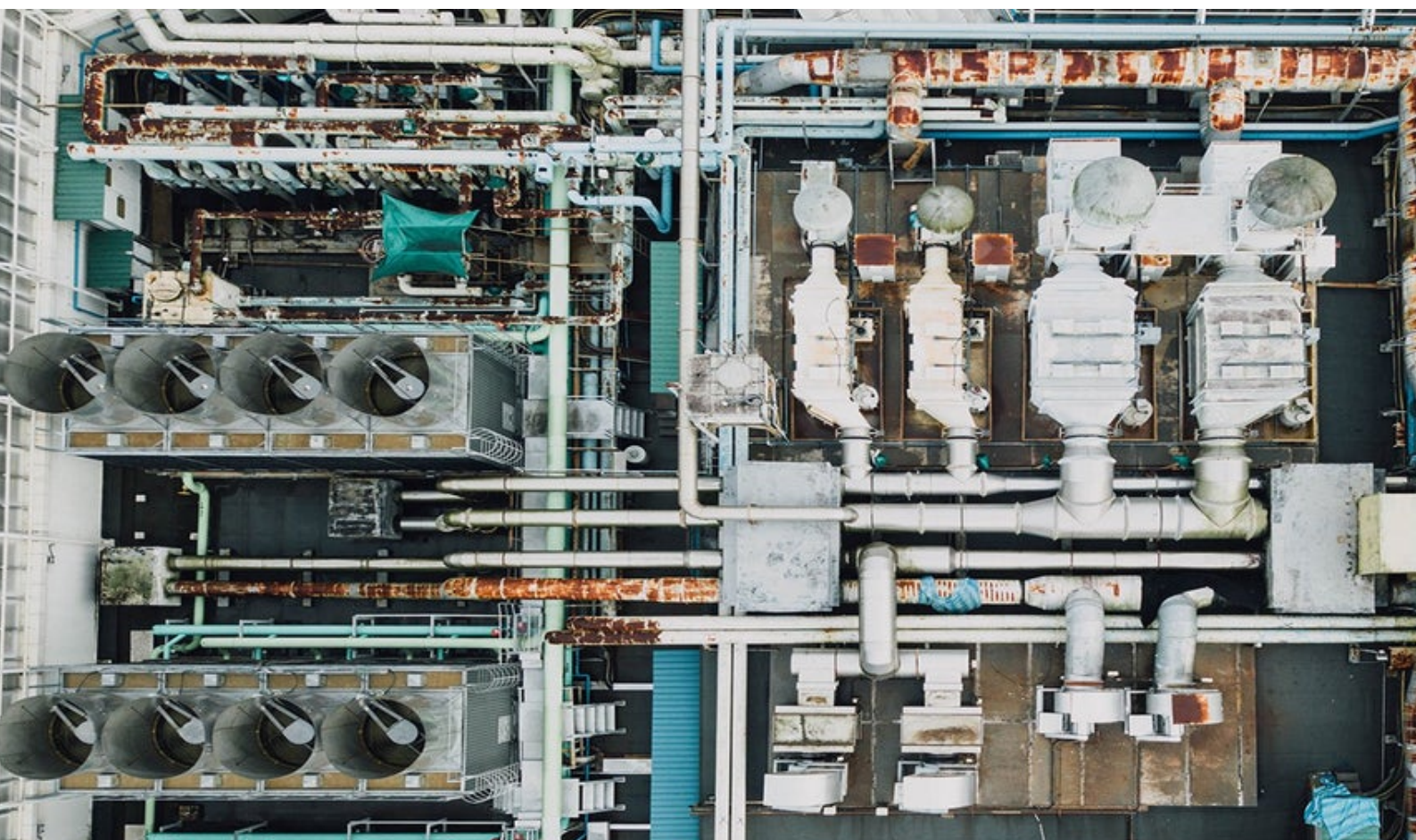


GUIDE:**HOW CAN MUNICIPALITIES SUPPORT THE
DEVELOPMENT OF INDUSTRIAL SYMBIOSIS?****Authors:**

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1 EXECUTIVE SUMMARY

Industrial symbiosis can be defined as a situation when the waste or residuals of one entity are transferred to another for utilisation in production processes. The concept of industrial symbiosis has similarities to natural symbioses where different organisms collaborate for mutual advantage and where no resources are wasted. Industrial symbiosis is achieved through a collaboration between entities for mutual economic and environmental benefits through the exchange of by-products.

Industrial symbioses can also benefit municipalities by attracting companies to locate to and/or remain within the municipality, ensuring jobs and tax revenues, draw in further partners, create a strong local brand and perhaps also assist in reducing waste treatment costs. How can interested municipalities support the initiation, development and expansion of industrial symbioses within or overlapping their borders? That is the key question which this guide aims at addressing.

The guide builds upon nine cases, where municipalities in the Baltic Sea region¹ have influenced an industrial symbiosis. Data has been collected via interviews with representatives of the municipality in question and one or two company representatives of the industrial symbiosis, followed up by desktop study. The guide both looks into the organisational enablers within the municipality, as well as how municipalities can support industrial symbiosis through business development, waste- and supply services, land use planning, and public procurement. It also considers how municipalities can seek to mitigate obstacles to industrial symbiosis that might otherwise arise in law and operations administered by municipalities, for example in waste treatment and land-use planning

The aim of the guide is to enrich and inform the tool box of the municipalities to support the development of industrial symbiosis through experience sharing. The project has been commissioned by the Baltic Industrial Symbiosis (BIS) Project (2019-2021) and financially supported by the European Regional Development Fund, together with Norwegian and Russian funding.

The study finds that a municipality can play a strong role in seeding, development and expansion of an industrial symbioses by:

- Including objectives for industrial symbiosis within a broader **vision** of sustainability, which all political and administrative **leaders** actively support and work towards
- Addressing industrial symbiosis in local **strategies** that legitimise supportive actions and ensure funding, as well as link industrial symbiosis to the municipality's other strategies on local development, business promotion, and/or sustainability
- Creating the right **systems** to support industrial symbiosis such as compiling databases of waste- and resource streams, organising networking meetings, and establishing innovation hubs
- Establishing a **structure** of responsibilities and tasks related to industrial symbioses
- Ensuring motivated and qualified **employees** with the right skills to support industrial symbioses such as facilitation-, communicative-, and planning skills
- Fostering an entrepreneurial and collaborative **culture** of trust and innovation by engaging employees and by establishing development departments within the municipalities with room for creativity
- Participating in **partnerships** in order to share knowledge and to identify new synergies

¹ Covering Denmark, Finland, Norway, Poland, Russia and Sweden. However, limited experiences have been identified in Poland and Russia, thus the focus is on the Nordic countries.

- **Communicating** internally and externally thereby contributing to engaging employees, efficient partnerships, and a supportive culture.

The study further finds that a municipality can support the development of an industrial symbiosis through actions under four administrative areas:

Land use planning:

- Actively planning industrial areas, where companies that have potential to exchange resources can locate close to one another, through collaboration between planning and business departments. It can further be an advantage to plan industrial areas in advance to be able to offer a plot when a potential industrial symbiosis has been identified.
- A disincentive for exchange of excess energy is taxation of the consumption of energy, but by establishing a 'Harbour model', where the municipality owns the plot and rents it out to an administrative body, which again rents it out to companies, taxes on energy only need to be paid for the first use. This has been done in the municipality of Skive (Case 2). The example demonstrates how it pay-off to identify challenges in the planning process and assess whether these can be overcome.
- Plan to avoid or mitigate threshold limit values of noise, odour.
- Planning supportive infrastructure such as areas of renewable energy, grits, transportation, and waste collection.
- Engaging stakeholders to ease potential conflicts such as the visual outlook of heavy industry, dust, noise, smell, increased traffic, which are typically characterising industrial areas.

Waste- and supply management:

- Building suitable energy, transport, waste collection/treatment infrastructure to capture symbiosis opportunities
- Ensuring clean municipal waste fractions
- Facilitating dialogue across the value chain.

Business development:

- Identifying existing industrial strengths within the municipal area such as aquaculture, agriculture, or heavy industries, around which an industrial symbiosis can be developed.
- Creating awareness of the benefits of industrial symbiosis among businesses
- Screening/mapping resource- and waste streams and demands
- Facilitating match-making and knowledge exchanges through network building and maintenance. In this facilitation, it is key to build trust between stakeholders. Trust often emerges as a result of personal relations. Smaller, rural communities where everyone knows everyone, are often characterised by a high degree of trust, which the development of an industrial symbiosis can benefit from.
- Acting as a neutral facilitator between (potential) partners in an industrial symbiosis

Green public procurement:

- Developing procurement criteria that award points or otherwise give advantages to circular products and services.

2 INTRODUCTION

Resource scarcity, climate change, and loss of biodiversity indicate that the human activities and demands currently exceed planetary boundaries. Circular economy has been identified as one potential solution to these challenges by recirculating resources in the economy, avoiding waste generation, and gaining as much value as possible from limited resources. A circular economy can potentially reduce the demand for virgin resources, decrease carbon emissions from production, and give more space for nature and biodiversity to flourish.

Industrial symbiosis is a circular economy strategy, where one or more companies' waste and residuals become resource inputs to another company. Industrial symbioses are often located in industrial parks that foster innovation and collaboration between the companies. A municipality can support the development of an industrial symbiosis, and thus contribute to the realisation of carbon-reductions and decrease in resource demand. At the same time, the municipality can attract companies, create jobs, increase tax revenues, reduce waste management costs and brand themselves through an industrial symbiosis.

But what is the role of municipalities in industrial symbioses? And how can municipalities better support the initiation, development and expansion of an industrial symbiosis while ensuring that other municipal goals are met?

These two questions are addressed in this guide, which is based on the findings of nine cases from countries around the Baltic Sea where municipalities have somehow played a role in the development of an industrial symbiosis either through *land use planning*, *waste management*, *business development*, or *green public procurement*. In addition to the tool box linked to each of these four administrative areas, the guide also lays out the enabling organisational elements that can be put in place to support an industrial symbiosis. These enabling organisational elements are presented in the chapter 3, followed thereafter by potential actions within the four administrative areas. The nine cases appear at the end of this guide, but are referred to throughout the guide.

The guide is a product of the Baltic Industrial Symbiosis (BIS) project, which aims to support industrial symbioses across the Baltic Sea Region by establishing peer-to-peer exchange among practitioners. BIS is funded by the European Regional Development Fund, supplemented by Russian and Norwegian funding.

3 THE ROLE OF THE MUNICIPALITY

The municipality can play a wide range of different roles in an industrial symbiosis. The roles can include:

- An **initiator** that plans the industrial symbiosis and bring the right stakeholders together.
This is seen in the municipality of Skive in Denmark that guided by a strong circular economy vision took the initiative and drove the first steps in the development of GreenLab Skive (see Case 1)
- A **facilitator** that impartially facilitates dialogue and networking between the partners of an emerging or established industrial symbiosis.
The municipality of Kalundborg, Denmark, played such a role in the case of the well-known Kalundborg symbiosis², which eases communication, gives opportunities for all partners to have their say, and helps to avoid conflicts between partners.
- An **owner** of waste- and supply services that can be part of the industrial symbiosis.
The municipal waste treatment company in Fredrikstad, Norway (see Case 6) delivers high-pressure steam to local companies, and one of these companies makes water treatment products from, amongst other inputs, local byproducts from the industry. These products are sold back to the municipality.
- An **authority** that carries out environmental supervisions in companies as well as handles any claims due to e.g. noise or odour that an industrial symbiosis generates.
In the municipality of Malmö, Sweden environmental supervisions are used to communicate the potential benefits of industrial symbiosis to the companies. In that way, the municipality of Malmø exploits the channels they already have established to communicate about industrial symbiosis³.
- A **business** that needs to balance revenues and costs, and which can work strategically to support an industrial symbiosis.
An example is the inter-municipal waste company, of which Næstved is part owner, that due to a wish to reduce waste collection costs collects metal, plastics and glass (MGP) from households together in a single fraction. This unfortunately has been found to contaminate the glass waste and disables recycling by the industrial symbiosis, the “Glass Cluster”, also located in Næstved. Due to this and other identified problems MGP collection will be phased out across the whole of Denmark by 1st of January 2025. This reflects that the different department in a municipality need to communicate, but also that inter-municipal waste companies need to balance conflicting interests and economic concerns – as do the municipalities.

The role a municipality should take is dependent on the development stage of the IS.

Broadly speaking, there are eight enabling organisational aspects that can assist a municipality in supporting the initiation, development and expansion of an industrial symbiosis: Vision and leadership, strategy, structure, systems, employees, culture, communication, and partnerships (see Figure 1). The optimal design of these organisational elements for engendering IS are described below and underpinned with case examples.

