a more fluid and reactive interaction, as opposed to following a pre-planned script. In addition, empathy is highly connected to cooperation, teamwork, and leadership, all valuable aspects of coordinating a network.

With ego-drive comes the personal need to sell, which in the case of facilitating an IS, is about convincing a company to join the IS. There is a connection between making the sell and the sellers confidence and self-esteem. This translates into a certain persistency, where although many will say no to the seller it will not discourage the seller, rather it will incite the seller to get a yes next time. This drive is what will close the deal, which in this example would mean that the company says yes to a visit, a screening or entering into into a project around establishing a symbiotic exchange.

The seller's mindset results in, or is complemented by, creating a personal connection, building interpersonal trust, and finding the specific business case for each company.

Table 2.1

Since IS is still a fairly unknown concept for many companies, the facilitator will benefit from being adaptable, imaginative, positive and having a can-do attitude. Furthermore, having a pioneering spirit and being risk-willing can be necessary to keep up the spirit and momentum needed, as IS collaborations may take time to form and the facilitator might spend time trying to facilitate a connection that in the end never succeeds. Being a team player, having fun and creating an ambiance of optimism and positivity between the companies as well as internally in the facilitating organisation will both create a great work environment as well as make the companies reach out again later on if they wish to revisit the IS potential. Developing a trustful and respectful relationship with the local companies also derives from a genuine interest in other people's work and reality.

Lastly, the facilitator must be willing and interested in discussing existing challenges and possibilities with companies and in the broader stakeholder network. A core mindset is to trust that solutions can be found within the network. It is important to be aware of environmental challenges and to be able to think about symbiotic potentials to counter environmental challenges and to put these into a business context [4].

> "
> **We've been called cowboys, as we are not afraid of risk, have a pioneering spirit and work a little outside the box.**
>
> Michael Elgaard, Ressource City

Qualifications

The facilitator does not have to be an expert or specialised in the detailed practicalities of resource sharing, technology and innovation. The facilitator can be both a generalist and a technically proficient person. Both will have advantages in developing the IS. For example, the technically proficient person with knowledge of technology, chemistry, process engineering or similar fields will be able to act as a technical sparring partner for the companies. On the other hand, the business proficient person will be able to cater to the business- and strategic potentials.

> 66
>
> # When the facilitating organisation starts out you don't have to have all the competencies in-house. Instead, you can buy them externally and with time get them in-house.
>
> Lisbeth Randers, Kalundborg Symbiosis

Again, the most important is to be open, proactive and to create and maintain trust and relations among stakeholders. Speficic technical- and business skills can always be covered by using external consultants if they are not in-house, such as modelling and calculating new business models[5] or understanding technical specifications for resource matchmakings. Universities can also be involved and potentially mobilise students, who can for example map the local business environment for IS potentials.

Whether being a generalist or a technically proficient person, having at least and overarching understanding of symbiotic potentials increases trustworthiness as a competent and realistic facilitator, as well as enables the facilitator to see possibilities, solutions, and relevant symbiotic matches, which the companies do not necessarily see themselves. In addition, the facilitator should be able to fulfill the role as a fundraiser, project leader and understand project management.

In terms of organisational support, the mother organisation can potentially provide basic services such as IT support, accounting, external communication, and marketing, depending on the organisational structure. Despite not necessarily having the luxury to be many in the team in the beginning, it is important to at least have someone to spar with and with whom to combine competencies. This could be through a colleague, a mentor, and/or an advisory board.

As there is an increasing focus on IS in the EU and globally, there are repeatedly projects aimed at improving and developing the field and the people working with it, such as facilitating organisations. The partners of the BIS project are likely to be updated on relevant courses, mentoring or organised knowledge exchanges within the field, and are open for requests.

Advisory board

As mentioned above, it can be benefitial for the facilitating organisation to establish an advisory board.

Some of the advantages of an advisory board are that they contribute with their own knowledge and network and can be a part of advocating IS and the facilitating organisation to other stakeholders. This in turn provides the facilitator with key competencies to draw from in the development of the facilitating organisation as well as the IS.

The advisory board could be a group of stakeholders from the local community and could represent companies, policy makers and/or other relevant organisations.

Moreover, the facilitator might find a champion in the advisory board (see part 1 table 1.3), who can contribute with introductions to local companies, policy makers or other organisations and thereby validate the concept of IS and the facilitating organisation.

The facilitating organisation is responsible for determining the structure such as how often the advisory board should gather and how much time the board members should spend. It is the facilitator who coordinates, leads, and facilitates the meetings.

When developing the strategy for the facilitating organisation, the facilitator can make use of the advisory board and use these competencies to help determine the strategic focus and goals. Involving the advisory board in the strategic development ensures their ownership and continued willingness to help the facilitating organisation.

MAKING A STRATEGY FOR THE FACILITATING ORGANISATION

“

You need to come up with a strategy because if you don't have one, you are kind of lost. A strategy gives you something to hang on to and gives you a direction to choose one thing over the other.

Paul Nemes, Paper Province

Creating a strategy is a way to tie together the sections previously described in this part: identity, business model, and competencies (see table 2.2).

IDENTITY	BUSINESS MODEL	SKILLSET
The identity of the facilitating organisation describes why the organisation exists, the mission, what it intends to offer, how it differentiates from other similar organisations and the most important stakeholders of the organisation. The choice of identity is often a result of the focus areas and ambitions of the mother organisation.	The business model concerns the legal structure of the organisation, and how it will secure both base funding and project funding. The choice of business model is a consequence of the legal setup of the mother organisation, which also affects the possibilities of applying for funding.	Skillset is both the facilitators personality and mindset, which is needed when establishing IS and the internal qualifications of the facilitating organisation.
STRATEGY The strategy connects the three aspects of the facilitating organisation; identity, business model and skillset and gives the facilitating organisation a direction to follow and goals to fulfill.		

Table 2.2

The strategy for the facilitating organisation can be used for external communication as well as be a part of creating an internal direction, which can make it easier to follow a particular direction and make decisions.
In rapidly changing situations, such as the beginning of an IS, it can be valuable with a short-term adaptable and flexible strategy[6]. As the facilitating organisation becomes more established it might be better with a strategy with goals for a longer period, for example a four-year period. This is a timeframe that will allow the facilitator to achieve the goals and gain momentum to build on for the next four years. Reviewing the strategy after four years allows for a dynamic organisation that can change parts of the strategy to align the organisation with the surrounding environment and thereby continue to be relevant and stay innovative.

Another strategy to be developed is a strategy focused solely on the development of the IS, this particular strategy will be elaborated on in part 4 ▪

INSIGHTS FROM A BIS PARTNER

Ressource City was established in 2015 as a city development project aligned with the circular economy. The strategy for the project was based on three pillars: innovation, knowledge, and inspiration. In 2016, the strategy shifted towards also including circular business development. In 2020, Ressource City updated its strategy, to adapt to the developments of the projects and its stakeholders. The strategy was developed in collaboration with the advisory board and a political working group and built on what worked in the previous strategy. The new strategy is based the three pillars: growth, value, and knowledge. Each pillar is connected to different areas: growth, value, and knowledge for the local businesses, value and knowledge for the region, and knowledge for the international arena.

This way, the facilitating organisation aims at balancing the needs of different stakeholders in its strategy.

# CHAPTER 3
FACILITATING INDUSTRIAL SYMBIOSIS
PART 3

Establishing Symbiotic Exchanges

The innovation process and the facilitators role

Identifying the problem

Inventing the solution
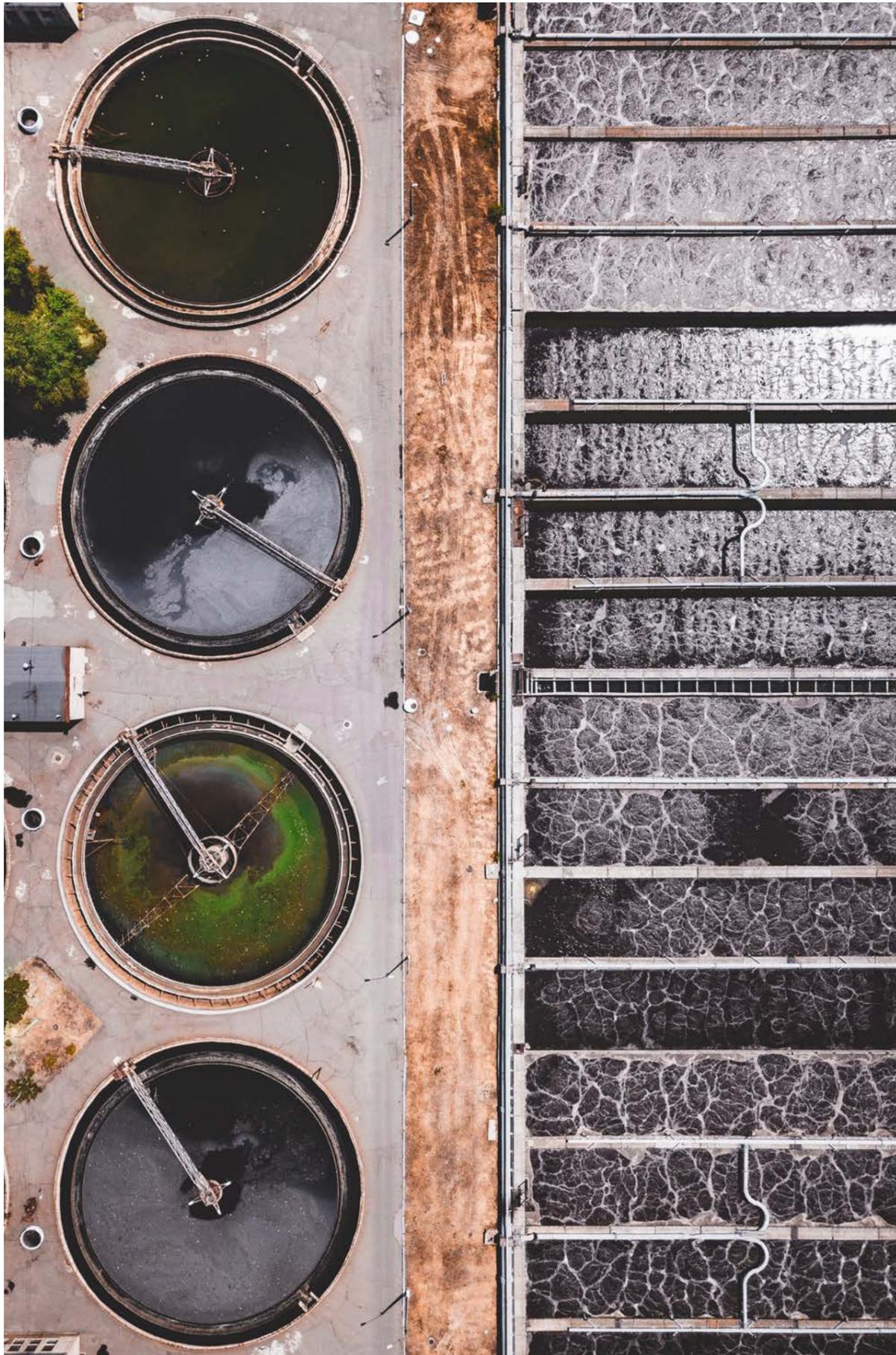
ESTABLISHING SYMBIOTIC EXCHANGES

This part clarifies the process of establishing symbiotic exchanges between companies, by describing how a symbiotic exchange emerges, while highlighting the role of the facilitator.

Recalling from chapter 1: A symbiotic exchange is a resource exchange among two or more companies, in which one company's waste is another company's resource. The companies are often from different industries, although in close geographic proximity, and the exchange can include resources, such as energy, materials and water. When several symbiotic exchanges are connected in a network, it is considered an industrial symbiosis network. Such an industrial collaboration has the potential to result in economic, social, and environmental benefits (see chapter 1)[1]. In a successful IS, new projects and partnerships around current and new symbiotic exchanges are continuously established.

As seen in figure 3.1, and as will be clarified throughout this part, the process starts with enabling idea creation both in dialogue with individual companies, through dialogue and resource screenings, and through networking events amongst several companies. Then, the realisation of the idea is supported by the facilitating organisation through matchmaking, conducting research and obtaining funding. Successful implementation of symbiotic exchanges has a positive impact on the creation of new exchanges, and the overall embeddedness of the network, creating a reinforcing mechanism.

This process has been depicted by several organisation in the field of IS. One example is the Symbiosis Readiness Level developed by Kalundborg Symbiosis to show how a symbiotic exchange develops through 9 steps (see Insights from a BIS partner below).

INSIGHTS FROM A BIS PARTNER

Kalundborg Symbiosis has developed a "Symbiosis Readiness Level", in order to validate the process for specific industrial symbiosis projects, ultimately leading to resilient partnerships.

1 **The good idea** is developed through pre-feasibility studies, based on knowledge from best available technology, local knowledge and understanding of the underlying concepts of IS.

2 Then, **local resources are mapped**, as well as existing collaborations, external stakeholders and environmental issues, both qualitatively and quantitatively.

3 **The screening is completed** when potential companies are analysed for resources and motivation, both qualitatively and quantitatively.

4 The idea then goes through a **proof of concept,** where the business model is validated, the practicalities are tested, and relevant legislation, taxes and policy, are taken into account. This leads to a pre-commercial agreement between the partners.

5 Then, the project's **sustainability assessment is finalised,** by analysing the impact on the Sustainable Development Goals, resources and the environment.

6 The last step before commitment, is the **system qualification,** including the final tests for low-rate production, and the verification of compliance with all obligations, certifications and standards.

7 The partners are then ready to **commit** to the full-scale realisation of the project and develop a common communication strategy.