² Svendsen, N. L., Kaarsberg, S. C., & Watson, D. (2019). Policies Supporting Industrial Symbiosis in the Baltic Sea Region. *Baltic Industrial Symbiosis*

³ Svendsen, N. L., Kaarsberg, S. C., & Watson, D. (2019). Policies Supporting Industrial Symbiosis in the Baltic Sea Region. *Baltic Industrial Symbiosis*

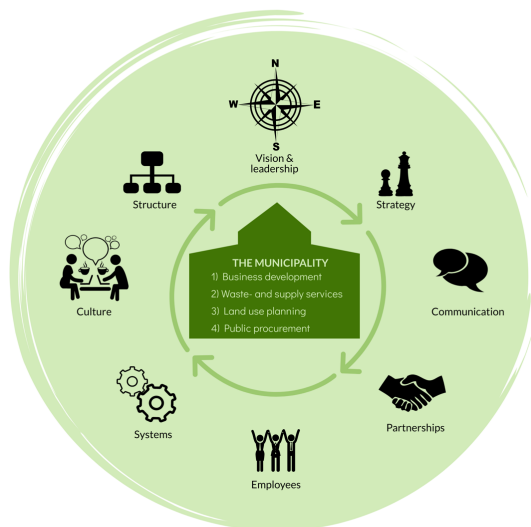


Figure 1: The role of municipalities in developing industrial symbiosis

- Vision and leadership:** The municipality should adopt a clear vision for industrial symbiosis within or overlapping its borders and ensure that necessary political- and administrative leaders support the realisation of the vision.

Skive, Denmark's ambitious "Green Tech Valley" vision inspired creativity and innovative approaches to the establishment of GreenLab Skive – an industrial symbiosis centred around energy (see Case 2). In Digipolis, Finland, the city mayor took an active role in the municipality's Circular Economy Steering Group and points out Digipolis when given the chance in public debates, which legitimised public financial support to the company (Case 4).

- Strategies addressing industrial symbiosis:** As a formalisation of the element above, the municipality can anchor industrial symbiosis in one or more relevant strategies, requiring or enabling the city administration to actively support industrial symbiosis. Industrial symbiosis objectives can be anchored by, or integrated into strategies on land planning, business promotion, and/or sustainability. Objectives for IS in such strategies can be linked to earmarked funding and/or a concrete action plan that prescribe how the objective should be implemented in practice.

Næstved Municipality in Denmark, has established "Ressource City" (Case 1), which is mandated through Næstved municipality's Business Development Strategy and its Land Planning Strategy. Ressource City furthermore has its own strategy. The strategies taken together provide a clear political mandate to act towards circular economy. Ressource City has received a ten-year grant in order to implement the strategic goals for circular economy including the Glass Cluster.

On the island of Gotland⁴, Sweden industrial symbiosis is included within the Region's Regional Development Strategy 2040 and in its Growth Plan 2021-22 (see Case 9). This combination of long-term and short-term strategies allows the setting of relevant goals for different time horizons. The inclusion of industrial symbiosis in regional planning ensures that IS becomes an integral part of the future development of the island.

Hitra Municipality, Norway, adopted a strategic plan for the development of the Hitra Industrial Park, a centre of aquaculture symbiosis (see Case 5). The strategy has created organisational anchoring and ensured trust between the various departments of the municipality, allowing the administration of the

⁴ Region Gotland which was formed in 2011 enjoys both regional and municipal mandates and responsibilities <https://www.gotland.se/104323>

industrial park to work independently and autonomously with the tasks at hand. This has led to strong executive powers and allowed rapid progress in the development of the Park.

- Systems:** A municipality can wield various system-based tools to support industrial symbiosis. The concrete tools applied by the municipalities are described under the four administrative areas. *Mapping of resource and waste streams can be an important first step in identifying potential industrial symbioses. Such a mapping of resources brought the Thams cluster in Norway⁵ to life and was a key activity in the identification of potential reusable resources in the Digipolis IS, Finland (Case 4). Such mappings of resources are based on digital platform systems, where resources are registered and can be reviewed.*

Sotenäs Symbiosis Centre utilizes life cycle analysis as a tool to quantify progress in the environmental benefits of industrial symbiosis. This can be quantified for the network as a whole or for individual firms in the network. Sotenäs municipality also views testbeds as an effective system to enhance innovation and development in the field of industrial symbiosis (Case 8).

- Structure:** A municipality can create administrative structures and allocate responsibility and tasks in such a way as to effectively optimise support to industrial symbiosis. This can differ from municipality to municipality depending on needs, but can include a department or individuals dedicated to the development of IS who are also given a mandate to cooperate with other departments and with industrial partners. Administration of IS can also be partly outsourced to private companies.

Digipolis in Finland (Case 4) has ten employees dedicated to foster industrial symbioses. The roles of the employees are flexible, which allow them to support development on a project-by-project basis. The main responsible person for industrial symbiosis in the municipality of Gotland, Sweden, belongs to the 'Sustainable Growth' department (Case 9). However he has been given a strong mandate to communicate and collaborate with employees in other municipal departments who have relevant competencies. This includes the Community Development team and engineers from the waste, water and energy management departments.

In ECO3, Finland (Case 3), there is currently one full-time employee in the platform company managing the cluster; Verte Ltd., and it is more common to delegate most tasks to independent companies outside the cluster. This ensures that the right competencies are in place and gives the company a flexibility to hire consultants on project basis.

- Employees:** It is a considerable benefit if employees engaged to support IS have the right set of competencies and are highly motivated. Required competencies can differ depending on the role of the municipality in the IS.

Across all the cases competent and motivated employees have been key in initiating, developing and expanding industrial symbioses. In Skive, creativity, communication- and planning competencies were essential to realise GreenLab Skive. In Næstved, the ability to communicate and facilitate networks have contributed to establish a strong network of companies in the municipality, and led to new collaborations.

In Hitra Municipality (Case 5), the Municipality is actively involved in a cooperation group together with industry, creating an arena for communication, problem solving and a shared "we-feeling", enabling and strengthening trust between the parties.

- Culture:** Building a supportive culture of trust, innovation, and collaboration with and between local companies and other stakeholders can be a key enabler of industrial symbiosis. *Many employees in Skive municipality have at some point been involved, to a greater or lesser extent, in*

⁵ Svendsen, N. L., Kaarsberg, S. C., & Watson, D. (2019). Policies Supporting Industrial Symbiosis in the Baltic Sea Region. *Baltic Industrial Symbiosis*

contributing to the development of GreenLab Skive, and have developed an ownership perspective and pride over GreenLab Skive.

The Sotenäs Symbiosis Centre promotes a creative culture and out-of-the-box thinking in order to enable innovative ideas by allowing flexibility in the roles and responsibilities of the employees at the centre.

In Hitra municipality a culture created and shaped by stakeholders' proximity to natural resources has been instrumental for the aquaculture IS to be established. Embracing and employing this culture in new industrial endeavours is of paramount importance. A "we-feeling", and trust in and mandate for the operational administration to solve their tasks is crucial for the islanders at Hitra.

- **Partnerships:** To support the development of an industrial symbiosis requires public-private and triple helix partnerships (public, business and research collaboration) to ensure sufficient knowledge to inform the development of an industrial symbiosis as well as to identify new synergies.

Sotenäs municipality collaborates with about 10 universities and institute in order to gain more knowledge and experience. Triple helix partnerships enabled Fredrikstad municipality to influence the academic content in new educational programs at local universities/colleges to be aligned towards IS thinking and IS solutions.,

- **Communication:** As industrial symbiosis is a collaboration between several entities exchanging resources, sufficient communication is important to create trust and common understanding of the cooperation. Besides, external communication can inspire other actors to engage in industrial symbiosis and contribute to brand the industrial symbiosis and the municipality.

Ressource City in the municipality of Næstved works to communicate on the Glass Cluster, which has raised attention and has contributed to a strong branding of the municipality. In Digipolis, a systematic external communication was particularly important due to the geographically dispersed nature of the partners in the symbiosis and the need for a wider contact surface with a variety of stakeholders. The Sotenäs Symbiosis Centre organises study visits in order to raise awareness and spread knowledge and experiences externally.

In the municipality of Skive, Denmark, the municipality invited citizens to participate in public meetings about GreenLab Skive. At the meetings the citizens were explained about the vision and ambition of the GreenLab Skive, and they were able to 'smell' the biogas plant. The citizens were further invited to generate ideas for making GreenLab Skive more attractive. Some of the ideas were to establish a path around the industrial area and plant trees, which have been realised by the municipality.

4 LAND USE PLANNING

Land-use planning is a critical factor that can support or hinder the development of industrial symbiosis. Municipalities do not have full freedom to utilise land-use planning as they see, but must navigate within national and sometimes regional policy landscapes. This policy landscape is briefly described for each of the countries around the Baltic Sea Region below. Thereafter, it is described how municipalities can support industrial symbiosis through land-use planning.

4.1 Policy landscape

There are some variations in how responsibility for land use planning is organised across governmental levels between countries. However, in all Nordic countries, municipalities are responsible for developing and

implementing local plans. Local land use planning is regulated by national planning legislation as well as various environmental protection legislation typically concerning the protection of valuable habitats and nature types e.g. forests or water environments as well as biodiversity. In EU, Environmental Impact Assessments need to be carried out for greater building projects with significant environmental impact⁶. EIA informs about a construction's impact on the environment. An EIA can ensure compliance with environmental regulation, and inform the decision making in a way that the construction harm the environment as little as possible. Legislation on cultural values and tourism can also affect the land use planning. The policy landscape affecting the planning of industrial symbiosis is described below for each of the countries.

4.1.1 Denmark

In Denmark, the municipalities are responsible of preparing local plans every fourth year. The local plans require approval from the Danish Business Authority and the Environmental Protection Agency. The Planning Act aims to ensure that economic, social and environmental concerns are balanced in local plans. It is the city/county council that decides the actual balance between the different societal concerns⁷.

Municipalities are to safeguard the operating conditions and development opportunities for production-, transport-, and logistics companies, which is a theme in local plans (according to §11.b, 16, in the Planning Act). The municipalities can protect and promote new and existing production-, transport-, and logistics companies by reserving zones for industry placed outside urban areas to avoid conflicts with threshold limit values of noise, odour, dust and other air pollutions. Areas where industry is likely to affect environmental sensitive areas can be pointed out as a "consequence area" indicating that the municipality should pay attention to the pollution of a given area and, in some cases, develop a mitigation strategy. The Land Use Act states that production-, transport-, and logistics companies of national interest must not be imposed stricter requirements due to local planning⁸.

To avoid scattered and unplanned buildings, land in Denmark is divided into three zone types: urban areas, open land, and summerhouse areas (according to §34 in the Planning Act). In open land zones, municipalities can only allow construction of buildings that are related to agriculture, forestry, or fishing⁹. The municipalities can change zones in local plans, but these changes must be approved by the Business Agency and Environmental Protection Agency. As local plans are made and approved every fourth year, the planning of an industry park should be planned well in advance.

Danish municipalities are obliged to reserve industry areas that include infrastructural concerns, and which allow for the industry area to develop further. Danish municipality moreover has a great mandate in land use planning within the environmental regulation framework. The greatest challenge is to find proper space, as most of the land is currently taken.

4.1.2 Finland

In Finland, land use planning is defined in the Land Use and Building Act issued in 2000 and revised in 2020¹⁰. Here, the main objectives are to create the basis for high quality living environments, to promote ecologically, economically, socially and culturally sustainable developments, to ensure participatory planning processes, and finally to guarantee the quality and transparency of planning decision processes, and to ensure the availability of planning expertise. The highest priorities are achieving good living environments and sustainable development¹¹.

⁶ EC (2014). *Environmental Impact Assessment (EIA)*: <https://ec.europa.eu/environment/eia/eia-legalcontext.htm>

⁷ The Danish Business Authority (2017). *Plantemaer*: <https://planinfo.erhvervsstyrelsen.dk/plantemaer>

⁸ The Danish Business Authority (2020a). *Produktionsvirksomheder, transport- og logistikvirksomheder*: <https://planinfo.erhvervsstyrelsen.dk/erhverv>

⁹ The Danish Business Authority (2020b). *Zoneforhold*: <https://planinfo.erhvervsstyrelsen.dk/zoneforhold>

¹⁰ Finnish Ministry of Environment (2020) *Land Use Planning System*. Received on 12 of October from https://www.ymparisto.fi/en-us/living_environment_and_planning/Land_use_planning_system

¹¹ VASAB (2018a) Country Fiche on Terrestrial Spatial Planning - FINLAND, VASAB.org

There are three levels of planning in Finland. It is the municipalities that draft and approve local master plans and local detailed plans. The municipalities are guided by regional plans drafted and approved by the Regional Councils (with representatives from all municipalities within the region) with long-term principles on regional land use and the community structure. Finally, the development and adoption of regional plans is steered by National Land Use guidelines issued by the Finnish Ministry of Environment¹². The Land Use Guidelines aim among other things to achieve the objectives in the Land Use and Building Act.

Overall, the planning system is hierarchic (top-down) and vertical coordination ensures that national goals are considered at local level. The Regional land use plans are legally binding for the Local master plans, which are in turn legally binding for Local detailed plans, and all plans are steered by the National Land Use Guidelines. The country is currently undergoing a regional reform, where regions will be given a greater mandate in land use planning¹³.

The plans are flexible and can vary in their level of detail and instruction. They can be very general strategic documents or detailed prescriptions for direct regulation of land use. The local master plan can cover an entire municipality or only parts of it. The latter are called Partial master plans. Municipalities may cooperate in drafting joint local master plans in which case they must be approved by the Ministry of Environment¹⁴. The local master plans issued by the municipalities define the location, size and function of what may be built. They must promote healthy living environments while developing infrastructure and protecting natural and built environments¹⁵. This includes taking into account the functionality, economy and ecological sustainability of community structures, the reduction of environmental hazards, business conditions and opportunities to organise sustainable energy, water and waste management.

The local master plans can support industrial symbiosis through ensuring proper infrastructure for long-distance transport, as long distances are a potential barrier for symbioses in the large country. It is in the local master plans that energy systems which can potentially receive secondary resources are drafted. Finally, the local masterplans affect the built environment through individual building approvals and wider zoning, and through other parameters defining the business conditions such as good access to services.

In Finland, the municipalities have a smaller mandate in land use planning, compared to the other Nordic countries, as the regions are playing a greater role. As a result, vertical coordination is vital in planning industrial symbiosis. The municipalities can contribute to plan industrial symbioses by planning infrastructure of long distances and energy systems.

4.1.3 Sweden

The physical planning in Sweden is regulated by the Planning and Building Act¹⁶. Municipalities have the main responsibility for planning. The purpose of the provision is, with regard to the freedom of the individual, to promote societal progress with equal and proper living conditions and a clean and sustainable environment, for current and future generations.

¹² Finnish Ministry of Environment (2020) *Land Use Planning System*. Received on 12 of October from https://www.ymparisto.fi/en-us/living_environment_and_planning/Land_use_planning_system

¹³ VASAB (2018b) Country Fiche on Terrestrial Spatial Planning - FINLAND, VASAB.org

¹⁴ The Finnish Ministry of Environment Forest and Nature Agency, Denmark (2004) Regional planning in Finland, Iceland, Norway and Sweden, Nordregio

¹⁵ The Finnish Ministry of Environment (2020) *Land use planning*. Received on 12 of October from https://www.ymparisto.fi/en-us/living_environment_and_planning/Land_use_planning_system/Land_use_planning_system

¹⁶ Plan- och bygglag (2010:900)

The Planning and Building Act does not prioritise between different societal concerns - that is the responsibility of the municipalities. What is described in the Planning and Building Act is *how* the process of planning needs to be carried out. For example, the municipality needs to announce that there is a plan proposal for a certain area and during what period comments can be submitted, and after any adjustments, the municipality shall give all those affected the opportunity to review the finished proposal. In addition to the Planning and Building Act, the third chapter of the Swedish Environmental Code¹⁷ contains basic provisions for management of land and water areas and these shall be applied when deciding on planning and when considering matters concerning permission or prior notice.

A municipality's comprehensive plan covers the entire municipality and presents the basic characteristics of its intended use of land and water areas. Furthermore, a detailed development plan enables the municipality to regulate particular areas. The detailed development plans are legally binding for building permits.

Most municipalities promote industrial activity as part of their job creation strategy. According to the Municipal Act¹⁸, municipalities may implement measures to promote business in the municipality. However, individually oriented support to individual companies may only be provided under special circumstances, which are defined on a case to cases basis. Municipalities may allocate land for industrial development in the comprehensive plan and can prepare detailed development plans to allocate areas suitable for industrial use.

Planning of industrial areas involves taking into consideration environmental concerns such as odour and noise, and aligning with the existing and planned water, energy and transport infrastructure. For example, one could investigate how to facilitate environmentally-friendly commuting and transportation of goods. Also, if the implementation of a detailed plan can be assumed to have a significant environmental impact, the municipality needs to carry out an environmental assessment of the plan.

Overall, the municipalities in Sweden seem to have a major role in establishment of industrial symbioses. They have to, nevertheless, adhere to the national legislations, especially with reference to the planning process and environmental permits.

4.1.4 Norway

In Norway, the actual physical planning process of relevant areas is regulated by the national Plan and Building Act (PBA)¹⁹. One central element connected to the PBA is a regulation requiring Environmental Impact Assessment (EIA) for projects of a certain type and scale. This, in general, always applies to the municipal overall planning strategies, area plans and other municipality partiality plans, regional plans and zoning plans, when plans involving measures (specified in the regulation's appendix) that could harm nature, environment or communities. This applies also if the plans are regulated by other acts or regulations than the PBA. Examples are power plants for heating or melting of cast iron, water dams, mining or production of paper mass.

In addition, the national *steering structure* is constituted by governmental guidelines / expectations from government/cabinet resolutions (which in Norway is anchored in the UN sustainability goals). Subordinated to this is national policy guidelines on a regional level, following the PBA, and thereafter, municipality level regulation plans and in addition municipal societal- and area plans. The municipalities can themselves constitute the plan, but the County has a guiding role and, among other relevant affected public

¹⁷ The Swedish Environmental Code <https://www.government.se/legal-documents/2000/08/ds-200061/>

¹⁸ Kommunallag (2017:725). https://www.ymparisto.fi/en-us/living_environment_and_planning/Land_use_planning_system

¹⁹ Plan- og bygningsloven (2008). Received from <https://lovdata.no/dokument/NL/lov/2008-06-27-71>

parties, can make objections to the plans in cases of significant regional or national importance. If this is done, the objection will be sent to the Ministry of Local Government and Modernisation.

The local municipality can, as a consequence, prioritize what purpose various parts of the area should be designated to (for example industry, nature conservation, farming, residential areas and so on), and, when required (by law or the consequences of the project) also develop a zoning plan. The PBA states that a zoning plan should be developed by the municipality for all major measures that can affect environment or society, and permission cannot be given for such measures without a zoning plan present.

In addition to the regulations regarding zone planning in the PBA, the municipalities can also define specific areas as '*consideration zones*', meaning that the area part of the plan should show special consideration to the extent necessary for the area under consideration. This can be related to issues as noise, special infrastructure requirements, farming, mineral resources or herding of reindeer.

The municipalities also need to apply the Norwegian Pollution Act²⁰. The Pollution Act states that it is illegal to pollute, but it is also possible to apply for exemptions. The application from the polluter should go to the relevant Plan authority (municipality), and in addition, the polluter needs to get a permit (to pollute) from either the County Governor (minor pollutions or risk of) or the national Environmental Agency (major pollutions or risk of). A general principle is that the polluter pays the costs related to the pollution, and that there can also be set limits by the County Mayor or Environmental Agency.

All applications are also considered in relation to the Biodiversity Act²¹ to preserve nature's biodiversity.

All land use planning, or change, involving measures that could affect environment or society needs – by law - to be assessed, so that eventual impacts or consequences are transparent (to all interested parties) and can be objected to by public institutions. The responsibility and/or access to object is shared between various public agencies or institutions, but more important is it that the final word lies with the national ministry – meaning that the power to decide what kinds of industrial symbioses can be realized are national and centralized. In other words, the municipalities are dependent on acceptance from before mentioned public institutions and finally, if plans are objected to, the national ministry.

4.1.5 Russia

In the Russian Federation, it is mainly the Town-Planning Code of the Russian Federation²² that regulates spatial planning. However, spatial planning is also guided by goals, priorities and tasks set in several other federal strategic and socio-economic planning documents such as the Energy Strategy of Russia for the period up to 2030²³.

Furthermore, there are a number of decrees and legal documents that do not formally refer to spatial planning documents, but are closely related to them by content, such as Fundamentals of the State Policy of Regional Development of Russia for the period up to 2025 (approved by the Presidential Decree of 16.01.2017 N 13). Here, for instance, goals for regional development are defined, including ensuring sustainable economic growth and scientific and technological advancement of the regions, increasing international competitiveness of the economy and improving quality of life. Similar goals and priorities are stated in the Decree of the President of Russia of 07.05.2018 N 204 "On the national goals and strategic objectives of the development of the Russian Federation for the period up to 2024" (aiming at, among other things, accelerating economic growth and technological development) and The Strategy of Spatial Development of

²⁰ Lov om vern mot forurensninger og om avfall (1981). Received from <https://lovdata.no/dokument/NL/lov/1981-03-13-6>

²¹ Lov om forvaltning av naturens mangfold (2009). Received from <https://lovdata.no/dokument/NL/lov/2009-06-19-100?q=biologisk%20mangfold>

²² (RF Code of 29.12.2004 N190-FZ)

²³ Approved by the Government of the Russian Federation of 13.11.2009 N 1715-p

the Russian Federation for the period up to 2025 (prioritising the development of potential centres of economic growth).

At Federal level separate land-use planning schemes are developed for the energy sector, healthcare, tertiary education, country defence and state security and each mode of federal transport. At regional level, regional land-use planning schemes are developed, while in cities of statutory significance, master plans are developed. Finally, at municipal level, masterplans of settlements, masterplans of urban districts and land-use planning schemes of the municipal districts are developed. On all three levels of governance, land-use planning schemes are approved for a minimum period of 10 years. For master plans of settlements and urban districts and other schemes including construction of infrastructure, the minimum period of approval is 20 years. However, amendments are needed rather often due to outdated schemes²⁴.

Overall, it seems that initially the main drivers for industrial symbioses in planning schemes are to be found at Federal and regional level rather than municipal level. Recently, this has been indicated by the adaptation in 2018 of the 'Strategy for the development of industry for processing, recycling and disposal of production and consumption waste for the period up to 2030' issued by the Ministry of Industry and Trade. This strategy includes goals on establishing 70 eco-techno parks by 2030. The locations of these parks are decided by regional authorities on the basis of applications from potential investors²⁵.

4.1.6 Poland

In the Republic of Poland, land use policy is regulated by the Act of 27 March 2003 on land use planning and development, including its several amendments and other regulation, resulting in more than a hundred legal acts²⁶. Three main acts influencing spatial planning are 1) the Zoning and Development Act, 2) the Building Law Act, and 3) regulations issued to implement Building Law and Zoning and Development Act²⁷.

The Republic of Poland is divided into three administrative divisions national, regional and local administrations, with separate legal documents. There are a total number of 2,478 local administrations in Poland²⁸. It is the local administrations that are responsible for creating and maintaining zoning and development policy, while also drafting guidelines for future local development plans. The local development plans issued are legally binding, and it is the responsibility of the Minister of Investments and Development to ensure that each state's development plan aligns with national policy²⁹. However, there is no requirement for the updating of lower-level documents after alterations of higher-level documents. Public investment in infrastructure overrule land use plans³⁰.

In 1994, the Zoning and Development Act was introduced, which became effective in 2003. In practical terms this law abolished all land use plans enacted prior to 1995, meaning that many municipalities found themselves in a legal vacuum, where new plans were not yet prepared. In 2018, only 30,2% of Poland was covered by land use plans³¹. When areas are not covered by development plans, instead, interested parties have to submit building permit applications directly to the local administration. The approval of these applications depends on expected conformity with the existing neighbourhood; at least one plot in the neighbourhood

²⁴ VASAB (2019) Country Fiche on Terrestrial Spatial Planning - RUSSIAN FEDERATION, VASAB.org

²⁵ Svendsen, N. L., Kaarsberg, S. C., & Watson, D. (2019). *Policies Supporting Industrial Symbiosis in the Baltic Sea Region*. *Baltic Industrial Symbiosis*

²⁶ VASAB (2018c) Country Fiche on Terrestrial Spatial Planning - POLAND, VASAB.org

²⁷ DLA Piper (2020) *Applicable Legislation and Governance*. Received on 19th of October from <https://www.dlapiperrealworld.com/law/index.html?c=PL&t=zoning>

²⁸ Stańczak, J., Znajewska, A. (2018) *Population. Size and structure and vital statistics in Poland by territorial division in 2017. As of December, 31*, Statistics Poland, Warszawa

²⁹ DLA Piper (2020) *Applicable Legislation and Governance*. Received on 19th of October from <https://www.dlapiperrealworld.com/law/index.html?c=PL&t=zoning>

³⁰ VASAB (2018c) Country Fiche on Terrestrial Spatial Planning - POLAND, VASAB.org

³¹ VASAB (2018c) Country Fiche on Terrestrial Spatial Planning - POLAND, VASAB.org

must be constructed in a similar manner. Furthermore, there must be access to public roads, the necessary infrastructure must be in place and the land cannot be protected by specific environmental laws etc.³²³³

In 2016, Polish agricultural land was considered vulnerable to foreign speculative acquisition of real estate that would not guarantee the use of the purchased land for agricultural purposes. As a reaction to this concern, the Polish parliament amended the Law on Agricultural land with the Act of 14 April 2016, which suspended the sale of real estate or parts thereof comprising the State Treasury Agricultural Property Stock for a five year period (valid until 29 Apr 2021), with the exceptions of real estate and areas designated in the local zoning plan or the land use plan in the municipality for non-agricultural purposes, including technology parks, industrial parks, business centres etc.³⁴

Overall, the local level in Poland can to plan industrial symbiosis. However, there are few concrete examples.