8 The project is then ready for **commercial production**, including a commercial agreement.

9 The success of one project around a symbiotic resource exchange then contributes to the **resilient partnership**, meaning a robust, dynamic, and "organic" network, which in turn allows for more symbiotic exchanges to be developed.
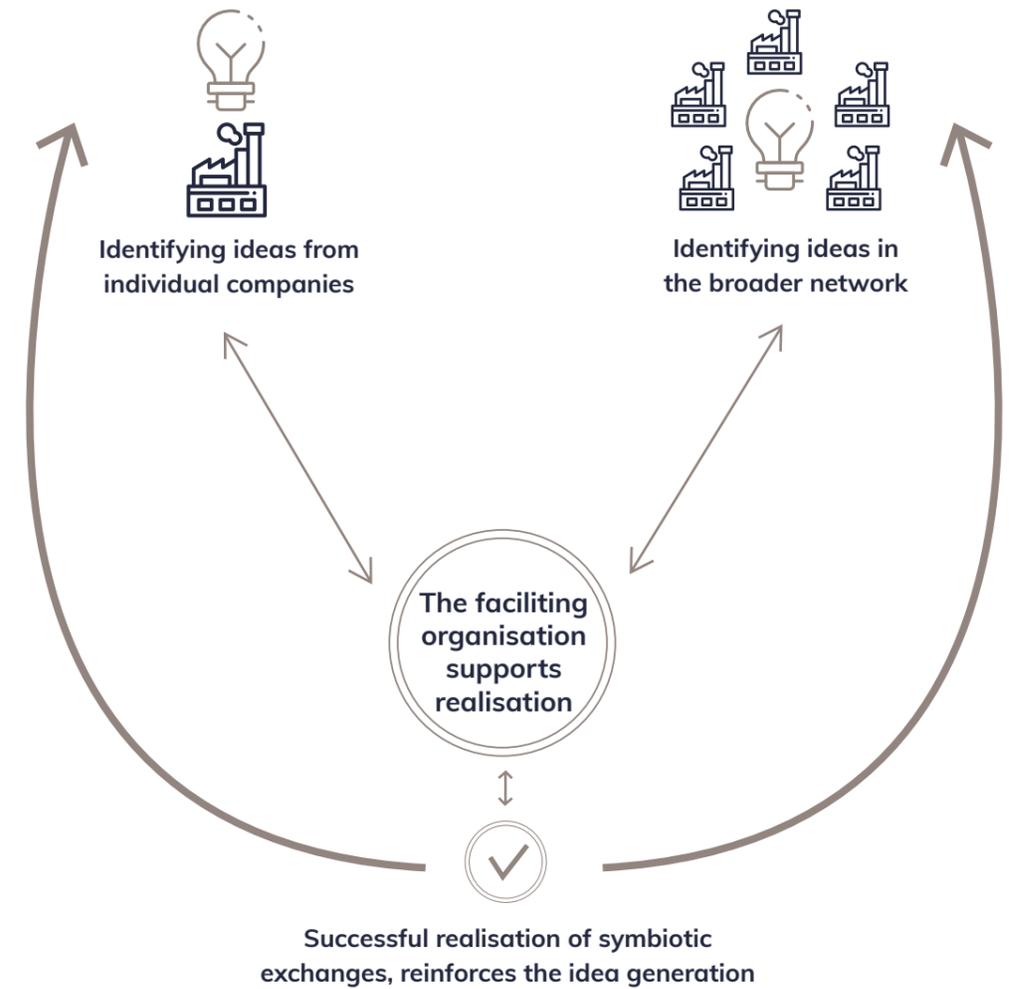

Figure 3.1

THE INNOVATION PROCESS AND THE FACILITATORS ROLE

Since the collaborating companies in the symbiotic exchanges and IS network are from different industries that do not normally collaborate, the process of discovering new symbiotic exchange potentials, resembles that of an innovation process.

Innovation might seem to occur by chance and coincidence. Although the innovation process in many ways is an unpredictable journey into the unknown, innovations are not necessarily accidental events that are unplanned, nor unmanageable (see info box 3.1.). On the contrary, innovations can be facilitated, and the odds for success can be improved[2].

Info box 3.1

Taking inspiration from the technological innovation processes, laid out by Stanford department for Bio-design (See figure 3.2), the innovation process for symbiotic exchanges is found to follow these steps: 1) Identifying the problem, 2) Inventing the solution, and 3) Implementing the project[3].

The facilitating organisation can contribute to the entire process, however most facilitating organisations are not actively part of step 3; the implementation. As such, this guide describes the facilitators' impact on the first two steps, by creating an environment that increases the chance that a potential symbiotic exchange can be identified, and next, creating an environment where the solution can be invented[4], while the third step is not described in this guide. Although the facilitating organisation is often not involved in step three, the facilitating organisation can use the successfully implemented project to inspire new projects and for internal and external communication purposes (See part 4: Ensuring the drive).

Despite the rather linear visual representation in figure 3.2, the journey is not straight forward. It is characterised by multiple iterations, and the borders between the phases and stages are fluid. Further, since an IS preferably consists of many projects around symbiotic exchanges running at the same time, the facilitating organisation needs to parallelly support several processes at different stages. This means that the facilitators need a decent proficiency of project management, as well as the ability to juggle several tasks and projects simultaneously (See part 3: Establishing the facilitating organisation).

Phase 1: IDENTIFY

1.
Needs finding

2.
Needs screening

Phase 2: INVENT

3.
Concept Generation

4.
Concept Screening

Phase 3: IMPLEMENT

5.
Strategy/ Development

6.
Business Planning
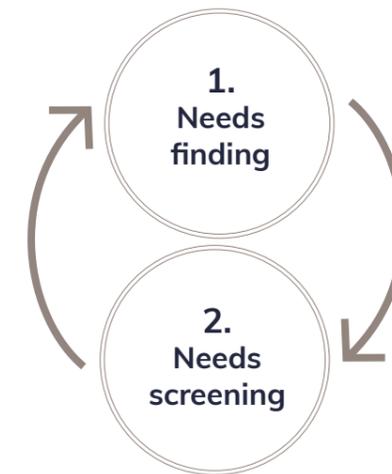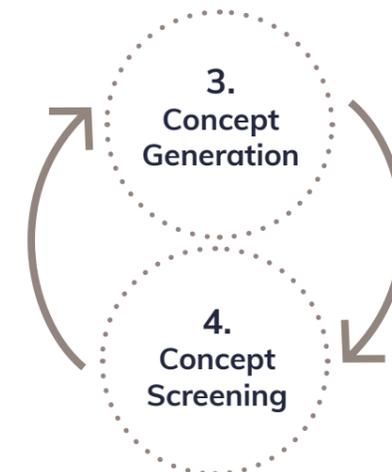
Figure 3.2

IDENTIFYING THE PROBLEM

Innovation starts with the insight that there is a problem waiting to be solved, or a need not yet fulfilled. Identifying the problem, starts with creating awareness around the potential of IS and symbiotic exchanges. This is done both with individual companies and the network.

Creating awareness for symbiotic exchanges

Most companies focus on their core activities and might be sceptical about the potential of cross-industry resource collaboration. The realisation that there is a problem to be solved or a potential to do something different, therefore depends on the companies' awareness of the potentials in resource optimisation and sharing. Starting with creating such awareness of IS is therefore preparing the field for identifying a potential symbiotic exchange.

In the beginning, when the awareness is low, there is no need to talk specific waste stream potentials and practicalities with the companies, as what counts is their opinions, perceptions and understanding of IS in general[5]. The very beginning of establishing a symbiotic exchange, is therefore often rather long. The facilitator must spend a considerable amount of time talking about IS and simply making companies familiar with the concept and interested in the potential of the idea.

There are two elements that are essential for creating the awareness of and belief in IS: approach & arguments, which are detailed below.

Approach

When establishing connections with local companies, it is not the companies that agree to hear more about IS and the facilitating organisation, but people from these companies. Therefore, it is the individual representatives who need to be convinced before the idea can be introduced to others in the company and potentially formalised as a company commitment.

The most powerful approach at this point is therefore not technical arguments, but people skills. Motivating people is a complex process, which needs to be sensitive to personality and situation. Different companies, and their employees, are likely to have different levels of understanding of the concept of circular economy in general and IS in specific, as well as the environmental impact of their own company and industry. The approach therefore needs to be adapted to their personal starting-point, mindset, and industry. Especially important is to keep in mind what the company

can gain from the situation, and what role it may play in the overall vision of the IS[6].

As mentioned in part 2: The facilitator's skillset, approaching a company requires a seller's mindset. The representative from the facilitating organisation is selling the concept, the idea, and the potential, and should transmit a business knowledge and an understanding of the companies' point of view.

The companies are likely to be sceptical towards the facilitator's ability to take the concept of IS from theory to practice. Entering these types of projects is a serious commitment for the individual companies, and they therefore need to be convinced of the concept and business case before they want to explore potential solutions.

Moreover, for the company representatives to take the idea into their organisation and start formalising the company commitment, trust needs to be built. The company needs to trust the facilitating organisation as a competent partner, and the potential of symbiotic exchanges to produce real life benefits. In general, companies that already have a personal connection to the facilitating organisation, are more likely to be open minded, which is why a large personal network is a benefit as a facilitator. In addition, actions say more than words, and it is therefore critical for the reliability of the facilitating organisation, that promises are kept, and that the approach is proactive and consistent. The reliability of the facilitating organisation is not something that can be quickly achieved and will have to be shown repeatedly. Visiting the companies tells them that developing an IS is in fact a real offer, that the commitment and interest in their potential is solid, and that the facilitating organisation is willing to work hard for the symbiotic exchanges and to create an IS network.

Arguments

When the more general understanding of IS is established, the dialog with the companies can benefit from more specific arguments.

There is an increasing belief in and awareness of, climate change and environmental degradation in society. Consequently, there is an increasing focus on how companies can and should contribute to creating a sustainable future. The discourse of resource efficiency and circular economy has grown so strong that companies are beginning to feel a need to deliver on this agenda[7]. Oftentimes, companies are in fact looking for a way to contribute but are lacking the time and knowledge of solutions. The facilitating organisation can therefore argue that becoming a member of an IS is a way to work towards their desired sustainability ambitions.

Although an increasing amount of companies state their concern about

climate and environment, the business case tends to have the last word. As such, connecting the environmental argument to the business case is important. Research shows that working on sustainable initiatives increases sales and recognition[8]. Further, symbiotic exchanges are associated with saving costs on raw materials, saving costs on waste management, potentially creating income based on waste as a resource and improving resilience towards resource scarcity and volatile resource prices. Lastly, research shows that companies that are active in clusters are more attractive for talent, more profitable and innovative[9]. Engaging in an IS can therefore have a positive impact on the bottom line.

Pointing to success stories from other IS and similar companies as well as local examples, can communicate and simplify the above arguments, and thereby strengthen legitimacy and trust in that symbiotic exchanges are in fact realistic and beneficial.

> "
>
> # One of the goals of being a partner in the BIS project is to create local symbiotic exchanges, which we can use to convince more local companies that IS is in fact a good business case.

Nikita Lomagin, Tyreman Group

A convincing tool to use is to show the concept of IS visually from the very beginning. Even before any symbiotic exchanges have been established, the facilitating organisation should prioritise developing visuals. As Lynell Burmark puts it; *"Our brains are wired for visuals"*[10]. The visual can for instance be of the companies in the region, an overview of the resources leaving or entering the region, or the flow of job creations. In this way, the visual will communicate what is currently happening in the area and this can be used by the facilitator to convince companies and other local organisations of the need for developing symbiotic exchanges. Oftentimes, universities are capable of supporting and developing such overviews. However, making the visual should not be regarded as something that needs to be done profesionally from the very beginning. The most important is to communicate the idea, as seen by this "basic" drawing of the symbiosis map, made by Symbiosesenter Sötenæs, see figure. 3.3

This visual will naturally change as companies join the IS. At that point, the visual should rather be focusing on the established symbiotic exchanges, no matter how few they are. The visual is used to develop, grow and communicate the IS (see part 4: Communicating the results). As such, the first visual becomes part of the common story of the IS (see part 4: Common Story).
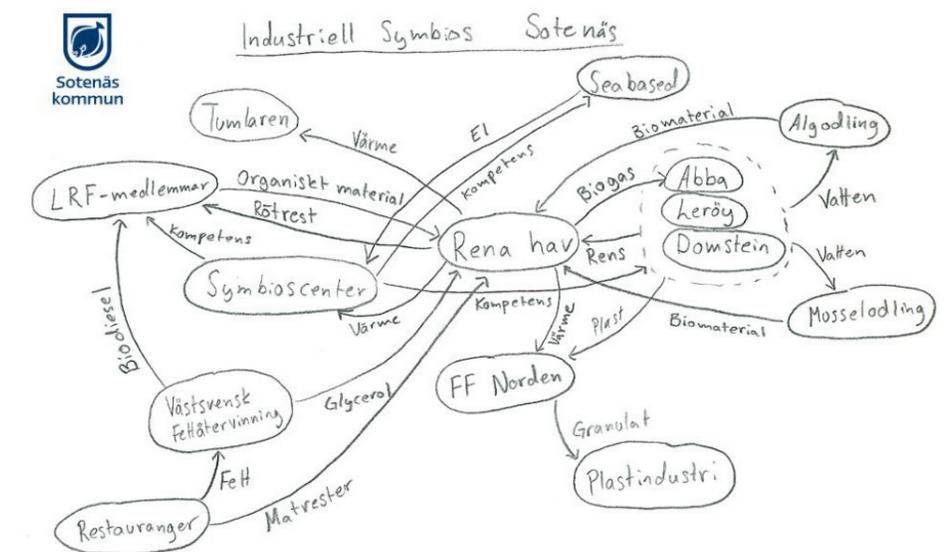