4.2 Local planning of industrial symbiosis

Local planning is an inevitable aspect of developing industrial symbioses. When planning an industrial symbiosis, the municipality need to take several considerations into account including:

- **Prioritising industrial symbiosis and balance with other societal concerns**

Land use planning is a subtle balance between often conflicting societal concerns including urban development, nature protection, and business development. When an area is reserved for an industrial park it cannot be part of a nature area, used for housing, agriculture or any other purpose. It is up to the municipality to navigate between these conflicting concerns and select the choices that generate most societal value. The impact on other business sectors, nature and species, as well as urban areas should always be taken into considerations when planning an industrial symbiosis in order to reduce negative impacts. In Sweden, if an industrial symbiosis is only a vision – and not a requirement – a municipality cannot refuse a company a plot within an industrial symbiosis, even though it does not contribute to the symbiosis. In the Denmark, the municipality is obliged to point out areas for industries with assess infrastructure.

- **Placing the companies exchanging resources close to one another or relevant infrastructure**

Ideally, entities in an industrial symbiosis should be placed close to one another to reduce transportation costs of the exchanged by-products. This is also the case for exchanges of water, electricity and heat. This can be enabled through locating potential exchanging companies within an industrial park. The municipality of Gotland is, for example, planning such an industrial park. However, there are also examples where it has not been possible or economically viable to relocate existing companies next to each other as seen in e.g. the Glass Cluster in the Municipality of Næstved, Denmark, where the two main exchanging companies are placed 10 km away from one another or in Digipolis where the platform is spread out across Lapland and even includes companies from northern Sweden and Norway. In these cases, the municipality can focus on infrastructure and communication.

Municipalities can further priorities companies that exchange resource when allocating space in an industrial park.

- **Ensure the right infrastructure that enable exchange of resources, materials and energy**

The exchange of resources requires grids (typically water, electricity, gas, heat) or road transport infrastructure depending on the resource type. Transportation of solid resource inputs for production is often heavy, implying that a route, which avoids urban areas, should be pursued. Industrial parks are often rather energy consuming; the municipality can therefore consider establishing renewable energy

³² VASAB (2018c) Country Fiche on Terrestrial Spatial Planning - POLAND, VASAB.org

³³ Radzinski, A. (2015) *The system of spatial planning in Poland: time for a change?* AESOP Young Academics. Received on 19th October from <https://aesopyoungacademics.wordpress.com/2015/05/22/the-system-of-spatial-planning-in-poland-time-for-a-change/>

³⁴ Żróbek-Różańska, A. & Zielińska-Szczepkowska, J. (2019). National Land use Policy against the misuse of the agricultural land—Causes and effects. Evidence from Poland. *Sustainability*, 11(22), 6403.

facilities that can feed demand, such as the municipality of Skive has done with both wind turbines and solar panels to provide the GreenLab Skive IS with renewable energy. In Hitra, the municipality has invested in a new harbour, enabling the opportunity of low-energy transport of physical resources to or from the industrial park, for further use elsewhere in the region. Since Hitra is an island, continuous upgrading of roads, including an underwater tunnel leading to the island, is highly significant for resources that are sourced inland.

- **The industrial park should not negatively affect urban areas with noise, odour or pollution beyond threshold limit values**

Industrial parks can be noisy, increase transport to and from the park, pollute locally, and in some instances also emit odours. Therefore, industrial parks can advantageously be located at a distance from housing, offices and recreational areas. If at all possible, it can be a good idea to have a buffer zone around the industrial park that both enable an extension of the industrial park and reduce the negative impact of neighbours. Threshold limit values of noise, odour, dust, and other air pollutions should be complied with in accordance with the Land Use Act. This applies both ways. In symbioses involving sensitive production processes such as the production of food as in Hitra, the industrial park itself should not be negatively affected by the neighbouring areas.

- **Engage stakeholders in the development to ease potential conflicts**

Citizens can be against industrial parks and the construction of larger areas with windmills or solar panels either because such industrial parks affect their view, recreative activities or natural areas, or emit pollution, noise, or smell. To ease resistance and potential conflicts, municipalities can inform about, and engage citizens in, the planning and construction of the industrial symbiosis including the benefit it will create for the city; but also engage citizens in generating ideas that make the industrial park more attractive for citizens. The municipality of Skive has developed its industrial park integrating ideas from citizens such as constructing paths and planting trees, which give the industrial park another visual look. The expectation is that in ten years from now, citizens will use the industrial park for recreation as the trees have grown into a forest decreasing the industrial vibe. Skive municipality also demonstrated the smell that the biogas plant would emit, by simulating the smell, so that citizens had a realistic impression of the risks, which further contributed to citizen acceptance.

5 WASTE MANAGEMENT

In the Nordic countries, municipalities are responsible for collection and treatment of waste from households and similar waste from businesses, often managed by a municipal-owned waste company (sometimes owned by several municipalities). Municipal waste can be a resource stream for exchange with other partners in the industrial symbiosis.

More specifically, municipalities should pay attention to:

- **Ensuring clean waste fractions**

Clean waste fractions, collected separately, and with low levels of contamination can be a pre-requisite for a high share of secondary resources (recycled material) applied in new products. The Glass Cluster, in Næstved, Denmark, uses glass waste collected by municipalities across the country. However, glass that has been collected by municipal waste companies together with plastics and metals (the so-called MGP fraction) is not of high enough quality to be used in new products and cannot be used by the cluster.

- **Facilitating dialogue and collaboration across the value chain**

Facilitation of dialogue across the entire value chain, and in particular between citizens, collectors,

and processors can support that waste is pre-sorted, collected, sorted and treated in a way that increase the value of the waste resource.

6 BUSINESS DEVELOPMENT

In the Nordic countries, municipalities and regional or intra-municipal business hubs can support sustainable and circular business development and the development of industrial symbiosis. The more specialised a business development agency is in circular economy and industrial symbiosis, the more competent an effort to support the development of industrial symbiosis it can deliver.

- **Creating awareness**

Municipalities can play an important role in creating awareness about the business case for circular economy and industrial symbiosis, in particular. Industrial symbiosis has the potential of reducing input and waste treatment costs, unlocking innovation possibilities, contribute to a green and responsible brand, and making the company an attractive place to work. Municipalities typically meet businesses when carrying out environmental control of production sites. Such meetings can be used to promote circular economy and industrial symbiosis as it is done by the municipality of Malmö³⁵.

- **Building competencies within municipalities**

The municipalities need to have the competencies and a proper tool box to support the development of industrial symbiosis. A first step is to build these competencies within key business development agencies; the municipality itself or a related hub. These business development agencies need to have knowledge about circular economy and industrial symbiosis, and competencies in both the technical- and organisational development of an industrial symbiosis, or alternatively outsourcing the task to consultancies. In both Skive municipality and Næstved municipality, a department of development rather than administration can enable innovative thinking and release resources for development projects such as an industrial symbiosis. In Hitra, the municipality has actively tied connections to the local business development hub, inviting to cooperate in various ways to enable and strengthen their joint efforts together with the businesses.

- **Screening of resource and waste streams**

In order to identify potential exchanges of materials between companies and utilities, a screening of all companies' and supply entities' side-streams that feed into an overall mapping is a key tool to support IS. Such a mapping can advantageously be built on digital platforms. By mapping resource flows, it is possible to identify potential industrial symbiosis or other relevant exchanges of resources. The emerging industrial symbiosis in the Thams cluster in Norway was identified through a mapping carried out by students in collaboration with the local business hub, and financed by the region of Trøndelag. Likewise, Digipolis mapped all by-products from companies in the region with quantifications and descriptions of the companies, which resulted in the identification of 1.4 million tons of annual residues that could be used in industrial symbioses.

- **Match-making between companies**

When an industrial symbiosis or otherwise a possible and meaningful exchange of resources have been identified, the companies and entities need to be matched, and the collaboration need to be facilitated. First of all, the municipality should clarify if the parties in the potential industrial symbiosis are willing to join, and if they have proper technological and organisation competencies. It is further important to align expectations and build trust among the parties. The municipality or related

³⁵ Svendsen, N. L., Kaarsberg, S. C., & Watson, D. (2019). *Policies Supporting Industrial Symbiosis in the Baltic Sea Region. Baltic Industrial Symbiosis*

business hub can facilitate such clarifying meetings. Sotenäs Symbiosis Centre in Sweden and ECO3 and Digipolis in Finland have all played important roles in setting up a network of different companies and identifying the possibilities for symbiosis between companies. Hitra Municipality has initiated a mapping and subsequent matching of relevant companies in their region suitable for symbiosis.

- **Providing test beds**

Industrial symbiosis often brings great innovation potential, likewise collaboration among the companies in an industrial symbiosis can deliver economies of scale benefits. The municipalities can support that these innovation and collaboration possibilities are explored. The Sotenäs Symbiosis Centre supports with physical space for business meetings, as well as development of testbeds which allows companies to test new ideas. ECO3 in Finland operates activities to accelerate start-ups and find suitable funding for business development.

- **Neutral facilitator**

During the implementation and operation of an industrial symbiosis, it can be an asset if the municipality can be a neutral moderator between the parties if any disagreement should arise, but also to facilitate and manage the collaboration in general. The municipality of Kalundborg plays such a neutral, facilitating role in administrating the Kalundborg symbiosis³⁶. Likewise, Digipolis operates as a mediating platform not only between private companies involved, but also between private companies and the local authorities.

7 GREEN PUBLIC PROCUREMENT

In theory, municipalities can support the development of industrial symbiosis through Green Public Procurement by demanding or rewarding companies working with circular economy and industrial symbiosis. Only a few concrete examples have been identified, where public procurement have contributed to the development of industrial symbiosis,. Two of these can be found in Sweden and Finland, where the municipalities of Lidköping and Nokia requested biofuels for municipal transportation services, which – together with others enablers - resulted in the construction of local biorefineries that later led to the development of industrial symbioses centred around them³⁷.

It is more common that municipalities promote circular economy through public procurement by demanding that products:

- Consist of less materials
- Consist of clean materials
- Are multifunctional
- Consist of secondary resources (recycled material)
- Are designed to be easily separated, repaired and/or recycled
- Are requested as a service through renting, leasing or sharing
- Are continuously repaired and maintained
- Have a warranty ensuring a long lifetime (or its' sharing parts are)
- Are taken back after end use to be reused or recycled.

³⁶ Svendsen, N. L., Kaarsberg, S. C., & Watson, D. (2019). *Policies Supporting Industrial Symbiosis in the Baltic Sea Region. Baltic Industrial Symbiosis*

³⁷ Linköping University (2020). Industrial symbiosis in Lidköping: <http://www.industriellekologi.se/symbiosis/lidkoping.html>

8 CASES

In the following section, nine cases are presented, in which a municipality has impacted the development of an industrial symbiosis.

8.1 Næstved's Glass Cluster (DK) – when a clean waste fraction is the key

The Glass Cluster symbiosis, in the municipality of Næstved, Denmark, recycles 100,000 tons glass yearly and provides heat for 1,250 households. The recycled material makes up 95% of glass for packaging, while the remaining dust is used to produce insulation. The municipality's circular economy department "Ressource City" has embraced the cluster, and communicated and shared the success-story as part of the Næstved brand. Yet, ironically glass waste from local households in Næstved is collected in such a way that it cannot be used in the Glass Cluster. This highlights a need for clean waste fractions.

Building a Network and Naming the Glass Cluster

Following the economic recession in 2008, Næstved faced declining economic growth and job losses. The city council established "Ressource City" to combat this decline and simultaneously promote resource efficiency, and circular and sustainable business development. At that time the circular economy was not that high on the political agenda nor in the media spotlight, and the establishment of Ressource City was a bold move. Næstved municipality sees Ressource City as a strategical investment³⁸, and it is included in both the new strategy for Business Development³⁹ and in the Plan Strategy⁴⁰.

Perhaps unusually for a municipal department, "Ressource City" prioritises creativity and possibilities rather than administration and paper work. Ressource City's network of companies, knowledge institutions and universities, business hubs, and other public entities enables knowledge sharing on the circular economy across stakeholders. It also allows for informal lobbying and new collaborations. The commercial representatives of the Glass Cluster have met decision makers at these network meetings giving them the possibility to informally discuss challenges on, amongst other issues the current waste regulation.

The Glass Cluster

Key partner in the Glass Cluster, Reiling Glass Recycling, recycles 100,000 tons glass yearly from Denmark. The recycled glass is used in high quality glass products by a further partner, Ardagh Glass Holmegaard. Remaining glass dust is used to produce glass fibre insulation, while surplus heat from the production is distributed to the District Heating Plant 'Fensmark', where it contributes to heat up 1,250 households.

Ressource City was responsible for branding the exchange of secondary glass as "the Glass Cluster" and has communicated the success-story far and wide to inspire others to work with circular economy. Næstved municipality and the Glass Cluster was selected as one out of C40 and Realdania's "Cities 100": 100 cities with an innovative and ambitious approach to reducing climate footprints⁴¹. The communication contributes to a branding of the municipality of Næstved, which can attract both companies and citizens to the municipality. The involved companies have received much attention for their Glass Cluster nationally and internationally.

³⁸ Næstved Kommune (2020). *Ressource City Strategi 2020-2023*: <https://ressourcecity.dk/wp-content/uploads/2020/04/Ressource-City-strategi-2020-2023-2.pdf>

³⁹ Næstved Kommune (2019). *Erhvervsstrategi*: https://naestvederhverv.dk/wp-content/uploads/2019/06/Erhvervsstrategi_maj2019_final-1.pdf

⁴⁰ Næstved Kommune (2016). *Mærk Næstved – Godt liv for familien. Planstrategi*: <https://www.naestved.dk/media/4gtmkmva/planstrategi2016-27.pdf>

⁴¹ Realdania and C40 (2019). *Cities 100 – 100 city projects making the case for climate action*: <https://realdania.dk/publikationer/faglige-publikationer/cities100-2019-edition>

Mixing Fractions Prevents Recycling by the Glass Cluster

The waste company, AffaldPlus, which is owned by the municipality of Næstved and five neighboring municipalities, collects metal, glass and plastics (MGP) together in a single fraction from households in order to reduce costs following a successful smaller pilot.

A combined collection of glass- and metal waste is cheaper to run and waste companies can make profit on the subsequent separation and pre-sorting of metals and glass. Thus, both municipalities and waste companies have economic incentives to establish MGP collection. In Denmark in 2020, 22 out of 98 municipalities collect the MGP-fraction⁴².

However, experiences with MGP collection across Denmark have found that the glass waste becomes contaminated by other fractions⁴³. The result is glass of insufficient quality for use by the Glass Cluster, which is the only example of glass recycling in Denmark. Both Reiling Glass Recycling and Ardagh Glass Holmegaard have found that separate collection of glass is the prerequisite for the business model of the Glass cluster. The glass waste collected from households in Næstved ends up in Poland, where a lower concentration of recycled glass in new products allows the use of the contaminated glass.

Due to glass contamination and as a part of a legislation on separate collection of waste, the Danish EPA will phase out MGP collection across Denmark by January 2025. Yet, the change in regulation allows for a common collection of glass and metals, which will deteriorate the quality of the glass fraction.

ENABLERS

- The political- and management support of Ressource City and its proactive non-bureaucratic approach
- Ressource City creation of a network of companies and communication efforts on the Glass Cluster.

DISABLERS

- Mix of metals, glass and plastics in the MGP fraction collected by the municipal waste company, AffaldPlus, lower the quality of glass waste and prevent use by the Glass Cluster, where 95% of glass in new products comprises recycled material.

⁴² AffaldPlus+ (2020). *Sortering af metal, glas og hård plast*: <https://affaldplus.dk/da/sortering-af-metal-glas-og-haard-plast>

⁴³ The Danish Environmental Protection Association (2020). *Analyse af kildeopdelt metal, glas og plastik*: <https://mst.dk/service/publikationer/publikationsarkiv/2020/jan/analyse-af-kildeopdelt-metal-glas-og-plastik/>

8.2 GreenLab Skive (DK) – the Future of Energy?

A local goal for carbon neutrality⁴⁴ and energy self-sufficiency by 2029 in Skive, central Jutland, and the vision of a transition to a “Green Energy Valley”, called for actions out of the ordinary. With a supportive organisational structure, a willingness to take risks, earmarking of funding, and creativity in solving legislative barriers, the municipality laid the seeds for and nurtured the growth of an innovative industrial symbiosis.

Societal value overturns planning restrictions

In land use planning, municipalities have to navigate through many and often conflicting societal concerns including business development, housing and nature conservation. These concerns are balanced through the Danish Land Use Act that amongst other things requires rural areas⁴⁵ are to be kept free of buildings other than those for agriculture, forestry and fishing. It can therefore be difficult to find available areas for industries, especially groups of industries forming a symbiosis.

The municipality experienced such difficulties when identifying a location for GreenLab Skive. It should be close to high capacity electricity and gas networks, be easily accessible for employees and visitors, and have a size of approximately 150 acres⁴⁶ with room for extension.

An otherwise suitable greenfield site – “Salling” – would be hindered by the restriction on industries in rural areas. This was overcome through active dialogue with the Danish Ministry of Industry, Business and Financial Affairs: the highest land use authority convincing the Ministry of the imperative societal value of GreenLab Skive.

GreenLab Skive

GreenLab Skive is an energy-focused green industrial park that has developed into an industrial symbiosis. As of 2020, nine waste-, supply - and private companies are located in GreenLab Skive, exchanging energy, excess heat, biomass and non-recyclable plastic waste. GreenLab Skive is planned to grow further and attract more energy-demanding companies to take part in the innovative energy symbiosis.

GreenLab Skive Symbiosenet has established energy and data grids that enable exchanges of excess energy and resources between the companies located in the area. GreenLab Skive produces both solar and wind energy that meet the companies' energy needs. A central element of GreenLab Skive is a power-to-gas plant (P2X) that converts wind energy to gas, which enables energy storing and secures the supply.

The Harbour Model

The Taxes Act on Electricity taxes the consumption of electricity (51 DKK/GJ) to promote energy efficiency in industry and households⁴⁷. This tax also applies to surplus renewable electricity production that is exchanged through public electricity grids. The Heat Supply Act, meanwhile, taxes recovered energy to avoid intentional generation of surplus energy. Although the taxes aim to achieve energy efficiency, via penalising the exchange of surplus energy they hinder energy-based symbioses.

To avoid these disincentives the municipality of Skive constructed a so-called “harbour model”. In the harbour model the municipality owns the land, rents it out to a limited company GreenLab Skive A/S, which in turn rents it out to the participating industries. This construction enables excess energy to flow freely between companies through private rather than public energy grids, thus avoiding taxation⁴⁸. Taxes are only paid on the final consumption by each industry.

⁴⁴ Skive (2010). *Klima- og Energi strategi 2029*: <http://skive.viewer.dkplan.niras.dk/media/1348380/k-e-strategi-2029.pdf>

⁴⁵ Defined as not being an urban areas nor being an area with summer cabins

⁴⁶ GreenLab Skive (2019). The Future of Energy is our Business: https://my.eventbuizz.com/assets/editorImages/1570623704-Workshop_3_1400-1515_-_Christopher_Sorensen.pdf

⁴⁷ The Danish Tax Authority (2020). *Bilag A: Kort beskrivelse af energiafgiftssystemet*: <https://www.skm.dk/aktuelt/publikationer/rapporter/omfang-af-dobbeltregulering-af-co2-udledningerne-ved-kvoter-og-afgifter/bilag-a-kort-beskrivelse-af-energiavgiftssystemet/>

⁴⁸ The Danish Tax Authority (2020). *E.A.4.3.4 Elektricitet omfattet af reglerne*: <https://skat.dk/SKAT.aspx?oid=2061604>

An organisational structure that enables development and a commercial mindset

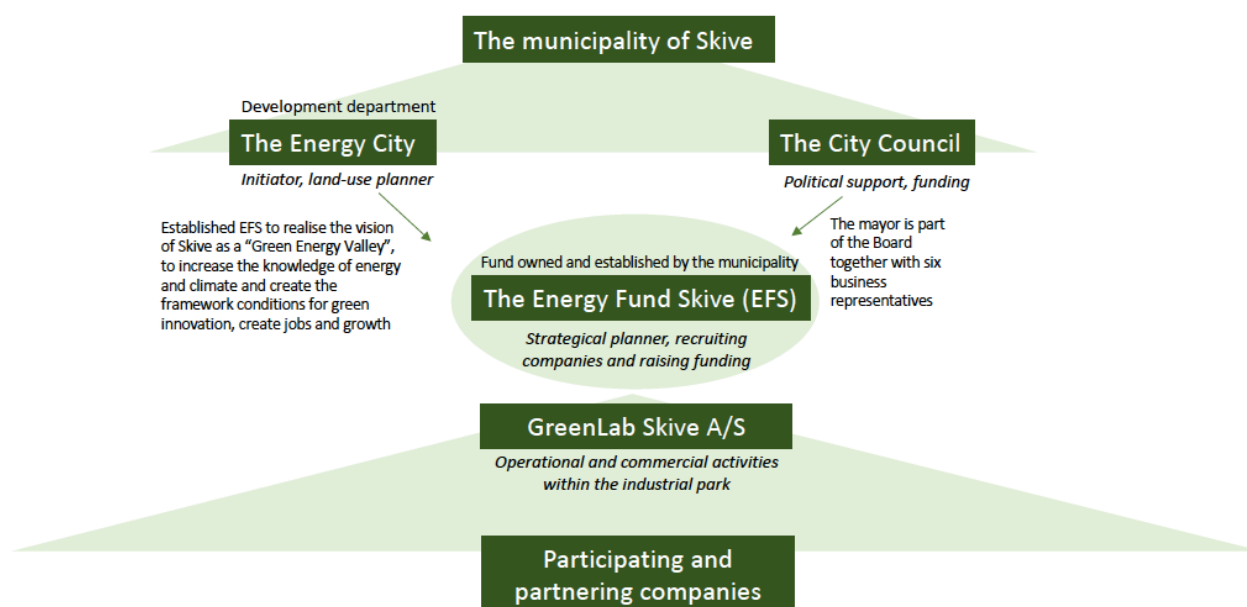
Many municipalities are so busy with administrative work that they have little time and capacity for proactive innovation and development. In Skive, a specialist department 'the Energy City', was established to solely develop projects contributing to carbon-neutral and energy self-sufficient city by 2029⁴⁹. The "Green Energy Valley"⁵⁰ concept was conceived by the Energy City. Risk-taking and employees with the ability to transfer ideas into action, were key in developing GreenLab Skive.

A first step was to initiate a fund – Energy Fund Skive - earmarked for green business development. The fund's board comprises the city mayor and six business representatives with knowledge of energy, supply and business development. This set-up has attracted private investments and the participation of energy-innovative companies. The Energy Fund is responsible for the overall strategic direction of the symbiosis, while day-to-day administration is carried out by GreenLab Skive A/S⁵¹.

A strong consultation and inclusion process

A 30-metre-high industrial plant and pre-perceptions of odours from biogas could easily have let to local resistance against GreenLab Skive. The municipality used consultation and inclusion activities to create broad local support and avoid such objections. Despite the efforts, some neighbours have complained about the smell from one of the factories in GreenLab Skive. The municipality gave the company an injunction to stop the smell. The smell has been significantly reduced, but the obstacle shows how the municipality has different interest that need to be taken into account, in this case both caring about their citizens and their businesses.

The city council has supported the development of GreenLab Skive via approval of local plans and the allocation of resources. GreenLab Skive has also received funding from the Danish Business Authority, European Regional Developments Fund and private investors. Most civil servants employed by the municipality have at some point been involved in activities related to Greenlab Skive and have, thereby, developed ownership perceptions of the project. The municipality sold the idea of GreenLab Skive as a generator of green growth and jobs. The strong narrative and value creation have been important in engaging local citizens, the city council, employees and investors alike.



⁴⁹ Energybyen Skive (2020). Energibyen Skive

⁵⁰ Skive (2010). Klima- og Energistrategi 2029: <http://skive.viewer.dkplan.niras.dk/media/1348380/k-e-strategi-2029.pdf> s. 26

⁵¹ GreenLab A/S is today 30% owned by the municipality of Skive, 30% by Norlys⁵¹ and 30% by the philanthropic Fund Spar Vest and 10% of the Energy Fund.

A Norwegian GreenLab

The case of GreenLab Skive demonstrates how a municipality's vision of a green energy valley can develop into an impressive industrial symbiosis in a short period of time, six years, with the help of a strong vision, thorough planning, mobilisation of local support, talented employees and political support and financing. The model is transferrable and is currently being copied in the Norwegian Municipality of Nes under the name "GreenLab Nes"⁵².

LOCAL ENABLERS

- A strong local vision of a "Green Energy Valley" and a political aim of becoming carbon-neutral by 2029
- Political- and management support, and willingness to take risks
- Engaged employees with strong networking-, communication-, and problem-solving qualifications
- A supportive structure, where the Energy Fund Skive and Green Lab Skive have taken over the commercial activities, while the municipality takes care of land use planning; the harbour model; the ownership structure.
- Mobilisation of local support through citizens meetings.

⁵² Kunnskapsbyen Lillestrøm (2019). *Nes satser på grønn industri*: <http://kunnskapsbyen.no/naeringsutvikling/nes-satser-pa-gronn-industri/>

8.3 ECO3 (FI) - The City in the Crux of an Urban Industrial Symbioses

Initialising industrial symbioses is a complex task, but with the right competencies, cooperation and infrastructure, city authorities can create circular economy zones utilising urban waste streams. The case of ECO3 demonstrates how sometimes the main obstacle can be taking the actual leap towards change.