Figure 3.3

The Thams Industrial Cluster was established in 2018, on a combined initiative from the regional county council as well as local industry. The establishment was however prepared and enabled by several years of work by both parties, including gathering experience, raising awareness and initiating the conversation about IS in the region. Parts of this preparation was a collaboration with students from the local university, who were tasked with mapping the region's resources by the county council in the summer of 2017. More specifically, and what proved powerful in the following dialogue with the local industry, was that the map focused on how most of the resources were leaving the area, and as such constituted a loss of potential value. Visualising the flow of resources specifically for their region, made a strong and concrete proof of the potential for resource optimisation and symbiotic exchanges, and the potential benefit for the companies in collaborating about resources. The facilitators experienced that having the visual overview eased the communication to companies significantly. The map is shown below, and the green arrows pointing upwards towards the globe, signifies the resources leaving the area.
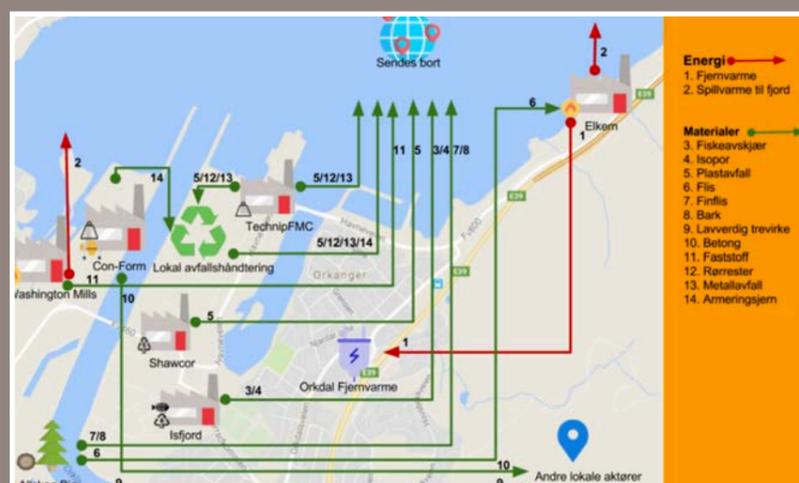
Facilitating the emergence of ideas

When the initial interest and curiosity towards the potential of IS is established, the facilitator can start creating a beneficial environment for more specific ideas to emerge[11]. There are (at least) two tactics for enabling the emergence of ideas: working directly with individual companies and facilitating broader networking opportunities for a range of companies. What is often found, is that the two are mutually reinforcing. These two tactics will be described below.

In the beginning, the easiest is often to focus on individual companies. With time however, and when companies are starting to collaborate in an IS network, the emphasis can shift towards organising networking events. Through 'organised interactions', the facilitator activates the exchange of knowledge and strengthens relations among companies, public bodies and other actors[12]. Moreover, when several companies in the local business ecosystem are collaborating in the IS network, less time is spent on advocating for the concept of IS, as the local companies are familiar with the concept. However, introducing and explaining the concept to new potential companies and to refresh the story and concept of the IS to external organisations is necessary throughout the lifetime of the IS.

Identifying ideas in individual companies

In the beginning of identifying ideas in individual companies it might be beneficial to start with identifying the companies with a higher potential. These can be identified through desktop research and performing resource screenings.

Companies with high potential can both be those already engaged in symbiotic exchanges[13], and those within resource intensive industries. There are many ways to identify and get in contact with companies, and the facilitating organisation is advised to be creative and open minded. Examples could be to:

1   Make use of the facilitators personal network and connections. This is found to be the most effective way to get in contact with companies. This points back to the benefit of having a large network.

2   Connect with organisations with company insights and connections, either the local business council or public departments that can provide access to the local industry or organisations that own areas with industry, for example harbours. These are likely to be familiar with the local companies and know which will be affected in the

case of new policies and regulations, and who are likely to be open to new ideas, such as symbiotic exchanges.

3   Make use of academic institutions and collaborate on mapping local resource flows as a way into the companies.

4   Pay attention to the local business environment through local newspapers and organisations.

5   "Cold calling" is also possible, although harder.

The first contact is advised to be dedicated to simply raising awareness about IS and translating what is going on elsewhere in society, to spark the company's curiosity. It is recommended to arrange physical meetings to ensure a personal connection and the chance to create a sense of familiarity. This builds personal trust in the facilitator and is an opportunity to communicate the potentials of IS. It also allows for a better understanding of the company and shows a sincere interest in their everyday work. Small talk is good and even crucial, creating the space and opportunity to listen to their challenges and needs. Lastly, talking in person is likely to increase their sense of responsibility towards you and the project. When the relationship is sufficiently positive, it is time to move on to the resource focus, however, it is important to note that the first meeting could also involve a screening, depending on the prior knowledge of and introduction to the company representative.

Screening and upholding the conversation

When a potential company is identified and contacted it is advised to do a screening of its resource consumption and disposal. This creates an overview of the resource use for the company, is a way for the facilitator to have an honest talk to the company about resources and is the foundation for identifying the problem, thereby finding the potential for optimisation and future symbiotic exchanges.

Most companies are unaware of the actual extent of their resource consumption. A screening contributes with this aspect for the company. In addition, the screening can encourage a conversation about the company's approach and view of sustainability and priorities in general, as well as shed light on coming regulations, policies, and changing needs from suppliers. See info box 3.2 about a screening tool developed by Kalundborg Symbiosis that can be used.

SCREENING TOOL

Kalundborg Symbiosis and Symbiosis Center Denmark have created a screening tool that facilitators can use to get an overview of the flow of resources in and out of a company. The screening tool requires the company to find data on the amounts and associated costs of resources. The facilitator uses the screening tool to go through energy, materials, water usage and waste generation. Besides tracking energy, materials and water, the screening tool is also a tool for dialogue, since it guides the facilitator through questions relating to the company's ambitions with sustainability and interest in potentially collaborating in symbiotic exchanges.
After the screening, the facilitator turns the data and dialogue from the screening tool into a report in which the facilitator recommends next steps for symbiotic exchanges for the company. A follow up meeting is scheduled in which the facilitator and the company go through the results of the report and from there they can determine the next steps forward towards symbiotic exchanges.
The screening tool is available as open source. Access to the screening tool template and a supporting webinar, can be granted by contacting Kalundborg Symbiosis.

Info box 3.2

The screening tool is a way for the facilitating organisation to structure and systemise the approach to companies and gives an overview of resource input and output. Using the screening tool gives the facilitator a method to approach a company and get an overview of its resources. This can then be used to start match-making companies based on resources. The facilitator should be aware that the companies are asked to share potential confidential information. Therefore, the facilitating organisation should have a way of storing the data from the screenings and a professional approach, when matchmaking companies afterwards.

By using a screening tool, the facilitator can "ask the stupid questions", which is important to challenge the ways things have always been done in the company that the facilitator is screening. Further, the facilitator can be the neutral part that simply facilitates the screening, without being experienced as being criticising the company. To do the screening it is an advantage to have technical knowledge of potentials with energy, materials, waste and water. Lastly, using a tool, which has been tested by other facilitating organisations, can provide legitimacy and increase the trust from the companies that are screened.

Remember that the aim with the screening, is not necessarily to identify a solution for resource optimisation. At this stage, the aim is rather to identify flows of resources, the company's challenges and ambitions with particular resources and sustainability. Later on, the identified challenges might be turned into potentials as they are investigated and hopefully solved in collaboration with other companies or experts.

Once a screening has been made, it is important to follow up to create trust in the facilitator. Do not be afraid of being persistent, and do not be put off if the process is slow and feels uphill. Remember that companies can be reluctant to embark on a new initiative, let alone one that requires cross-company collaboration.

Lastly, by doing screenings of the different companies in the network, the facilitating organisation builds up an overview of who the companies are, what they do, their production processes, challenges, and potentials. This is valuable knowledge for the facilitator and is useful for matchmaking companies based on resources, specific problematics, or specialised networking.

INSIGHTS FROM A BIS PARTNER

All of the BIS partners that are facilitating organisations have conducted screenings with their local companies. Some of the key learnings from these were:

1 In order to successfully mobilise companies to a screening, a range of communication strategies can be relevant, such as information on local websites, articles in newspapers and journals, and through local stakeholders and networks.

2 The screening tool can be used both virtually and in person. Using it virtually can save time and expenses related to transport and ease the coordination with the companies. It is however encouraged to also meet in person, to support relation building and enable the gathering of more detailed data from the production facilities.

3 The screening should be detailed enough to create a wide foundation to build on when identifying potential symbiotic exchanges or resource optimisation. The facilitating organisation should not overlook the potential for internal reuse and recycling.

4 The facilitating organisation should be prepared for rather technical and industry/company specific considerations, in order to identify potential symbiotic exchanges.

5 Many companies do not own the building they are operating in, which hinders the realisation of building related optimisation. The facilitator should therefore strive to know this in advance, in order to be prepared to focus on other potentials for symbiotic exchanges.

6 An important part of obtaining the company's interest, is to argue for the business case and the potential for financing the implementation. The facilitating organisation should therefore be familiar with possible financing options.

7 The cost of waste handling might be too low to constitute a financial incentive.

8 In order to obtain sensitive information, the facilitating organisation needs to create trust, and be in regular contact with the companies.

9 The screenings are a good time to introduce the possibility of matchmaking events, and the facilitating organisation should therefore have knowledge about other companies in the region, to be able to identify potential symbiotic exchanges.

Symbiosis Center Denmark has gathered all the learnings in the "Concluding summary report", which can be found by contacting Symbiosis Center Denmark.

Screenings do not need to be the only topic of the connection with the companies. Simply calling or visiting on a regular basis, to ask how they are and what they are working on, upholds the connection and trust with them, as well as a short mental distance to the facilitating organisation. It thereby creates a space where ideas can be brought up informally and allows a revisit of previous discussions. Even if a previous screening did not result in a concrete project, things are likely to change, and revisiting the company and the topic can get it off the ground at a later point. Or the company might reach out to the facilitator outside of a planned meeting, because of the created trust.

Identifying ideas in the broader network

Although the facilitator identifies the problem in individual companies, the facilitator needs to connect this to other companies in order to create symbiotic exchanges. This can prove challenging, as most companies are not aware of what their neighbour is doing, and do not see their waste materials as alternative sources of input to their neighbour's production. Consequently, the problem-solving part of the innovation process (figure 3.2.), requires a collaboration between several companies. Research shows that for success in innovation, individual creativity and intelligence matter far less than connections and networks[14]. The focus should therefore be to facilitate an environment that allows people to be innovative, see info box 3.3, for more information on creating and facilitating innovative teams.

The IS network has the potential to be a platform for collaboration around innovation, being a network of companies. Creating a network with successful collaborations and innovation capacity is however a long process, as the facilitator needs to turn it into an *embedded network,* characterised by unspoken connection and familiarity between the companies. Establishing such a tight knit network might seem overwhelming. However, it starts with the facilitating organisation bringing companies together, preferably in an open and informal setting[15], which allows for the creation of relationships and communication between the companies. Following this comes the circulation of knowledge and the formation of relationships, which in turn creates an embedded network[16] (see figure 3.3.).

Info box 3.3

Creating an embedded network

It is an advantage if the companies already know each other, for instance from past collaborations, and therefore have already developed trust and familiarity. However, this is no guarantee for innovation, as it can depend on timing and the ability to leverage the existing relationships in a new way by the facilitator[17]. The facilitator can contribute to the necessary setting by creating a more laid-back atmosphere, that opens for more topics than strictly business.

The spread of knowledge and the creation of relationships is ensured by communication, relations, and exchanges between the members, coordinated by the facilitator. When successfully monitored, it leads to the rise of unspoken connections and familiarity between the companies. This results in an embeddedness of the network, which is characterised by:

> **Short mental distance** which implies a social proximity with each other and one another's products and processes, that makes it possible to have one another in mind in case new ideas or possibilities for resource sharing or collaborative projects come up.
> **Fine-grained Information transfer** which refers to communication that takes place between the companies without the facilitator necessarily facilitating the communication. As such, a level of network has been built among the companies, in which they can discuss company strategy, long-term visions and potential collaboration. Such a level of communication eases the long-term planning and collaboration[18].
> **Joint problem-solving arrangements** which refers to mechanisms and set-ups that allow for more flexibility and adjustment throughout the process of collaboration, but also the possibility of learning to collaborate, which is important to create a cooperative culture[19].
> **Trust** is defined as "the belief that an exchange partner would not act in self-interest at another's expense"[20]. In an IS, this refers to the possibility for the actors involved to have an understanding of the common value that can come out of the collaboration, to be able to define common goals, and that there is a consistency between expectations from the collaboration and the other companies' general commitment towards society.

Moreover, the dissemination of knowledge leads to an embedded network, which is a way to ensure mutual understanding and alignment between the members. The more aligned the members are in their views, priorities, and incentive for participation, the more likely it is that their actions are coordinated and that the innovations succeed by finding mutually supportive roles[21]. It is therefore important that the facilitating organisation continuously works to create this alignment.

Embedded networks are known to lead to bottom-up initiatives[22], meaning that ideas are initiated by the network itself and not solely by the active work of the facilitator. Bottom-up initiatives are therefore a good sign that the network has reached an embeddedness, and that the actors are internalising the drive to collaborate around resources. An embedded network is an important part of a strong culture, the importance of which is elaborated on in part 4: Ensuring the drive

When the network has reached a level of embeddedness, it can generate new ideas for projects and innovations through open- and focused network groups, which are elaborated upon below[23][24].

Open network groups

Open network groups bring companies together, regardless of size, industry, and specific resources, to see what happens by simply putting them in the same room. Smaller companies often value such opportunities, as it gives them the often rare chance to meet bigger companies. This approach is beneficial, as it is the differences between the companies that makes an IS possible[25]. Ideas to open network groups that the facilitator can make use of are:

> Workshops or seminars
> Company visits and on-site guidance. An idea is to have a company host the networking event and thereby show their company to the other network partners.
> Policy tours
> Intimate meetings such as periodical meetings, face-to-face discussions, follow-up activities, lunch meetings
> Casual social events for the network

These kind of events gives the facilitator the possibility of creating a neutral space where the day to day competition is left by the door.

Although an idea might come up during these networking sessions, the companies will have to bring it back to their organisation, and the process ahead towards a finished project is still long. These meetings are nonetheless valuable, as the people in the industry are busy, and most do not have the time or knowledge of IS to discuss symbiotic exchange possibilities with their neighbours. Organising these open and undefined networking events can give them familiarity and information, and thereby the basis for finding ideas for collaborative projects with time.

Focused network groups

The second tactic is to organise recurring and regular networking events that are more focused. For instance, companies can be grouped according to industry, common challenges, or resource streams, such as energy, safety, LEAN production, or wastewater. It can be beneficial to include both companies and experts on the topic, in the same groups. The topics can be dedicated to come up with new projects, or more loose brainstorming or knowledge exchanges.

Learning from each other is found to increase trust and a cooperative culture. Doing it in a non-competitive environment further increases the willingness to share information and consequently the chance of new projects coming up[26].

INVENTING THE SOLUTION

After identifying the problem and an idea, the phase of inventing the solution is where the facilitator encourages companies to act on the emerged idea. This is done by getting internal permission to explore how

it can be realised.

For the facilitator, the process from idea to an actual project, involves arranging matchmaking-meetings with potential partner companies (within or outside of the IS), supporting the companies with the technical development, and helping to secure funding. The order of these aspects is by no means fixed, and the process is characterised by reiteration and adaptation. For instance, researching or testing a potential resource might reveal that the initial matchmaking does not fit, and that there is a need for another company. There are different ways to approach this process, the insight from Paper Province describes their unique approach.

INSIGHTS FROM A BIS PARTNER

Example of focused innovation

development from Paper Province

1st step   Gather a group of 5-6 people from different areas/industries, to brainstorm ideas for solving a specific challenge that a member company has (e.g. a consultant, a researcher, the company with the problem, other relevant organisations).

2nd step   Look more into the ideas and investigate whether some of the other companies in the IS or outside, are working with something relevant. Then reach out and suggest a collaboration.

3rd step   When a partner company is found, there might be a need to go even further into the technical investigations, such as with a pre-study. Then, in order to take the project further, there is most likely a need for funding which the facilitating organisation helps with.

4th step   After the idea has been tested and verified by a successful pilot, the companies are invited to take the responsibility to scale up the innovation.

Matchmaking

Since the projects and innovations in an IS are about company collaborations, an important role for the facilitator is to be the link between companies that can be a potential match for the symbiotic exchange[27]. This is where the value of having a large network and an overview of the resources in the different member companies becomes relevant.

In the beginning of an innovation project, alignment between the companies can be challenging, as the situation is often unclear, and the practicalities and outcomes of the project is a collective discovery[28]. Because the value proposition is not known in advance, the companies might experience a "chicken and egg" situation, where no one is willing to commit first[29]. This is where the facilitator comes in, as the companies might only truly commit when they are convinced that the idea will in fact become something real and that the result will be beneficial[30].

Further, matchmaking companies can be a delicate subject, as the information about their input and output resources can be subject to confidentiality. Some IS facilitators therefore act as the gatekeeper of the information and verifies with the company that another company can be made aware of the existence of the resource, or they set up meetings without disclosing the details. This system requires that the companies trust the facilitating organisation[31]. The meetings are dependent on a high level of trust among partners and willingness to share information. Focusing on only one resource can ease the challenge of company confidentiality, as the companies thereby do not need to disclose the entire resource flow.

In this process, there might be some challenges in case the match is between companies of different size. Firstly, the quantity of the output product might not match with the required input. Secondly, big companies often have a longer chain of command, and therefore a longer decision-making process, compared to smaller and more agile companies. And lastly, bigger companies often have more thorough and standardised processes and structures for collaboration and disclosure. This might be demotivating for both parties, where the big company weights the extensive process against the potential outcome, which initially is unsure, and the small company loses motivation to spend the necessary time and energy[32]. The facilitating organisation can ease this situation by supporting with research, funding and alignment of the parties.

The facilitator should be aware that a potential collaboration often needs to be discussed at length, both between the companies and internally. For it to develop into something more concrete and formalised, where both companies invest resources in the establishment of the symbiotic exchange, the idea needs to be matured, processed, discussed, and trust needs to be established between the partners. The facilitator should be prepared, that nothing might come out of the process, which leaves the

facilitator with the task of starting over with a new potential company and matchmaking.

Feasibility

At some point during the process, it becomes necessary to examine the technical, chemical, volume needs, or other, specifics of the resource exchange to figure out of it is possible and essentially feasible to collaborate in a symbiotic exchange. This requires that the companies share information about each other's pool of resources and by-products that can be supplied and handled.

The phase of inventing the solution, also includes the consideration of the specific economic practicalities, such as supply chains, cost of new commercial transactions, cost-benefit analysis, tax studies, and business models. This might require external consultants and the role of the facilitator is to focus on the organisation of new relations[33].

Funding

Depending on the project and the involved companies, there might be a need for external funding to support the investigation of the feasibility of the symbiotic exchange. The facilitating organisation with its network, experience, and overview, can be of great help, by looking both nationally and internationally for funding, and also help writing applications[34].

If funding is secured for the pilot or implementation of the symbiotic exchange, or if the companies decide to invest themselves, the companies will need to establish a formal agreement. Most facilitators are not part of the negotiations but can still be valuable all the way up and around the negotiations. The prerequisite for negotiating a contract is that the partners trust each other and have confidence in the project. Upholding the embeddedness and alignment of interests can be done through continued maintenance of the confidentiality[35], aided by the facilitator.

Although the facilitating organisation is often not engaged in the implementation of the symbiotic exchange, communicating the result plays an important role in maintaining and developing the embeddedness of the network, and the companies' motivation to look for more potential symbiotic exchanges. This drive will be further described in part 4: Ensuring the drive ▪
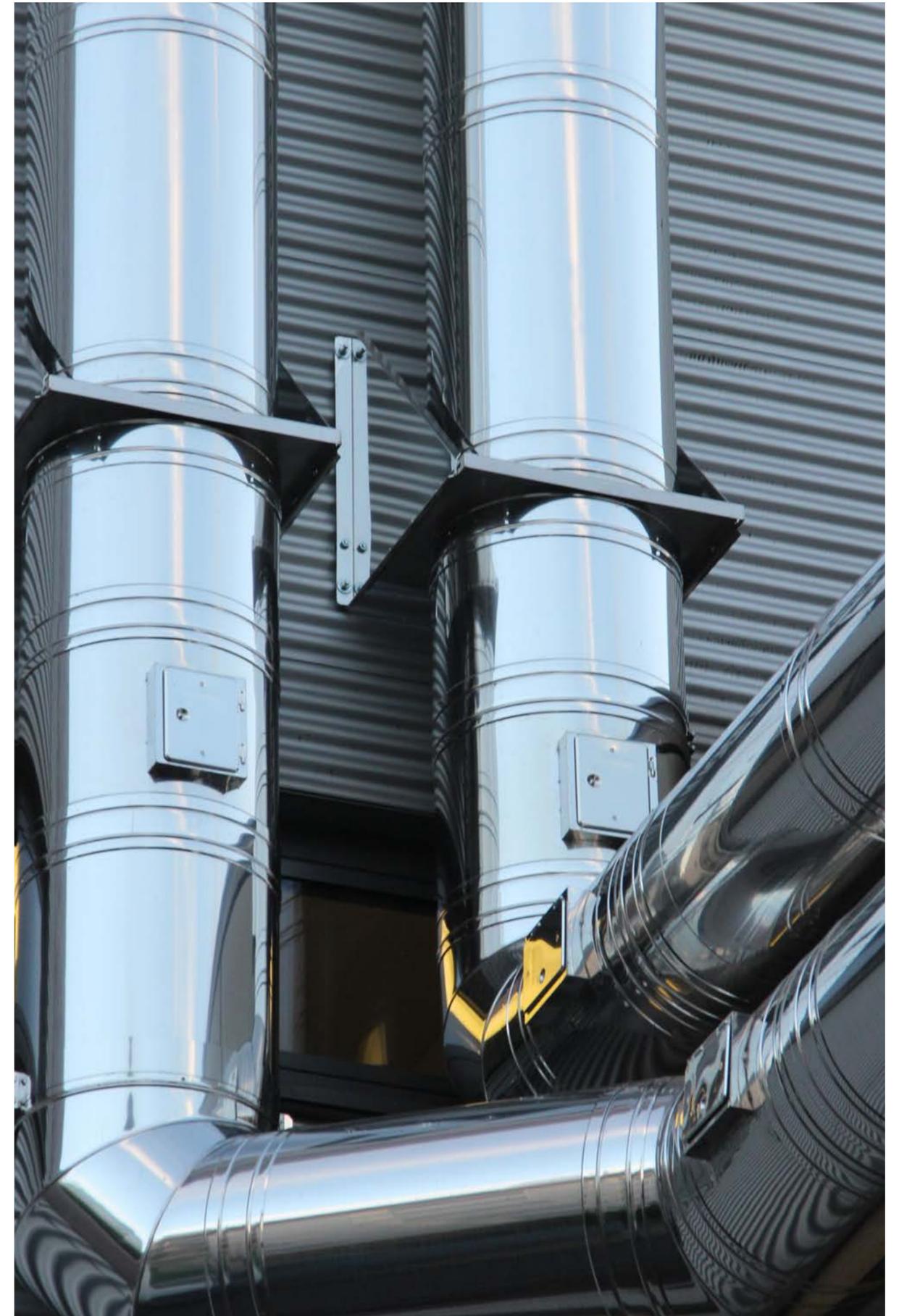
CHAPTER 3
FACILITATING INDUSTRIAL SYMBIOSIS
PART 4

Ensuring the Drive

Common story

Successful collaboration

External partnerships

Shared strategy
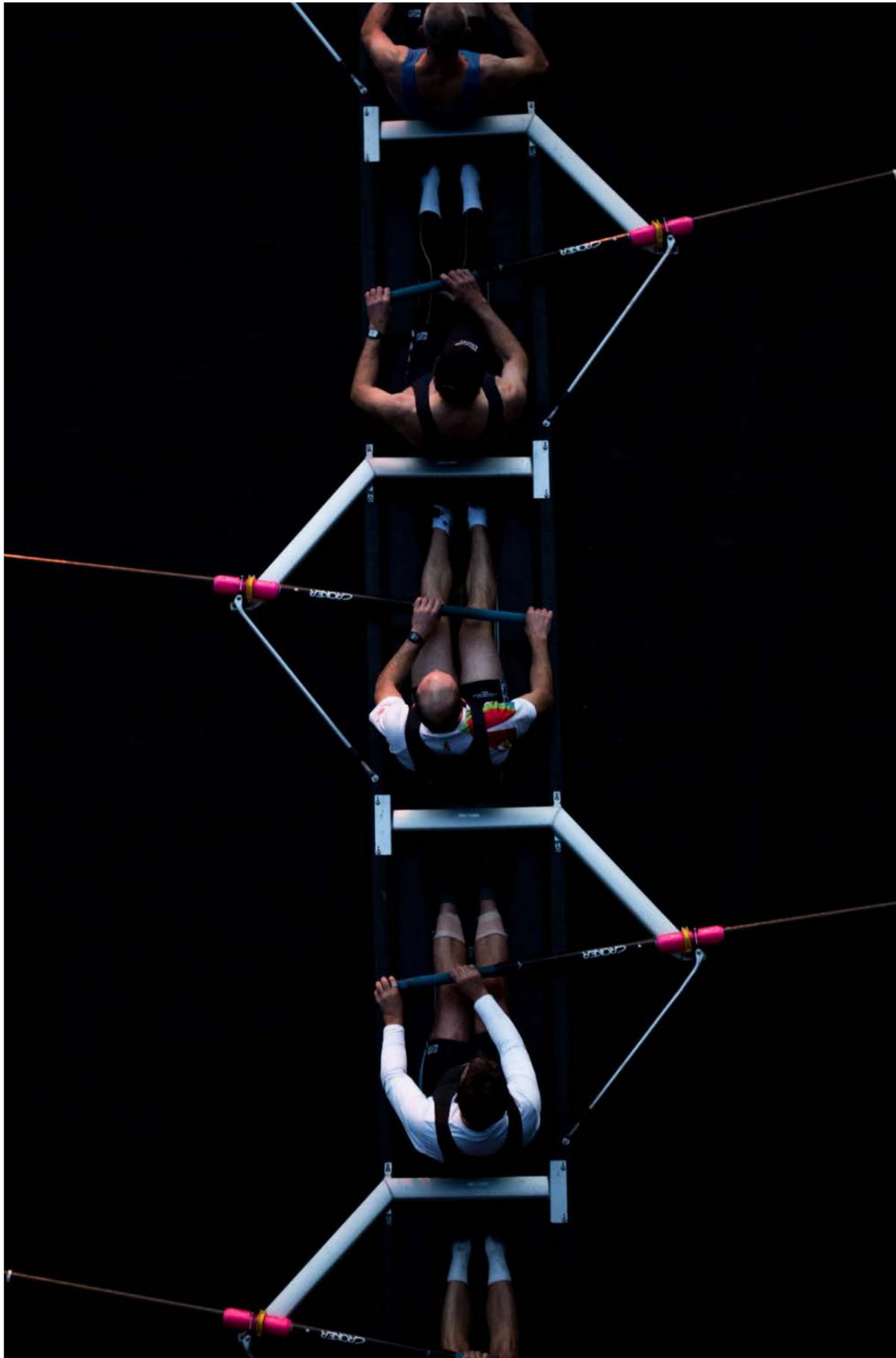
ENSURING THE DRIVE

This part investigates how the facilitating organisation can create the drive to secure continuous development and successful future symbiotic relations in the IS network.