Throughout 2013 and 2014, preliminary surveys and steps towards industrial symbiosis platforms were taken by Verte Ltd and Tampere University, during a period where industrial symbiosis and circular economy were concepts increasingly gaining attention in the national policy discourse. Key stakeholders, mainly from the public sector, succeeded in bringing together actors and in setting out the necessary measures for mapping and sharing by-products. Today, ECO3 is built around many small companies rather than a few large ones. The 28 companies involved are collaborating around the utilisation of side streams in nutrients, wood, technical by-products, and on efficient and sustainable energy production.

Main stakeholders involved in initialising ECO3 are Verte Ltd., a platform owned by the city of Nokia, the municipal water management company, the regional public waste management and Tampere University.

Urban Inputs and Outputs

One potential key barrier to industrial symbioses is a lack of stable markets for products produced using secondary materials⁵³. This was recognised in ECO3 and addressed by a roadmap that was produced within the platform. Based on policy actions in the roadmap the City of Nokia used public procurement to create a local market pull for circular products and services.

Established in 2014, **ECO3** is a bio and circular economy business area, a competence centre and a demonstration and test bed environment. ECO3 was initiated within the Kolmenkulma industrial park centred around the cities of Nokia and Tampere, that was itself initialised in 2005.

The ECO3 site covers 120 hectares and still expanding. ECO3 is a for-profit enterprise managed by Verte Ltd., which is a development company owned by the City of Nokia. Verte Ltd was founded in 2006 and operates as a platform company for circular economy.

ECO3 cooperates with private companies and universities, and as such it is a public-private-partnership (PPP). By 2020, the ECO3 network comprised 28 partner organizations from a variety of industries. Since industrial symbiosis activities were initiated an estimated 70 million Euros of committed investment have been reached and around 200 jobs have been created.

As an example, when a biogas plant was implemented in ECO3, a tender process for gas-powered vehicles was initiated based on the roadmap from ECO3, additionally creating a window of opportunity for two private gas filling stations. Furthermore, as an input for the private firms, the public sector provides raw materials in the form of biowaste and wastewater from households.

Overcoming Obstacles in Waste Legislation

Waste management legislation is another potential obstacle to innovative industrial symbioses. This is the case when waste regulation on how to classify waste is outdated⁵⁴.

⁵³ Johnsen, I. H. G.; Berlina, A.; Lindberg, G.; Teräs, J.; Smed Olsen, L.; & Mikkola, N. (Eds.) (2015). The potential of industrial symbiosis as a key driver of green growth in Nordic regions. Stockholm: Nordregio.

⁵⁴ Bojsen, NI.; Ullhøi, JP. (2000) *Industrial Symbiosis in an Extended Perspective*. The Aarhus School of Business. & Moodie, J., Salenius, V., & Leino, J. (2019). Industrial Symbiosis in the Baltic Sea Region: Current Practices and Guidelines for New Initiatives. Nordregio.

According to the Waste Act Finland, the municipal authority must manage administrative functions of waste management within the municipality, but the municipal authority can assign this task to any company owned, or part-owned, by the municipality⁵⁵. In the municipality of Nokia where ECO3 is located, waste management has been assigned to the non-profit company Tampere Regional Solid Waste Management which is owned collectively by seventeen municipalities in the Tampere Region.

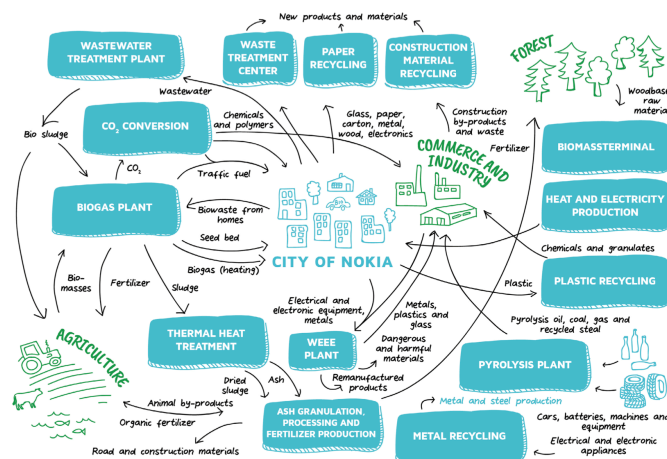
One main goal within the waste management company has been to maximise the recovery state in the seventeen municipalities⁵⁶, and as such, the visions of Tampere Regional Solid Waste Management and Verte Ltd., the company that runs ECO3, were aligned. The co-operation of these two publicly owned limited companies has enabled markets for waste fractions and the emergence of new private industrial scale industrial operations and business. As a rule of thumb, Verte Ltd. delegates its tasks to consultants and practitioners to ensure that suitable competencies are in place.

Business Development

As a competence centre, ECO3 operates activities to accelerate start-ups and help companies find suitable funding. The cluster provides facilitated dialogue between private companies and public authorities to understand and find solutions within legislative frameworks. Furthermore, expert assistance in incorporating circular economy principles as core business concepts is provided by ECO3. Finally, ECO3 offers companies cooperation, shared resources, concepts, platform services and joint visibility. All activities are funded by the city of Nokia, as they see the added value of new job opportunities, tax revenues generated by increased business activity and environmental benefits from the implementation of circular economy principles⁵⁷.

LOCAL ENABLERS

- ECO3 operates within the circular economy strategies that is outlined by the Council of Tampere Region, Tampere University and local research centres.
- Proximity of important infrastructure and logistical services has been a local enabler.
- The proximity of the local knowledge centre constituted by numerous universities and research centres has been a local enabler.



Source: ECO3 (2020) A diagram of the ECO3 concept.
<https://eco3.fi/en/nutrient-cycle/circular-economy-diagram/>

⁵⁵ Kallio, H.; Ermala, S.; Seppänen, M. (2019) Enabling 4P Collaboration: Multidisciplinary, Industrial-Scale Circular Economy Park; *Circular Economy, What are You Doing?* Proceedings of 29th ISWA World Congress 2019, Bilbao, Spain

⁵⁶ Tampere Regional Solid Waste Management (2020) Tutustu yhtiöön. Received on 8th of October from <http://www.pjhoy.fi>

⁵⁷ ECO3 (2020) Is your business a good fit for the ECO3 area. Received on 28 Sep from <https://eco3.fi/en/relocate-to-eco3-area/>

8.4 Kemin Digipolis (FI) - a Mediator Between the Private and Public Sector

Dialogue and trust are essential when working on innovative, industrial-scale and multidisciplinary projects cutting across a range of sectors. This is essential if municipalities are to build connections between companies where sharing of sensitive information such as resource side streams is necessary. Digipolis demonstrates how trust can be built up via the creation of separate platforms for the facilitation of dialogue between private and public sectors with emphasis on business development and support.

Matchmaking of Private Firms

For private companies seeking industrial symbioses it can be difficult to find the right partners⁵⁸. This requires among other things a good network and a willingness to share sensitive data on secondary resources and capacities for innovation. Digipolis is a publicly owned company that supports companies in networking and sharing.

In 2014, Digipolis (see box) put together a list of companies in the Kemi-Tornio region that have by-products with a description and quantification of these flows⁵⁹. 1.4 million tons of annual residues were identified that could be used in industrial symbioses – equivalent to 100 loaded trucks per day⁶⁰. Subsequently, companies were invited to participate in the cluster based on suitable matches in demand and supply.

Companies subsequently began producing value-added products from selected by-products and residual streams. Examples include silvicultural thinning practices, bioenergy from forest residues and two metal recovery plants⁶¹. Today, new companies independently approach Digipolis in order to understand how added value can be created by participating in the cluster.

Kemin Digipolis Oy is a technology park, a development company and cluster organisation. It is owned by the city of Kemi, the University of Oulu and municipalities of Simo, Keminmaa and Tervola. Today it comprises 54 companies and organisations with a total of 500 employees and a network of more than 160 industrial service business in Lapland. By-products from the primary production account for 1.7 million tons of residues on a yearly basis. Sources for these residues include pulp and paper mills, mines, metal producers, a cardboard factory, and fertiliser and fine chemical producers. The estimated value of the industrial symbiosis in the area is 700 million euros. Digipolis has been operating with SMVs and business development since 1993, and since 2010 focus has been enhanced on circular economy. Ten experts are working full time in the company.

Building Trust through Mediating Contact with Public Authorities

A prerequisite for Digipolis to map by-product flows in 2014 was, that the private companies trusted Digipolis sufficiently to share this information. The necessary trust was built in a long process starting from the creation of Digipolis by three municipalities and other stakeholders in 1993. Several elements have contributed to trust building. Having the Mayor of the City of Kemi vouch for Digipolis in public demonstrated top management level commitment, while securing continuous long-term public funding.

Separating Digipolis from other public agencies also enhanced objectivity and diminished political dichotomy. Digipolis is a public-private-partnership, where academia, the private sector and public authorities have been able to meet equally represented, and together shape strategies towards the circular economy. This has given companies the confidence that Digipolis represents their objectives instead of only enforcing law. From their side, the participating municipalities have been able to delegate much of their responsibility for circular economy transitions to Digipolis.

⁵⁸ Desrochers, P. (2001) Cities and industrial symbiosis: Some historical perspectives and policy implications. *Journal of Industrial Ecology*, 5(4), 29-44.

⁵⁹ Kemin Digipolis Oy (2020) Case: *Tapojärvi*. <https://www.digipolis.fi/en/teollinenkiertotalous/case-tapojarvi>

⁶⁰ Poikela, Kari (2017) *REMIX Kick-off Meeting Smart and Green Mining Regions of EU Lapland UAS*. Kemi https://www.interregurope.eu/fileadmin/user_upload/tx_tevprojects/library/Remix%20Digipolis%20Cluster%20&%20%20Industrial%20Symbiosis%20%203.4.2017.pdf

⁶¹ la Cour Belling, Liv (2017) *Nordic Bioeconomy 25 Cases for Sustainable Change*. Nordic Council of Ministers, Denmark

Breaking down Legislative Barriers

Legislation, including waste legislation, can sometimes act as a barrier to the development of new industrial symbioses^{62 63}. Several initiatives, within Digipolis, including a nationwide mapping in 2018, have focused on identifying such legislative obstacles. In the 2018 mapping, Interviews, roundtable discussions and workshops were carried out between representatives from industries and national and local authorities. These contributed to understanding and cooperation between sectors and helped companies to understand how authorities interpreted upcoming EU directives. A report capturing these experiences was published in 2019⁶⁴.

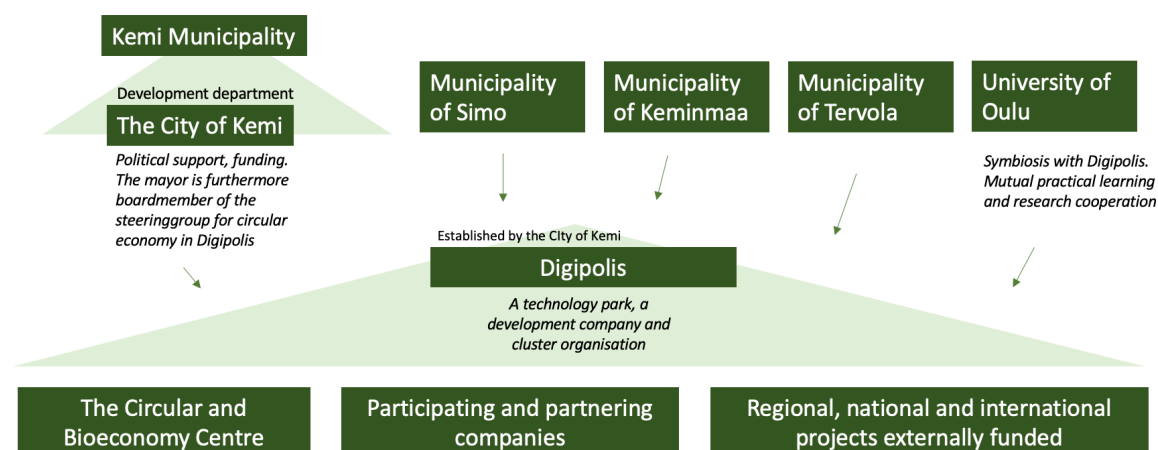
Understanding Industrial Symbiosis as Cross-Regional and the Need for Communication

One key understanding that separates Digipolis from other industrial symbiosis initiatives is that symbioses need not be limited to a certain geographic area; Digipolis is cross-regional. This has required the City of Kemi and the other owners of Digipolis to see the added value, nationally and locally, of having their company expand geographically.

Representatives from the company state that it is the strength of Digipolis, that the City of Kemi allowed them to work outside the region - even outside Finland, to find key competencies and the best opportunities for cooperation regardless of geography. Although Digipolis is mainly financed by the City of Kemi, a number of projects, such as Arctic Smart Growth, are run with external funding from e.g. the European Union and the Regional Council of Lapland.

The geographical expansion can also result in some challenges. First, there is the logistical challenges of the transport of by-products between companies, which increases the cost of symbioses. Secondly, it requires enhanced communication. Digipolis isn't a hot spot geographically, and in order to attract attention, the company has had to implement a systematic communication. This has included the establishment of the Circular Economy and Bioeconomy Centre, which can be described as an umbrella company for all circular economy activities in Digipolis.