Without an internalised drive among the participating companies to participate in and see the IS network grow and improve, the partners will likely not contribute effectively to identify potential symbiotic exchanges, invent solutions, or participate with energy and dedication in the implementation. Drive is however not something that can be easily created. It is an abstract and rather intangible concept, affected by many factors.

As shown in figure 4.1, drive is the result of a strong culture, which is created by 1) establishing a common story, 2) ensuring successful collaboration, 3) creating a shared vision, and 4) building an embedded network. The first three aspects are investigated in this part, whereas the development of an embedded network was described in Part 3: Establishing symbiotic exchanges.

Drive

↑

Strong
Culture

↗   ↖   ↖   ↖

| COMMON STORY | SUCCESSFUL COLLABORATION | SHARED VISION | EMBEDDED NETWORK |
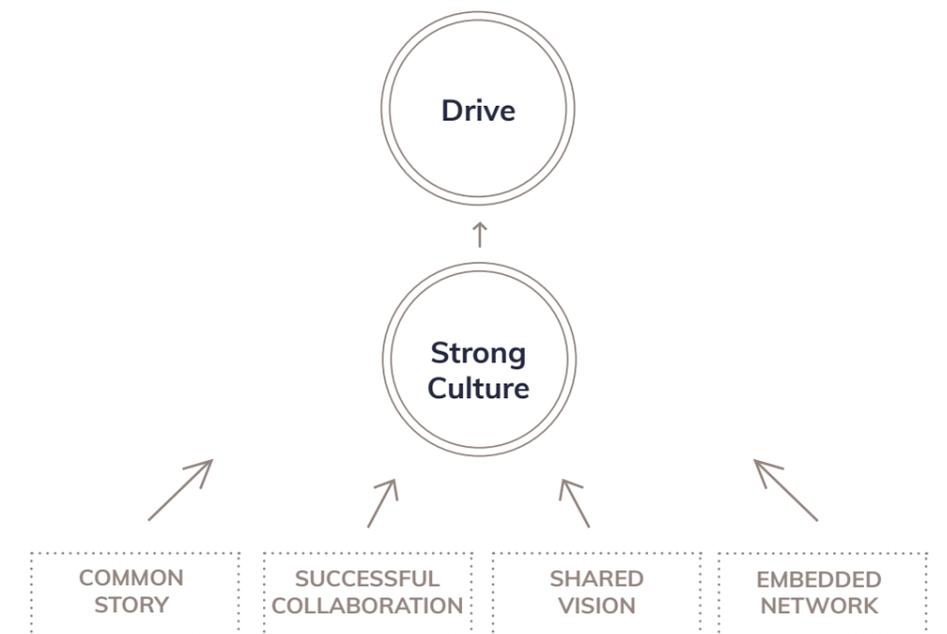
Figure 4.1

Although complex, the facilitating organisation has the possibility to influence the aspects of figure 1. Motivation and thereby drive, is a behavioural phenomenon, affected by how people act towards them, meaning that the facilitator's role is to motivate and encourage the network. Moreover, the facilitator supports the project to success, which positively reinforces the continuous motivation and effort of the associated companies. Lastly, direction is needed to carry something out with momentum. Here the facilitator is an important enabler of gathering the partner companies around a common strategy for the network.

A STRONG CULTURE CREATES DRIVE IN THE IS NETWORK

The culture of an organisation compromises the habits, values, and ways of acting, and is expressed in its self-image, interactions with the outside world, and future expectations. Organisational culture is a shared meaning, by which people identify themselves and other members of the same group. It acts as a glue that keeps the objectives of the organisation and the individuals together[1]. A strong organisational culture is especially important in a program or project-based organisation, where the hierarchy is flat, such as an IS network, since it guides the achievement of goals and objectives for all the member companies[2].
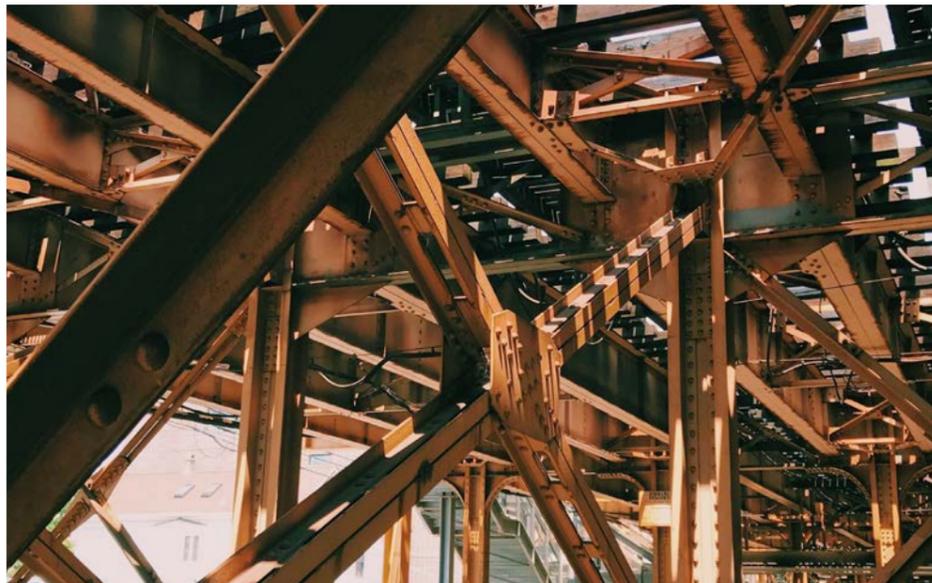
HOW A STRONG CULTURE AFFECTS DRIVE

The table below explains the effect of culture on behaviour[3].

CULTURE'S GENERAL EFFECT ON BEHAVIOUR

1 **Attachment and community:** A strong culture can give the feeling of belonging to the group and thereby reduce insecurity and strengthen loyalty.

2 **Motivation:** Socialisation with the community, leads the members to internalise the goals and ambitions of the organisation, which creates motivation.

3 **Trust:** The stronger the culture, the stronger the trust between employees and management, which reduces the need for control and monitoring.

4 **Collaboration and coordination:** All the previous points lead to better conditions for collaboration. In addition, members of the same culture develop a common language that additionally improves collaboration.

5 **Control:** In a strong culture, it is often a given how to behave and react in different situations. A strong culture leads the people to voluntarily do what is important.

Table 4.1

Connecting table 4.1 and figure 4.1 shows that attachment and community, together with trust relates to an embedded network and a common story. This is because it creates a disarming familiarity between the members and connects them around shared goals. This builds an embedded network, characterised by loyalty, commitment, and a willingness to contribute, and consequently makes the members less likely to disengage or leave the organisation. Stronger relationships increase the chance of new ideas emerging bottom-up, without the constant facilitation of the facilitating organisation[4].

"

Since we are in the beginning of building the IS network, the facilitating organisation plays an important role. With time however, the aim is that the member companies create a strong partnership and that new initiatives grow bottom-up.

Alexander Belykh, Tyreman Group

The motivation from a strong culture, as well as the aspect of collaboration, coordination, and control, relates to successful collaboration and a shared vision. This is because there is less need for detailed policies and procedures as there is an internalised understanding of the "way things are done around here"[5]. The experience of joint problem solving, such as from prior collaboration around symbiotic exchanges, creates dynamics and routines which leads to an efficient and effective collaboration.

Repeated interaction and collaboration contribute to create common values, philosophy, and expectations for the future, which ensures that everyone is working towards the same goal. This in turn motivates people and leads them to improve quality, productivity, and innovation[6].

Consequently, the efforts originating from the strong culture, leads to successful achievement and ultimately drive of the IS and its member companies. Having created an organisational culture and drive therefore allows the facilitating organisation to manage a large network, even if the facilitating team is proportionally small, as the members themselves become the driving force of the network.

What is special about culture that is created in an IS network is that all the member companies retain control of their own culture, and the culture of the IS becomes an additional layer built by overlapping subcultures. Therefore, the facilitating organisation should attempt to create an overarching culture that encompasses the subcultures and creates a strong culture across them[7]. A common history and member stability is required to do this and consequently, the IS should grow at a pace where the member base can be stable enough to develop, maintain, and strengthen the culture.

Tyreman Group was introduced to the BIS project through its participation in the Cleantech Cluster in St. Petersburg. The already existing companies participating in the local incubator became a starting point for the development of the network (see part 1, Insights from a BIS partner, p.23). For instance, Tyreman Group invited a shrimp production company, that was also part of the incubator, to move their production in the same area as Tyreman Group. Then, Tyreman Group realised that since their own business' core clients are mining companies, they often produce excess heat, which could be used in the shrimp production, which requires significant heat. Although this is an example of the proactiveness of the facilitating organisation, Tyreman Group, it still shows how the connection between companies is part of enabling the facilitating organisation to continuously consider new potential symbiotic exchanges. This is an example of the short mental distance and embeddedness of the local organisations in the incubator network (see part 3: Building an embedded network), and how this benefits the initiation of new collaborations.

COMMON STORY

Having a unique history, consisting of where the network comes from, what it does and why, and why the member companies are a part of it, is a big part of creating an embedded network. If the members of the IS network do not have a common story, goal achievement is difficult. Therefore, it is key for the facilitating organisation to create a common story by uncovering the history, crafting it into a shared narrative, and retelling it as a part of the IS's ongoing culture.

Building such a common story starts with documenting the very beginning, such as what triggered the initiation, the first steps and how the initial barriers were overcome. This can be communicated as part of written communication, orally at presentations, and in external communication. Stories carry more weight than data or numbers, as they connect with the emotional rather than the rational[8]. Using visuals to strengthen the message of a common story is explained in part 3 and will be elaborated on further later on in this part.

A common story is tacit and is integrated in complex social interactions and team relationships and can only be transferred by a significant degree of direct social interaction[9]. Telling the common story again and again, strengthens the bond and culture between the members. This is done by explaining and repeating how the IS network started, and how the first projects grew out of it. When adding new projects and symbiotic exchanges, their story should be narrated in a similar way as the prior stories of the IS, to build up the common story, confirming the resilient partnership.

SUCCESSFUL COLLABORATION

An important part of ensuring the drive in the network is that the efforts are carried out energetically and with progress. The processes of how the network can collaborate around innovating new symbiotic exchanges (see part 3), is the basis for successful collaborations.

Key parts of successful collaboration relate to allowing room for innovation testing, measuring and communicating results, building capacity and creating a shared strategy.

Innovation testing

The main barriers against engaging in an IS network from the companies' point of view, is the lack of resources in terms of time, money, and knowledge[10]. The facilitating organisation can assist the companies by supporting the people or companies in the establishment of symbiotic exchanges.

This is crucial to be able to keep the people and companies engaged and is an important part of creating drive in the network. For people to deliver, they need support, such as encouragement, advice, the provision of

resources, and influencing behind the scenes. Effective motivation means giving people room to use their skills, but not letting them feel that they are on their own.

Although many innovation projects around symbiotic exchanges come up during direct screenings and networking events (see part 3), another way to encourage new projects is by providing the facilities for idea and prototype testing, and by initiating resource analysis in order to inspire new possibilities. Many facilitating organisations also offer different types of virtual or physical centres, where information about resources exchanges and circular economy in general, is collected, to provide inspiration and learning for the member companies, see insight for inspiration.

INSIGHTS FROM A BIS PARTNERS

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With society's increasing focus on resource efficiency and circular economy, it is crucial to challenge the companies to be proactive in the development of innovations for symbiotic exchanges.

Magnus Persson, Paper Province

Several of the BIS partners are proactively offering innovation support as a place where companies can test their ideas.

Paper Province is actively involved in innovation development and testing. This is done, for example, through different "test beds". Test beds are physical or virtual environments where companies, academia and other organisations can collaborate on the development, testing and introduction of new products, services, processes, or organisational solutions. Paper Province either finances or works closely with different test beds. For instance, they collaborate with researchers in understanding the properties of a resource and test potential secondary uses of it. Then, the facilitating organisation tries to connect the innovation to relevant companies in their network. An example of such a test bed is LignoCity, which demonstrates and develops sustainable processes and products with lignin as a raw material. The test bed is in Bäckhammar and is focused on a technology that separates lignin from pulp mills, but is also open for the development of alternative technology. LignoCity provides access to a large-scale production of lignin as well as instruments, workshops, environments, and facilities that may be needed to realise a first product or industrial process.

Digipolis uses external labs to analyse waste products and alternative uses. If the test produces promising results, these are offered to the member companies, for which it is a 'first come first serve' system. When a solution or innovation is taken, it becomes the property of the company who then develops it further, often with additional support from the facilitating organisation.

Gdansk University of Technology has a proactive approach when it comes to innovation and technology and makes active use of the university resources to develop symbiotic exchanges or resource saving technology. Through another EU funded project, they developed a technology for low-temperature heat recovery, which can be useful for different parts of the process industry.

Tyreman Group has developed a Living Lab for innovation testing and showcasing of symbiotic exchanges. The reason behind this is that many companies might have an idea of how their processes can be optimised, but they lack time, a team of motivated and like-minded people, and other resources to test their ideas, which represents a significant barrier to establishing new symbiotic exchanges. The Living Lab consists of 4 areas/zones: Coworking area for residents of the Living Lab, presentation and education zone with eco-lecture hall, production area for practical tests and warehouse, demonstration area.

To give an idea of the potential of the Living Lab, Tyreman is currently testing the following symbiotic exchanges:

→ Production of fuel briquettes made from coffee grounds waste Using crush stone leftovers as a sand substitution in eco-friendly bench production recycling textile waste

Measuring performance

Measuring the performance of the IS network as well as the individual partner companies is indispensable when it comes to communicating the activity and results of the IS, and to guide decision making[11]. Since IS has the potential to create both economic benefits for companies, as well as environmental and social benefits for the society, measuring the performance should capture a range of indicators[12].

On the technical side, a quantification of the reduction of resources such as waste, water and energy, can provide a strong argument for joining the IS network. Impact on greenhouse gas emissions can encourage continued efforts and drive both from the facilitating organisation, the member companies and potentially other supporters such as local, regional, and national governments.

Apart from the technical performance, an IS network also produces other benefits for the companies and the community, such as financial savings, attributes to job creation, and relocation of people to the community. As such, the facilitating organisation should include several indicators to track and assess the performance of the IS. Figure 4.2 provides suggestions of indicators to track.
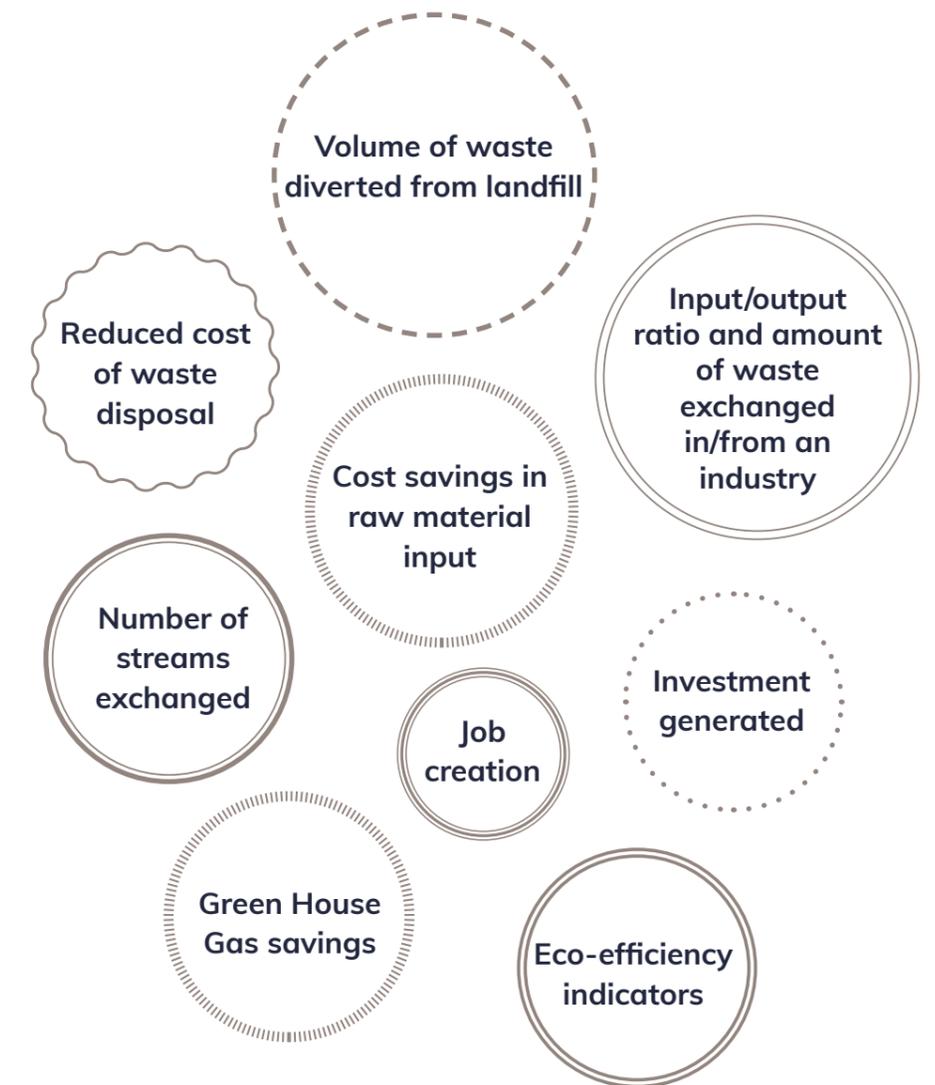
Figure 4.2

The facilitating organisation can involve knowledge agencies such as educational institutions to support in areas where the facilitating organisation or the companies themselves do not have the capacities, in the process of establishing baselines, supporting new innovations, and measuring performance in areas where they themselves do not have the capacities. This can include producing material mappings, uncovering linkages, inspire new projects around symbiotic exchanges based on new scientific and technological discoveries, and track results according to methods such as Life-Cycle Assessments, Material Flow Analysis, and economic and environmental studies.

There are several methods that can be used for measuring the technical performance of the IS network as well as the specific symbiotic exchanges, each with its benefits and drawbacks. Some of these are mentioned in table 4.2.

Life-cycle assessment (LCA) is a tool that addresses on the environmental aspects and potential environmental impact of products throughout their life cycle. The methodology is defined by two international ISO standards, and is highly reliant on data, providing an argument for cautious collection, right from the beginning. On the other side, the impact factors reflect the national average, and not the factors of the specific enterprises, making it difficult to use for assumptions for by-products.

The Emergy method considers the economic dimension and resources used directly and indirectly to generate a service or product, as well as the contribution to the local ecosystem. The approach considers parameters that are often left out in other methods. For IS, the Emergy method can evaluate each symbiotic flow, and express the economic activity on the local eco-environment, analysing the IS as a whole. It does however not give sufficient consideration to the impacts of pollutant emissions.

Material flow analysis (MFA) focuses on each waste flow separately, hence considering how firms are connected among them, and can support the identification of possible resources for synergies. However, since each flow has a different metric and comparing indicators concerning different flows is a difficult task, MFA indicators cannot be used to measure the overall contribution of each firm to the IS, nor to assess or support engineering or management measures.

The Enterprise Input-Output approach assesses the two kinds of functions that are performed in an IS: recovering the produced wastes and replacing the required inputs. Firms contribute to these functions by producing, requiring, and exchanging wastes. Through these functions, the IS generates two services, it creates economic benefits for firms and environmental benefits. Using this approach allows for assessing both the performance of each function, and the extent to which each firm contributes to the IS functions.

Table 4.2

Map material flows

Mapping material flows means to investigate the materials that flow in and out of the area and/or materials that flow among members of the IS network. These could be waste flows and by-products such as energy, water, and materials. Technologies like the Internet of Things and big data can support in collecting data. Table 4.3 shows some of the benefits of mapping material flows.

MAPPING INPUTS AND OUTPUTS HAS THE FOLLOWING BENEFITS

→ The facilitating organisation builds up a thorough overview that can be drawn on for specific projects.

→ Contributes to keeping the conversation going with the member companies, which might lead to new ideas for symbiotic exchanges.

→ Allows the facilitating organisation to be continuously updated around changes in production and processes of the different companies, and consequently be able to proactively facilitate adaptation in the network and resource exchanges.

→ Prevents the loss of tacit precious knowledge in the case of changes in staff.

→ Enables more efficient sharing of knowledge among the people in the facilitating organisation.

→ Visualises the internal synergies between the companies in the IS and the dependence on each member.

→ Be used to communicate the IS and common story externally.

→ Collecting the data in an open database or virtual knowledge centre can enable easy communication of the potential resources in the network, and consequently inspire to new projects around symbiotic exchanges.

→ Quantification and registration of material flows can provide additional benefit by allowing for tracking and measuring the data, which allows for more quantitative and convincing communication of success stories and benefits of participating in the IS.

Table 4.3

Communicating the results

An important part of facilitating an IS is to communicate the successes of the IS network and the specific symbiotic exchanges internally and externally. This both support the internal drive, as well as lays the basis for the IS network and the facilitating organisation to engage in valuable external partnerships.

Internal and external communication about the activities, achievements and ambitions of the IS network cements the common story of the network and partnership and creates a strong culture and drive in the network.

It is therefore fully acceptable to repeat the development and experiences of the IS, as it is part of reaffirming the common story and partnership of the IS network.

A powerful and effective tool to share achievements, as well as communicating clearly what the IS network is about is to visualise the waste streams and how they connect the member companies.

An example of this communicative tool can be seen in figure 4.3, which shows the various exchanges of resources between the partners in the Kalundborg Symbiosis.

COMMUNICATING ABOUT THE IS NETWORK AND THE RESULTS EXTERNALLY CAN PRODUCE THE FOLLOWING BENEFITS

→ Strengthen the prestige and pride for the members that are a part of the network and increase their motivation to contribute to the continuous growth of the IS network.

→ Attract new companies, thereby potentially discovering new symbiotic exchanges.

→ Make other IS facilitating organisations, as well as relevant national and international organisations aware of the IS network, which can potentially result in new projects and collaboration possibilities.

→ Create recognition, which has a positive effect on the ability to receive funding or project grants, which is for many IS facilitating organisations and IS network's, a continuous necessity.

→ Be seen and present in the media creates an expectation from the external world for the IS to continue its efforts, activities, and achievements, contributing to ensuring the drive.

→ Create and maintain the general awareness of IS as a concept.

→ Highlight the member companies as being a part of a sustainable solution. Showing how the member companies are working with innovation and sustainability is also likely to attract talent, as these topics are increasingly valued by employees, and especially by the younger generation.

Table 4.4

Figure 4.3

Most IS facilitating organisations use a mix of different channels for communication, such as Facebook, LinkedIn, their webpage, and newsletters. A way to reach a broader network is to be included in the newsletter and communication channels of the member companies, by contributing with content. Similarly, the advisory board of the IS can contribute to the communication through its own channels, which is especially relevant in the beginning and before the network has its own audience.

In addition to communicating the updates from the IS network, the facilitating organisation is also advised to take part in the public debate around IS and connected topics. This can be done through participating in talks and events, as well as writing articles and publications.

It is also advised for the facilitating organisation to take the lead in organising events around the topics, from small open networking events to larger conferences. This creates awareness of the IS network and can create legitimacy and attention to the work of the IS network.

INSIGHTS FROM A BIS PARTNER

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Our newsletter is received by several hundred people, many of whom are from the same organisations. This is very important as it is the people in the organisations who create the change and not the organisations themselves.

Michael Elgaard, Ressource City

From the very beginning, the broad and diverse network has been part of the core priorities of the facilitating organisation of Ressource City. They distinguish between the inner and outer circle of stakeholders, including both companies, local and national politicians and ministries, public institutions and other organisations. An important decision has been to not only communicate with the heads of the different companies and organisations but to include a broader range of people from the organisations.

A corner stone of their external communication and engagement with the stakeholders is their yearly conference about circular economy. Each year Ressource City focuses on a new topic within circular economy, and includes high level national speakers. After the speakers all the participants are divided into pre-selected workshops in which they hear inspirational presentations and contribute with their inputs and ideas on particular relevant challenges, for example the national waste plan or the national climate partnership for waste, water and circular economy. Each year, the challenges have been formulated with approval from the people who are responsible for writing the reports.

The conference manages to gather a growing number of participants from all over Denmark representing both public and private organisations, and has made Ressource City widely known both nationally and internationally. As an extended result of Ressource City's work, is the recognition of the Glas Cluster as one of the 100 world's greatest climate projects in 2019 featured at the C40 World Mayor Summit in Copenhagen and in the Cities100 report.

External partnerships

Being an active participant of external partnerships serves several objectives, both for the facilitating organisation, the IS network and the individual member companies. Networks which provide capacity building of the facilitating organisation are crucial for the scoping of new projects and success of current projects around symbiotic exchanges[13], which consequently contributes to the general drive of the network. External partnerships further increase the legitimacy of the IS network and the facilitating organisation, which can be used as leverage to meet and potentially collaborate with important organisations within the field, as well as to be listened to by relevant actors, such as policy makers.

"

International projects are a great opportunity to obtain international visibility and to collaborate with and learn from other facilitating organisations. There is also the potential that results from a project can be used to further develop and scale after the project period and in that way, get an even bigger impact. These results could also mean that the organisation get noticed more broadly and get the possibility of affecting the area at large.

Paul Nemes, Paper Province

Capacity building

The power of collaboration is equally relevant for the members of the facilitating organisation, as it is for the companies in the IS (see part 3: Identifying ideas in the broader network). Individuals create ideas, but interaction plays a critical role in conceptualising knowledge[14]. Engaging in external partnerships is therefore important to improve the quality of the IS network, and through this, contribute to ensuring the drive of both the IS network and the facilitating organisation. In addition, as the need for global solutions increases, active, dedicated, and competent networks on all levels are important to make progress on a larger scale[15].

Facilitating an IS network is at its core about creating innovative symbiotic exchanges (see part 3), communicating about the IS network and identifying and involving external partnerships and networks for capacity building. An important role of the facilitating organisation is to bring relevant expertise together, also stakeholders from outside the IS network.

In terms of research and technical understanding, research institutions are valuable partners. Engaging in networks, both locally, nationally, and internationally is a way to identify potential collaborators with whom to engage in innovation and research projects with. These projects can be funded by national and international funding programmes. Such projects are often characterised by a snowball effect, where one successful collaboration leads to another, and upholds the relationship to the partners as well as funding.

In addition to research partners, it is beneficial to connect broadly with industries in the region (also outside of the IS), as well as business development organisations, professional organisations within the field, relevant governmental institutions and other.

Lastly, building capacity of the facilitating organisation is also beneficial for the national and international community, as the facilitator activates the exchange of knowledge and relations among companies, public bodies, and others[16], and is the intermediary between industry and government institutions, including regulators and financial bodies. Being up to date with the developments in the field and being close to what is going on at the more practical level of industry, is therefore a significant outcome of capacity building[17] as well as maneuvering (see part 2: Facilitating several stakeholders).