The diagram above demonstrates how the ownership of Digipolis is organised with the main owner and financing agency being the City of Kemi.



Source: Poikela, Kari (2019). Towards a low carbon and resource-efficient circular economy. Centre for Circular Economy. <https://www.slideshare.net/OECD-regions/towards-a-low-carbon-and-resourceefficient-circular-economy-in-the-arctic>

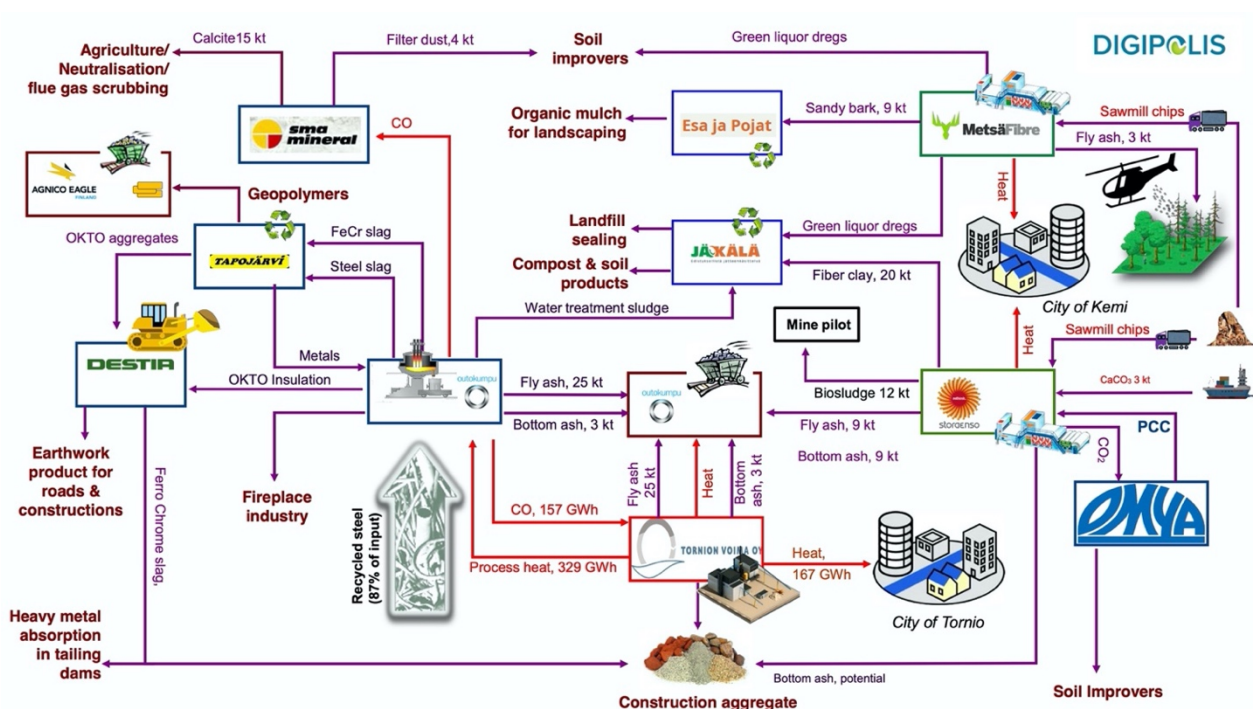
⁶² Bojsen, NI; Uihøi, JP (2000) *Industrial Symbiosis in an Extended Perspective*. The Aarhus School of Business, 24.

⁶³ Chertow, MR (2004) Industrial symbiosis. *Encyclopedia of Energy*, Volume 3;42:407–15. 9

⁶⁴ Circular- and Bioeconomy Centre - Kemin Digipolis Oy (2019) Challenges of industrial circular economy

LOCAL ENABLERS

- Political support from the key public figures created trust from the public and industries.
- Local knowledge centers such as University of Oulu and Lapland University of Applied Sciences have contributed with competencies and research facilities while giving practical experience and learning opportunities to their students.
- The large output of by-products is due to the main prevalence of primary production industries. The region of Kemi-Tornio accounts for 80% of Lapland's industrial production with over 5 billion EUR of exports annually.
- The municipality of Kemi has the strategy "Green Kemi" in which there are targets to ensure the promotion of circular economies.
- Important transport infrastructure is in place - among other things easy accessibility to harbours



8.5 Hitra Industrial Park (NO) – Emerging industrial symbiosis in Norway’s leading aquaculture region and the middle of the regions’ main sea fairway

Having nurtured the birth of Norway’s new, economically valued aquaculture adventure, Hitra is now heading towards circularity and symbioses. The island’s fishing background has resulted in a local entrepreneurial, industry-supportive and a “jump when you can” culture that has been a key factor in this transition. Through cooperation, a favourable legal framework, a “we”-strategy and local trust, Hitra Municipality has laid the foundations for a maturing industrial symbiosis.

Land-use planning and infrastructure investments

The municipality of Hitra and the Trøndelag region within which it lies are world leaders in aquaculture and have invested both money and resources into maintaining this position. Relatively big investments in area development (in excess of 300 million NOK) have been made by the municipality the recent years, and it sees itself as an active network, service (infrastructure) and area provider for the industry.

Hitra Municipality observes its obligations under the Norwegian Planning and Building Act⁶⁵ and at the same time takes full advantage of the opportunities that it offers. In establishing and developing the Hitra industrial park (see box), the municipality sees the legal regime for area planning as an advantage in terms of being able to earmark areas for particular needs. The municipality has played a very active role in supporting industrial and symbiotic development through proactive area planning via its municipal zoning plan.

Hitra Municipality has also actively sought *learning opportunities* for its public services (see water supply to well-boats issue further down) and has invested in, and offers, all necessary infrastructure (water, electricity, roads) leading to, and delivered to the industry park. Areas for transport have proactively been set aside in the municipal master plans and zoning plans. Infrastructure (ports and logistics) have been initiated and built based mainly on local trust and handshakes with central partners.

Facilitation of partnerships

The municipality has created a cooperation group, including the biggest actors and first movers into the park; Lerøy Midt AS (aquaculture), BEWI (packaging), MOWI (aquaculture) and Brødrene Sunde (packaging) identifying common industrial needs such as seawater intake, wastewater emission tubes and heat exchangers. In addition, the municipality has had clear expectations of active participation and paying ‘their fair share of the bill’ from involved businesses in the industrial park to secure the costs of the development.

For the aquaculture’s specific needs of water to the ‘well-boats’ (service/support boats to the aquaculture cages), one of the actors, Lerøy Midt AS has built a water pool in the sea that serves several of the aquaculture actors with clean water (to the well-boats) for de-licing of the farmed fish. The municipality delivers around 500 000 m³ of clean water to this pool without being involved otherwise or inhibited by any specific legal questions.

A big international aquaculture actor, Lerøy Midt AS, praises the municipality’s foresightedness and welcoming attitude towards the businesses. The municipality itself says their role originates, besides their strategy, from the maintaining of a *we-feeling (all contribute, all gain)*, common problem solving-attitudes

⁶⁵ The Norwegian Government (2020) *Plan and Building Act*. Received on the 12th of November from <https://www.regjeringen.no/en/dokumenter/planning-building-act/id570450/>

with among all interested parties, minimizing organizational bureaucracy, and maintaining close relationships with actors in the full value chain.

A culture of trust, freedom to operate and willingness to take risks

In Hitra Municipality there is a shared and clear will and vision between the political leadership and the administration and its employees. There is a strong focus on aquaculture and the biggest businesses in the industry, but there is also a perceived need to pay attention to the smaller, supporting local suppliers. The municipality employees are highly capable and operatively oriented professionals with strong abilities to execute and finish their tasks at hand. Centred as it is on island there is a common perceived need for ensuring efficient transport infrastructure and logistics both via sea and land.

Structures, both internally in the municipality and externally with interested stakeholders, are strong, constructive and support cooperation and trust. This is also manifested through a cooperation group identifying and addressing common challenges and how they should be solved. Within the municipality there is a good understanding conveyed from the political leadership, on the role of the administration, giving a mandate to freely operate, both with regard to trust and budgets.

Municipal representatives highlight a “we-feeling” when pointing to what kind of culture that has brought Hitra to where it is today. They also point to their historically developed coastal/fisherman mentality (dare to set ashore when opportunity arrives), evolved from the variable and rough weather in the area, dictating that one always needs to take the chance when opportunity arrives.

Looking to the future

The municipality points to more positive communication of their achievements outside the municipality and improved promotion of R&D by the municipality as factors it can improve on in the coming period. Also, dialogue with the regional administration could be improved to ensure better coordination. Chief Municipal Executive, Ingjerd Astad believes that responsibility for, and financing of road infrastructure, could be managed better by the Region. Today, allocation of resources for road improvements tends to be given to the municipality that has the loudest voice, rather than according to strategic priorities, one of which could be circular economy/industrial symbiosis.

Mapping of resources for symbiotic exchange between industrial actors, and the tools (methods, digital aids etc.) to perform it, is another area that needs strengthening.

Lerøy Midt’s managing director Sven Amund Fjeldvær points to industrial neighbours as a potential risk for symbiosis based on food production, an issue that needs continuous attention in the municipal zoning plan. ‘If we got someone here with odour or other externalities that can have a negative effect on food production, then we have a problem’, he says. This has not been a problem in the industry park to date. Fjeldvær addresses two other potential inhibiting factors, that both can be labelled *future capacity*. Future *area* capacity needs to be secured because more businesses will want to come to a successful industry park, and *transport* capacity, will also need continuous improvement to handle increased fish production that needs to be transported to markets.

Hitra Industrial Park

Hitra Industrial Park is situated on the island of Hitra 150 km south-west of Trondheim. The industry park aims at strengthening local seafood production through arranging for development and innovation by and through the main actors, and development of a strong supplier base. Two of the biggest companies in the park are aquaculture business Lerøy Midt AS and packaging business BEWI. The world's largest aquaculture business MOWI also operates on the island, is yet to move into the industry park.

The Industrial park is in a developing phase with regards to IS. For the time being, the industry focuses on symbiotic management through the sales of biological bi-products from the processing of farmed fish to biogas facilities outside the park, ensilage for animal fodder, protein capture, reuse of processed fish packaging, and recycling of residue waste from fish pens and cages used in aquaculture. In addition, Lerøy Midt AS has established a pool for fresh water supplied by the municipality, in the sea to provide for a common source of water for de-licing of the farmed fish. Lice are seen as the biggest environmental problem in fish farming.

In cooperation with the actors in the industrial park, Hitra municipality is developing a harbour terminal and hub for seagoing traffic. This is aimed at delivering sea transport logistics solutions for both public and industrial use, transport connection to and cooperation with other similar industrial areas in close proximity, and arranging state-of-the-art facilities for suppliers and farmed fish producers. It is a prioritized goal for the municipality to shift the transport of seafood produced from aquaculture from road to sea.

LOCAL ENABLERS

- Building upon the well-established fishing industry on the island
- Local entrepreneurial, industry-supportive and a "jump when you can" culture
- A strong island community with a high level of trust
- An including strategy developed in a collaborative manner.

8.6 Øra Industrial Area (NO) – Industrial symbiosis as a tool in the transition to a circular economy

A vision of achieving 100% circularity in the industrial area reflects a mindset for the future. Local forums for discussion and strong partnerships are highlighted as key factors for success, and the statutory duties of a municipality can function as an entrance for enhanced cooperation between stakeholders in industrial symbiosis.

Satisfying conflicting interests

Fredrikstad municipality is located in south-eastern Norway, about an hour's drive from Oslo. The municipality's Øra industrial area lies on the coast next to the mouth of Norway's longest river, the Glomma. Øra has been a vital part of the city's development for more than one hundred years. Part of the industrial area has been protected as a Ramsar Convention nature conservation site for wetlands since 1979. The juxtaposition of nature and industry in the area has required a careful balance in land use planning and development.

Close collaboration and dialogue between stakeholders regarding this topic, has been made possible through many different forums. One of these is a special environmental committee set up for the Øra site, where the industry and residents close to the industrial area can meet and have a constructive dialogue. The municipality has a secretary role in this committee. The former Østfold county governor has contributed with funds to find solutions that benefit everyone, like the birdwatching tower built close by. With respect to land use planning, the area in question is originally regulated for waste management as landfill.

Øra Industrial symbiosis

Øra industrial area is located in Fredrikstad municipality, and a large part of the exchange of resources in relation to industrial symbiosis consists of energy-exchange through the municipal waste treatment company Frevar KF, and material-exchange between the companies that use the excess heat and electric energy coming from Frevar KF. In addition, the biogas produced from Frevar KF is sold to Linde gas AS, who upgrade the gas for use in the city buses.

An iron-based biproduct from one of the companies engaged in the energy-exchange is used in the production of water-treatment equipment by another company, and Frevar KF is one of their customers.

Addressing concerns of vulnerability

Frevar KF is Fredrikstad's municipal waste company. Waste collection and treatment is a key element in the Øra industrial symbiosis. Frevar KF uses waste to produce heat for the district heating system, production of electric energy that is being sold to different actors, and biogas from anaerobic digestion of organic residual waste which, after an upgrade-process by an external actor, is used in city buses.