In sum, through national and international networks, organisations, and projects relevant to the IS, the facilitating organisation can improve its own competencies and knowledge, secure projects and funding, and keep the IS on the forefront of development in the field. In a reinforcing manner, such activity then provides results to communicate, and thereby reinforces momentum and drive.

SHARED STRATEGY

The different member companies of the IS network do not necessarily engage with each other regularly, nor is there necessarily any formal hierarchy between them. The shared strategy is imperative for the long-term success and continuous establishment of the symbiotic exchanges in the IS network.

A shared strategy contributes with a clear direction to ensure continued drive. When the members of the IS network are aligned on where they are going and why, the facilitating organisation can make decisions and choices that support the development of the network more effortlessly.

Companies are likely to change both their processes and resource use with time, and consequently the symbiotic exchanges will need to adapt. The shared strategy and thereby willingness and drive from the members has the potential to discover solutions to these changes and provide a platform for planning. This way, changes do not come as a surprise for the member companies, which is fundamental to ensure the trust in the network, as well as successful collaboration.

The strategy needs to be made with a high level of involvement of the partners of the IS network, in order to ensure engagement with and ownership of, the development of the network. Through the process, disagreements about the direction, roles, and structure of the IS might arise. This provides the facilitator with the opportunity to use the process to align the member companies and clarify potential conflicts and miscommunications[18]. The facilitator must communicate the role that the members will play in the vision, and what they will get out of it.

Establishing a strategy is also a way for the top management of the individual companies to signal that participating actively in the IS network is a priority, and that the employees have the support to dedicate time and resources to the IS network. This way, the people in the organisations understand and feel that things must and can be done differently.

Just as when establishing symbiotic exchanges, the strategy needs to grow together with the network. This means that in the beginning, it is valuable to aim for small scale initiatives and ambitions, and then gradually build capability, capacity, and confidence. This allows the members to get involved even in the beginning when the task seems overwhelming, and then later become more ambitious.

Moreover, it is important to set goals that the organisation needs to strive for, all the while not being unattainable. This leads back to the mission (see part 2: Mission), which could be used in the strategy to set up goals and milestones to achieve within a particular timeframe.

INSIGHTS FROM A BIS PARTNER

Kalundborg Symbiosis has created a shared strategic for the development of the IS network. In the strategy it is stated that by 2025 ten new symbiotic exchanges will be established.

Up until 2019 the IS network was directed by a board consisting of the CEO's of the different member companies. In 2019, an additional board was created, an advisory board, consisting of the middle managers of the partner companies. Including middle managers enables more pragmatic insights which consequently allows for more in-depth knowledge sharing and ideation sessions around technical solutions. This advisory board is tasked with making an action plan for how to reach the strategic goal of ten new symbiotic exchanges by 2025.

IS is a complex endeavour that requires a coordinated effort among multiple public and private stakeholders. The strategy is a valuable tool to connect the two. Connecting the strategy with public authorities, responsible for permitting and regulating within fields related to IS might be important. Single symbiotic exchanges are often not significant enough to get the attention of local authorities, and an overall strategy is therefore more suitable for affecting and working together with the long-term political processes needed to support the IS network. .

Lastly, the connection with the local and regional policy institutions can be a valuable connection to national and transnational (EU) networks and consequently the ability to have an influence on EU policies affecting the field ■

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It is crucial for us to preserve the link between the IS network and the national level in order to be fully integrated with, and relevant for, the national innovation system.

Paul Nemes, Paper Province

POLICIES IMPACTING INDUSTRIAL SYMBIOSIS[19]

A study on how policy can unlock the potential of IS in the Baltic countries, finds that Industrial symbiosis should be included in national circular economy strategies to increase awareness and to ensure national measure in support of IS. Likewise, the agenda on resource scarcity and on climate change offer great potential to promote IS as a tool to ensure resource efficiency and decrease the carbon footprint from production. In the Nordic countries, local and/or regional policies in direct support of IS are typically found in the region or municipality within which an IS cluster has already been established. The local actors with mandate to support IS constitute a great potential to support companies in IS activities ranging from capacity building, screenings and network facilitation.

This shows how valuable the connection to the local and national actors can be for the development of the IS network. The report includes insights from selected countries from the Baltic Region and can as such be an inspiration for whom to connect with.

Table 2.1

CHAPTER
4.0

Cases

KALUNDBORG SYMBIOSIS

Legal organisational structure: Non-profit organisation

Location: Kalundborg, Denmark

Founding year of facilitating organisation: 1996

Webpage: http://www.symbiosis.dk/en/

Kalundborg Symbiosis is recognised as the first industrial symbiosis in the world, and is considered a best practice example, attracting broad interest from multiple stakeholders. It is an association, which at the time of writing has 11 partner companies. The symbiosis is run by a secretariat in close connection with the Board of Directors, and in addition, the companies are represented in an Advisory Board focused on project development.

Kalundborg Symbiosis has a strong collaboration with Kalundborg Municipality, and they collaborate on several projects and knowledge sharing.

The facilitation of the symbiosis is taken care of by a secretariat, who is responsible for organising the board meetings, fundraise and secure progress on projects and the administrative work. The symbiosis has around 30 waste streams among partners, and more are in the pipeline. From 2019, when the Asnæs power station is fully converted from coal to biomass, the symbiosis estimates an annual saving of 635,000 tons of CO2, 14.1 mill € in socioeconomic savings and 24.2 mill € in business economic savings.

History

The local collaboration and the first seeds for the development of a larger industrial symbiosis partnership started in 1961, with the creation of a pipeline transporting surface water from Lake Tissø to the refinery, thereby reducing the use of groundwater in the refinery. Another key partnership in the symbiosis, was the exchange of high temperature steam from the combined heat and power plant, to many of the other partners in the symbiosis. These and other collaborations developed the Kalundborg area into an industrial symbiosis throughout the next 50 years.

Because of a growing interest from national and international delegations to visit and learn from Kalundborg Symbiosis, the partners decided to fund a secretariat to handle inquiries and ensure progress in the industrial symbiosis in 1996. At the very beginning in 1996 the secretariat was placed under the local business council and then moved to the Development Department in 2011, a connection which ensured close collaboration and mutual benefits between the private and public partners in the symbiosis and the municipality.

To ensure continued development and a more transparent structure[6], the Board of Directors of Kalundborg Symbiosis decided to reorganise the secretariat from being a publicly anchored association to be a private association at the end of 2019. Consequently, the secretariat is no longer placed under the Development Department of the municipality[7].

The vision for Kalundborg Symbiosis entering a new era of being more independent from the public, is to become the world's leading industrial symbiosis with a circular approach to production. The mission is to create sustainable development in the member companies through joint projects with the ambition to have ten circular economic projects fully implemented by 2025[8].

ØRSTED

KALUNDBORG BIOENERGY

EQUINOR REFINING DENMARK

KALUNDBORG UTILITY

AVISTA GREEN

KALUNDBORG MUNICIPALITY AND BIOPRO

NOVOZYMES AND NOVO NORDISK

GYPROC SAINT GOBAIN

ARGO

UNIBIO

DIGIPOLIS - KEMI TECHNOLOGY PARK

Current ownership: Public

Location: Kemi-Tornio, Finland

Founding year of facilitating organisation: 2012

Webpage: https://www.digipolis.fi/

Digipolis is a technology centre owned primarily by the city of Kemi, but also the cities Simo, Tervola, and the University of Oulu[1]. It is leading the industrial circular economy innovation platform in the Kemi-Tornio region, which is one of the key projects in the circularity roadmap for Finland[2]. Its local industrial ecosystem includes a large number of mines and metal producers, pulp and paper mills, a linerboard mill, fertiliser and fine chemicals producers[3]. The value of IS and environmental business in the area is estimated to be at EUR 200 million annually. Of the total of 1.3 million tons of industrial side streams that are generated each year, some are utilised internally, some are shared, and some are yet to be part of a symbiotic exchange[4]. Further, it is a founding member of the Nordic Industrial Symbiosis Network (2017)[5].

Digipolis supports local business development in many areas besides IS and offers office facilities and business development services. Today they are housing approximately 50 organisations and approximately 500 employees[6].

Digipolis, the City of Kemi and Lapland University of Applied Sciences are the founders and core actors of the Centre for Circular Economy established as part of the Digipolis organisation in 2017[7]. This is the entity that is working primarily with circular economy and industrial symbiosis.

History

The Kemi-Tornio economic area accounts for about 80% of Lapland's industrial production[8], and Digipolis - Kemi technology park is Lapland's largest technology centre and has been in operation since 1993[9]. The basic concepts of IS have been present in the Kemi–Tornio region for decades but the more systematic efforts to strengthen IS in the region commenced in the early 2000s, firstly initiated by private companies[10]. In 2013-2014, Digipolis technology park mapped the by-product and residues of industries in the Kemi–Tornio region, which significantly advanced the development of industrial symbiosis. The resulting data bank includes real time information on actors, references and potential new applications. This mapping, together with the positive mindset in the region regarding industrial symbiosis, paved the way for future activities[11], and in 2016, Digipolis - Kemi technology park became part of the Finnish Innovation Fund Sitra national circular economy roadmap as a key project[12]. This recognition ensured significant and important respect on the national level[13]. A natural continuation of the work of Digipolis was then the establishment of the Centre for Circular Economy in 2017.

The aim of the Centre for Circular Economy is to develop a more competitive business environment for companies involved in the circular economy and spread the operating models from the Kemi-Tornio region's industrial circular economy on a national scale[14].

KEMI-TORNIO CIRCULAR ECONOMY PLATFORM

PMJH WASTE MANAGEMENT CENTRE

E75

SMA MINERAL KALKKIMAA QUARRY

⌀ 25 km

AROMTECH TORNIO SITE

TORNIO

OUTOKUMPU KEMI MINE

OUTOKUMPU TORNIO PLANT

METSÄ GROUP KEMI MILL

SMA MINERAL RÖYTTÄ LIME WORKS

TAPOJÄRVI SLAG VALORISATION PLANTS

THE CENTRE FOR CIRCULAR ECONOMY - DIGIPOLIS

KEMI

STORA ENSO VEITSILUOTO MILL

PORT OF KEMI

SWEDEN   FINLAND

E8

PAPER PROVINCE

Legal organisational structure: Private, non-profit entity

Location: Värmland, Sweden

Founding year of facilitating organisation: 2003

Webpage: https://paperprovince.com/

Paper Province is an innovation cluster focused on forest bioeconomy in central Sweden. It is an economic association, which facilitates networking and collaborative initiatives among the more than 100 member companies[1]. The cluster has a close collaboration with local authorities and the educational sector, such as Karlstad University and Linköping University, as well as European partners, making the number of associated stakeholders amount to about 130 in total[2].

The main objective of Paper Province is to contribute to the transition to a fossil free society and to be a leading knowledge hub for *forest-based bioeconomy*[3]. Further, the primary task is to create sustainable growth for its member companies[4]. This means that Paper Province is active in a range of projects connected to the overall topic. Many of the projects are led by Paper Province, and receive funding from different funds, such as the Swedish "Tillväxtverket" and "Vinnova", and the EU[5].

Since 2015 one of Paper Province's focus areas has been industrial symbiosis, due to its key position in the circular economy[6]. In industrial symbiosis, they have found a particular potential for resource exchanges between pulp and paper mills, and among chemical industry facilities[7].

History

The region of Värmland has a century long history of resource sharing between forestry facilities. In 1999 the collaboration was formalised when

Paper Province was set up as a business cluster organisation focusing on supporting local collaboration and development within the forestry sector and talent attraction to the region[8]. In 2007 environmental projects became one of the main focus areas for Paper Province when the cluster started a centre for energy efficiency. In 2013, Paper Province was awarded a ten-year funding from the national innovation agency Vinnova, which set the association on a journey towards becoming an innovation cluster. As part of the project they have adopted the goal of being world leading in forest-based bioeconomy. The funding thus made it possible for Paper Province to broaden its scope from pulp and paper to the whole forest value chain[9].

Paper Province focus on transitioning to a fossil free economy and they see themselves as an organisation that connects the public sector, private sector, academia, and civil society[10].

RESSOURCE CITY

Legal organisational structure: Public

Location: Næstved, Denmark

Founding year of facilitating organisation: 2015

Webpage: https://ressourcecity.dk/

Ressource City is the centre of circular economy and focal point for the green transition in Næstved Municipality. As a platform for innovation, knowledge and inspiration, Ressource City contributes to the local businesses' growth by creating value and enabling local sustainable development. The local authority's project organisation Ressource City saw the light of day in 2015.

The essential drivers of Ressource City are Viden (knowledge), Værdi (value) and Vækst (growth).

Ressource City supports businesses in the process of transitioning from a traditional linear business model, towards a circular economy by encouraging and supporting them to try out green solutions at a minor scale. Naestved Municipality is a first mover and is eager to evolve in collaboration with businesses that are ready for the green agenda.
Ressource City collaborates with numerous local, regional, national and international businesses; startups; educational institutions; public authorities; NGO's and other relevant stakeholders to build on the already obtained knowledge and to strengthen and expand the philosophy of circular economy.

The Glass Cluster is a great example of Ressource City's work – and how a municipality can support sustainable business collaborations. Besides Ressource City, the symbiosis consists of the recycling company Reiling Glasrecycling and glass manufacturer Ardagh Glass Holmegaard. The Glass Cluster collects and recycles 125.000 tons of glass into circa 800 million bottles every year causing an annual reduction in CO2 emissions by 18.000 tons.

Næstved's Glass Cluster was one of the world's greatest climate projects in 2019 featured at the C40 World Mayor Summit in Copenhagen and in the Cities100 report. Read more at cities100report.com.

With the knowledge and experience in the field of sustainable development Ressource City also contributes to the education of the green generation, as well as the branding of Næstved as a sustainable municipality.

The aim of Ressource City is to continue to be a platform that supports green transitioning and circular economy in Næstved. Ressource City is a knowledge centre on resource potential of traditional waste streams, and its current strategy from 2020 - 2023 focuses on mapping value and resource flows and identifying collaboration opportunities between different businesses.

History

The area Maglemølle is located on the harbour close to the city center in Næstved. Both the city and Maglemølle have a long tradition of industry, but when the iconic paper mill in Maglemølle was closed in 1992[1], the mill and the harbor was turned into a business area with room for various industries[2]. In 2015, the municipality launched a local city development project for the built environment at the harbor, called Ressource City, with a philosophy of circular economy and the recycling potential of the business sector. At this point, the industrial symbiosis between two glass businesses was already established, which together gather, sort and recycle glass[3].

In 2018, Ressource City shifted its focus from solely being a city development project to also focus on businesses, and circular business development. This allowed Ressource City to build on the already obtained knowledge and to strengthen and widen the original philosophy of circular economy[4].

Cities100

SUSTAINABLE WASTE MANAGEMENT

→ Urban waste is no longer a wasteful matter, as cities are turning to innovation and the circular economy. From cities that are reducing waste via online tools or recycling, to transforming traditional landfills into ecological conservation sites and inventing ways to turn waste products into clean water, cities are re-imagining waste into valuable resources.

London
Paris
Næstved
Milan
Zhenjiang
Bengaluru
São Paulo
Durban
Sydney

THAMS INDUSTRIAL CLUSTER

Legal organisational structure: Private Association

Location: Orkanger, Norway

Founding year of facilitating organisation: 2018

Webpage: https://www.thamsklyngen.no/

Thams Industrial Cluster is an association with more than 30 member organisations. In between the yearly general assemblies, approving the overall strategic goals, a board directs the implementation of the strategy and direction of the cluster. The daily operations of the cluster are handled by the cluster manager.

Thams Industrial Cluster has a close connection the local authorities, Trøndelag County Council, with whom they collaborate on various projects[1]. Further, there is a strong collaboration with the local business association, the regional research institute, and the technical university also situated in the region[2].

The purpose of Thams Industrial Cluster is to strengthen the competitiveness of the local businesses by facilitating and inspiring the green transition, and more specifically the transition to a circular economy and together develop new tools and business cases within this field. The vision is to build a center for bio-circular economy as a future hub for IS matchmaking and as support for new innovative businesses[7].

History

Since the early 1900s, the area of Orkanger has been known for its industrial activities, and it is still one of the largest industrial agglomerations in Norway[3].

Thams Industrial Cluster was established because Trøndelag County Council identified a need to gather and facilitate circular and sustainable partnerships. By joining the EU project BSR Stars in 2016[4], Trøndelag County Council took the first steps. The project aimed at strengthening the competitiveness and economic growth in the Baltic Sea Region by connecting research, clusters, and SME's in innovation partnerships, and had a particular focus on circular economy and industrial symbiosis. The industry situated in the Orkanger region was challenged and gripped the opportunity to form their approach to embracing circular economy through industrial symbiosis. This paved the way for the establishment of Thams Industrial Cluster as a recognised association in 2018[5], eligible for public funding opportunities, and membership of the Norwegian cluster program[6].

TYREMAN GROUP

Legal organisational structure: Private

Location: St. Petersburg, Russia

Founding year of facilitating organisation: 2018

Webpage: https://tyreman.ru/company; https://tyreman.ru/bis_en

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Tyreman Group is a private company that works with tire management and monitoring systems, that saves and prolongs the life of tires. The company's engagement with industrial symbiosis formally started with their participation in the Baltic Industrial Symbiosis project in 2018. Tyreman Group is currently engaging new companies to the idea of industrial symbiosis, exploring the potentials for resource exchanges, and initiating the contact between the companies. Further, they have established a Living Lab, where a range of different actors can participate in a joint development process, testing and evaluating innovations on a continuous and free basis. This aim is to contribute to industrial symbiosis formation and demonstrate the ideas of this concept. This aim is to demonstrate the result of industrial symbiosis is available for free to the member companies of the industrial symbiosis.

Tyreman Group sees their role as facilitating industrial symbiosis as a way to diversify their business and strengthen their relationship with their customers. They expect that by engaging in IS, it will bring business benefits for them in the long run.

History

The interest in industrial symbiosis comes from the company's philosophy of resource efficiency. 80% of Tyreman Group's customers are in the mining sector[1], which has made Tyreman Group aware of the significant resource consumption that could be optimised by facilitating exchanges, benefitting both the environment and the companies' competitiveness[2].

Tyreman Group therefore became a member of the St. Petersburg Clean Technology Cluster for Urban Environment and the leader of the Clean Transport Technologies project[3], and in 2018 decided to take part in the BIS project.

Through this project, Tyreman Group has been conducting research on the possibility of forming partnerships between companies on the principles of industrial symbiosis in the North-West Federal District of the Russian Federation, with the aim of obtaining experience within the topic, create success-stories to further build on and be closer connected to international experts within the field of industrial symbiosis[4]. As of August 2020, they have 15 companies from different industries that are participating in the screening process of their resources as part of the BIS project. In the course of the screening process, Tyreman Group has identified several companies' potentials of turning production waste into valuable resources, and in the acquisition of cheaper secondary resources[5].

BALTIC INDUSTRIAL SYMBIOSIS

1 Münchell 1516
(Münchell)

2 КРОНИДОВ
(Kronidov)

3 DANONE — ONE PLANET. ONE HEALTH
(DANONE)

4 ГРАНД КАНЬОН — торгово-развлекательный комплекс
(Solomon – Grand Canyon)

5 буше
(Bushe)

6 99 RECYCLE
(99Recycle)

7 ENVIRO green engineering
(ENVIRO)

8 Fazer
(Fazer)
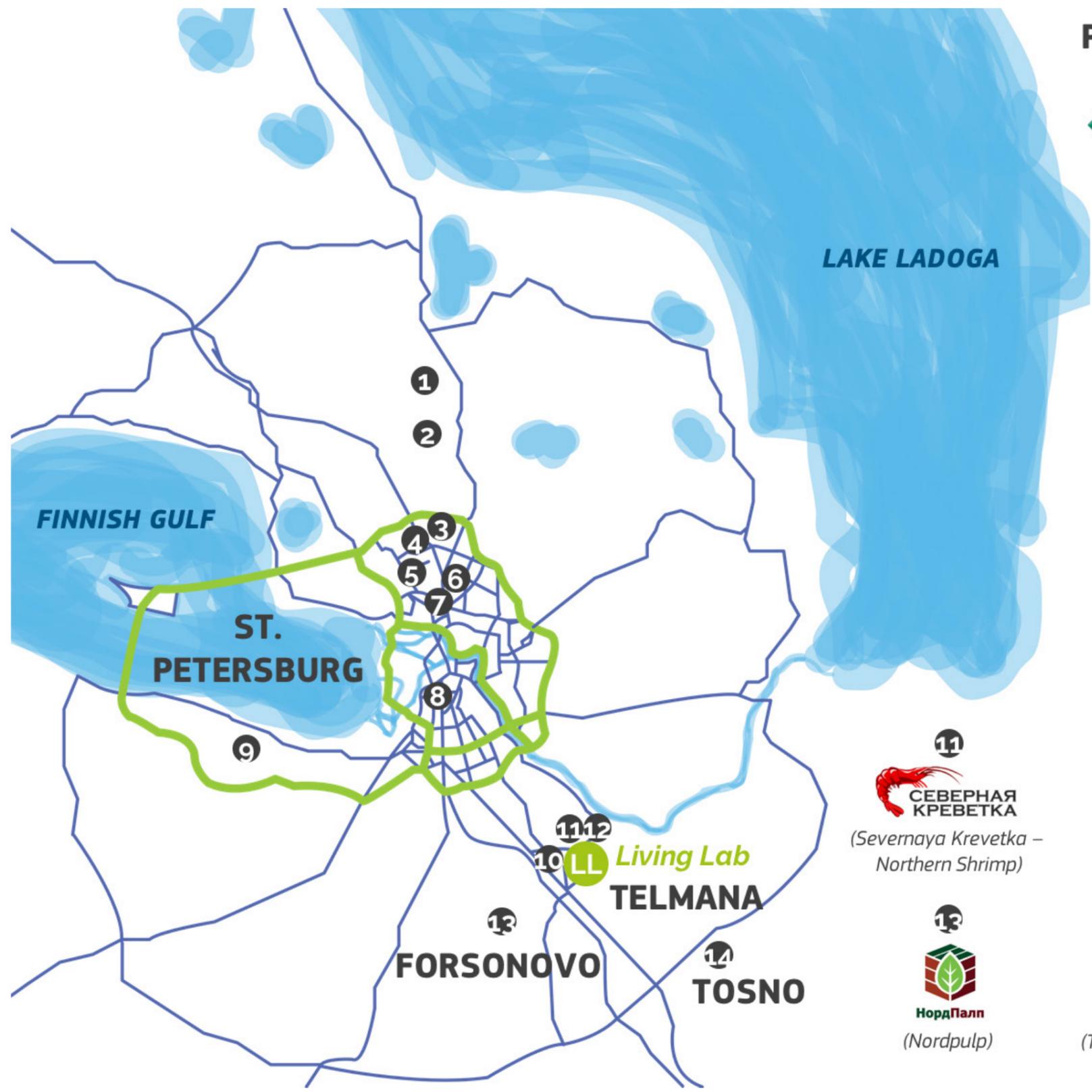
PETROZAVODSK

15 ООО «Карелприродресурс»
(Karelprirodresurs)

LAKE LADOGA

FINNISH GULF

ST. PETERSBURG

9 BIOCAD Biotechnology Company
(BIOCAD)

10 *(Tosnensky meat processing plant)*

11 СЕВЕРНАЯ КРЕВЕТКА
(Severnaya Krevetka – Northern Shrimp)

12 УМНАЯ SREDA
(Umnaya Sreda – Smart Environment)

11 12 10 LL *Living Lab*
TELMANA

13 НордПалп
(Nordpulp)

14 ТОСНЕНСКИЙ КОМБИКОРМОВЫЙ ЗАВОД
(Tosnensky Mixed Feed Factory)

FORSONOVO

TOSNO

GDANSK UNIVERSITY OF TECHNOLOGY

Legal organisational structure: None

Location: Gdansk, Poland

Founding year of facilitating organisation: 2012 (Oil & Gas Centre)

Webpage: https://chem.pg.edu.pl/bis/strona-glowna

The department of Chemical Technology at the Gdansk University of Technology is at the beginning of looking into how the university can best support and establish an industrial symbiosis or symbiotic relations between companies in the Pomeranian region.

The University is currently at the stage of investigating potential local collaborations by identifying interested stakeholders, building awareness of the potentials of Industrial Symbiosis and being present at relevant events. They experience a positive reception of industrial symbiosis from stakeholders. These activities provide the department with experience of the facilitating role of industrial symbiosis[1]. At the time of writing there has not yet been formalised a partnership between companies in the Region and the University to facilitate industrial symbiosis activities, however this is progressing as part of the Baltic Industrial Symbiosis project.

History

The Gdansk area has a long history of resource sharing between companies, such as using the by-product sulphur from oil production to produce phosphate fertilisers, to which the University has contributed with research, students, and funding[2].

Between 2017 - 2019, the University participated in the EU funded project "Urban Baltic Industrial Symbiosis", where they expanded their network, achieved closer contact with companies and gained access to an international network within industrial symbiosis, which has led to their involvement in the BIS project. Gdansk University of Technology contributed with knowledge in environmental technology and process engineering, which resulted in the pilot of a low-temperature heat recovery from gas with several benefits, for example absorbing impurities such as carbon dioxide and to be used for heating water. This result gave the University a valuable example of industrial symbiosis in practice in a country with current limited experience.

An initial step promoting industrial symbiosis in the Pomeranian region by Gdansk University of Technology was done through the establishment in 2012 an Oil & Gas Centre at the University. The Oil and Gas Centre was established to perform tasks primarily in the field of unconventional fuels, particularly in the field of oil and shale gas. The role of the Centre was among others to connect relevant organisations. Cooperation with exploration and production companies as well as local and administrative authorities. In the longer perspective the area of interest of the Centre was developed towards activities related to the circular bioeconomy. Currently, the research area is still focused on fuels (hydrogen, DME, waste-to-energy) and the consideration also complies the energy storage as well as technologies of new battery systems and their subsequent recycling. The Centre has no legal organisational structure, however the new vision of the Oil & Gas Centre is to take its learnings and transform the set-up into a Centre focused on industrial symbiosis facilitation[3].

Guide for industrial symbiosis facilitators

FOOTNOTES

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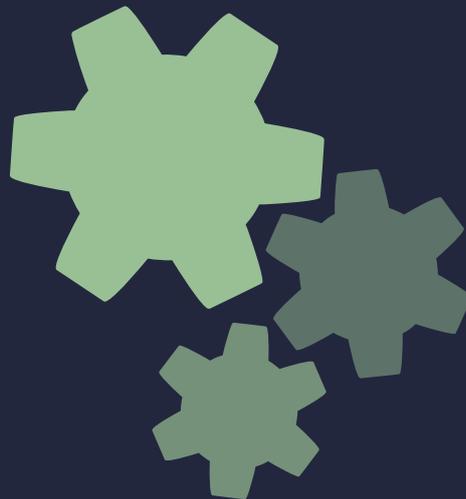
Kalundborg Symbiosis:

www.symbiosis.dk

Transition:

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