The private companies in the industrial symbiosis express the need for long-term reliability as a basis for making larger investments. The concept of an artificial market for resource-exchange is met with some caution by businesses since critical enabling factors such as public subsidies can change at short-term notice as political leadership and priorities change. Any symbiosis is very vulnerable if there are key actors/partners that are hard to replace, should they disappear.

Being able to “zoom out” and identify the future needs of the industrial area is an important and challenging exercise. If the municipality does not own the land themselves, as is the case for parts of Øra industrial area, making long-term plans for new-comers and expansion of existing companies requires an even greater effort in terms of cooperation between all the stakeholders. The municipality has made use of the tools it has at hand to guide future development in the direction of increased symbiosis.

Municipal plans, forums, and partnerships

The municipal business plan⁶⁶ together with an ambitious climate plan⁶⁷, act as strategic tools that both encourage and enable employees to work towards the promotion of industrial symbiosis. The main goals in these strategies of creating jobs and reducing climate gases are easily linked if the employees have a mindset of circular transition. In addition, the business-fund⁶⁸ established by the municipality, also works as a tool meant to assist and realize the strategies presented in the business plan. In 2020, the size of the fund was 30 million NOK, and one of the projects that have been realized partly through support from this fund is "Sustainable innovation through industrial symbiosis"⁶⁹. Important stakeholders in this project represent research institutions, such as NORSUS⁷⁰, the municipal waste treatment company Frevar KF, private companies, and NCCE⁷¹.

Relation building and creation of partnerships bear fruit in the form of a culture for discussion and cooperation. Local forums, like the Energy-forum Østfold and NCCE (Norwegian Centre of Circular Economy), are important platforms where stakeholders can meet on a regular basis. Challenges regarding the allocation of sufficient resources within the municipality is at least partially solved through seeking external funding, of which EU-projects or regional research-funds are valid options.

LOCAL ENABLERS

- A strong relation between the municipality and other stakeholders
- Ambitious climate- and business-plans
- A strong local vision of combining industrial development and environmental focus
- A municipal waste treatment company.

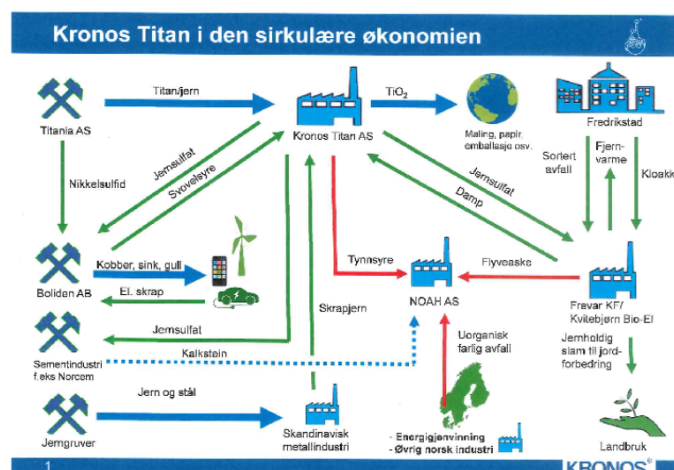


Fig 1: A graphic presentation of selected symbiotic relationships in Øra industrial Area

⁶⁶The municipal businessplan for Fredrikstad (2014 – 2017). <https://www.fredrikstad.kommune.no/globalassets/dokumenter/planer/naering-miljo-landbruk/naeringsplan-2014-2017.pdf>

⁶⁷The municipal climate plan for Fredrikstad (2019 – 2030). <https://www.fredrikstad.kommune.no/globalassets/dokumenter/kmb/barekraftig-samfunn/kommunedelplan-for-klima-2019-2030.pdf>

⁶⁸The municipal Smart- and businessfund in Fredrikstad. <https://www.fredrikstad.kommune.no/tjenester/naringmiljosamfunn/naering/naringsfondet/>

⁶⁹<http://ncce.no/baerekraftig-innovasjon-gjennom-industriell-symbiose/>

⁷⁰<https://norsus.no/>

⁷¹<http://ncce.no/>

8.7 Skogmo, Nærøysund, Norway

Nærøysund has a long history of living from and in balance with the sea and has a significant marine aquaculture industry. Together with the local business community the municipality developed a strategic development plan, +1000 that included the development of the Kråkøya harbour Energy Hub. The hub will offer renewable fuel for passenger boats and the local fishing and aquaculture fleet.

A thriving aquaculture industry

Nærøysund, with a population of just 9660, is located on the coast of Trøndelag and is one of the largest aquaculture municipalities in Norway. The large fishing industry includes seafood companies with a total annual turnover of more than NOK 6 billion. Rørvik is Trøndelag's largest coastal fishing port with 15,000 ship calls a year. Here, there are shipping companies, businesses within the supplier industry, and specialist trade for fisheries and aquaculture. The vast majority of these are owned by local actors.

A collaboration that lays a foundation for development and growth

In land-use planning, municipalities must navigate through many and often conflicting societal concerns in order to strike a balance that gives the most societal benefits. When beginning the process of developing a strategic development plan for sea and land in Nærøysund, the municipality began by asking the question "what is our common vision?".

Developing the resulting strategic development plan, +1000⁷² for Nærøysund, was a joint initiative between Nærøysund municipality, the Ocean Cluster "InnovArena" (see box) and more than 100 businesses. The +1000 strategy has become the "compass" for planning area development in Nærøysund. This, together with a culture for early inclusion of all interested parties for discussions when new areas are under (re) regulation, has been credited as the main factors of success by the involved parties.

The strategy aimed to create 1000 new jobs in part through building more synergies between the local businesses including exchanges of resources and energy. The Kråkøya harbour "Energy HUB" (see further down) is the first example of a symbiosis brought about by the +1000 plan.

In 2020 the strategy plan underwent revision to incorporate the *United Nations Sustainable Development Goals*.

InnovArena is an innovation cluster for aquaculture, fisheries, and the marine and maritime supplier industry on the Trøndelag coastline.⁷³

InnovArena seeks to be a unique platform for practical, knowledge-driven innovation for Coastal Norway, because:

- InnovArena represents the entire aquaculture value chain.
- InnovArena brings together leading and innovative companies in the country's most innovative business regions.
- InnovArena opens up for broad collaboration within teaching (incl. Students), research, and development.

⁷² As stated by the municipality, achieving sufficient manpower is priority number 1 <https://www.narøysund.kommune.no/nyheter/nok-arbeidskraft-er-jobb-nummer-1.16871.aspx>

⁷³ The Ocean Cluster "InnovArena". <https://innovarena.no/>

Enabled by integrated organisational structure

The municipal department for Strategy and Society has strategic responsibility for a range of issues including land use planning, social security, business development, agriculture, nature management, climate and environment, communication and project management (see Figure 1). This cross-cutting organisational structure does away with the silo mindset often present in government. It allows the department to consider a wide range of business, environmental and societal issues when making land planning and development decisions.

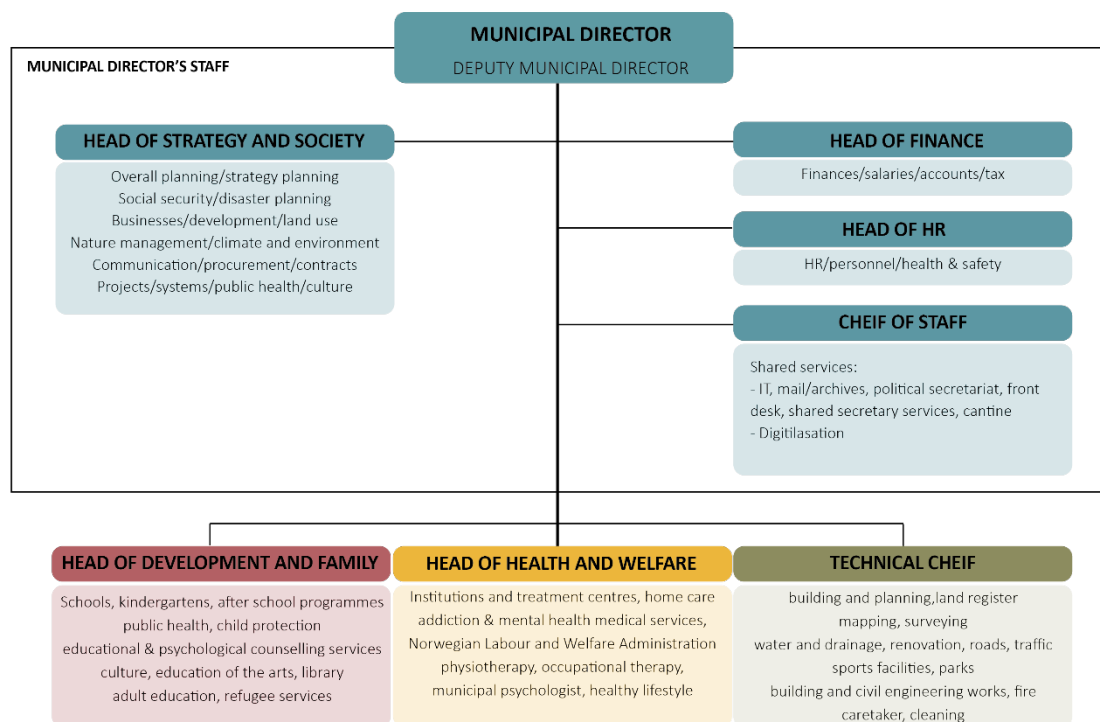


Figure 1: Organisation of the municipality (translated from “Kommunedirektørens stab”).

Green sustainable “Energy HUB” – Kråkøya

Kråkøya harbour is an example of a high level of vision and cooperation between a municipality’s employees, politicians and local business owners in area management and development. It is also an example of a potential that has not yet been fully achieved.

The 100-hectare harbour area, Kråkøya Kysthavn, is owned by Nord-Trøndelag Havn IKS Rørvik (NTHR) which is owned jointly by the municipalities of Nærøysund and Leka⁷⁴. NTHR has invested NOK 85 million in the construction of Kråkøya harbour with the associated Industrial Park.

The development of the area is a joint initiative between NTHR, the Namdalskysten business community (see Box) and the renewable energy cluster, Renergy⁷⁵. The objectives are to achieve a greener aquaculture industry and more sustainable fishing activities with emphasis on identifying technical and market opportunities for climate-friendly development. The project will identify steps the municipality and other actors can take to facilitate future green development as we make the transition to a zero-emission society. Nærøysund municipality and Trøndelag county municipality support the project with NOK 600 000.

⁷⁴ An IKS is a Norwegian organisational form for companies in the public sector with several municipalities as part owners

⁷⁵ <https://renergycluster.no/>

Namdalskysten Næringsforening is a business association for the business community on the Namdal coast based in Rørvik. They have about 150 member companies.

Renewable Energy Cluster (RENERGY) is an innovation cluster with renewable energy and associated technologies as a platform. The cluster aims to contribute to sustainable value creation and the transition to a renewable society. It does this by promoting innovation, increased production and efficient use of renewable energy and associated technologies. RENERGY works with the development of integrated energy systems and value chains to develop the solutions and business models of the future by bringing together players and technologies from the entire value chain for collaborative development. Over 90 companies and organizations participate in the cluster. The participants represent a complete value chain within renewable energy, with energy companies, technology suppliers, competence environments and end-users of energy.

Renewable fuels for coastal fleets

In Norway, it is a national goal that emissions from the transport sector will be cut by 50 per cent within nine years. To achieve this the transition must be made from fossil to renewable fuels. According to Thomas Bjørdal in Renergy, Renewable Energy Cluster, Hydrogen fuel is one future option that can greatly reduce greenhouse gas emissions in the transport sector.

Taking account of this national goal, the Kråkøya development project⁷⁶ amongst other things aims to produce renewable fuel for passenger boats working coastal routes and the local fishing and aquaculture fleet. Nærøysund municipality has applied for NOK 700 000 from the Norwegian Department of Environment to set in place a climate-friendly area plan and green transport solutions.

Trøndelag county has invested heavily in wind power over the last two decades. Under the planned symbiosis, wind power will be utilised for the local production of hydrogen-carrying ammonia. Norwegian energy companies *Trønderenergi* and *Nord-Trøndelag Elektrisitetsverk (NTE)* have a large wind farm on *Ytter-Vikna* in Nærøysund, with the opportunity and license to expand.

Several large marine engine manufacturers are considering converting/developing ship motors that can run on this fuel type. Taking advantage of these efforts, local company *MOEN Group* is leading an industrial consortium that has applied for Pilot-E funding to develop the world's first hydrogen-electric aquaculture vessel. They also recently ordered 10 electric hybrid sea farming boats which will be rented out to fish breeders and service companies who wish to use climate-friendly technology.

An important factor in the success of these development projects, according to harbour director Asle Andersen, is the inclusion of local professional competence. Working together and joining forces has also been vital, as found by aquaculture group NTS and ICT company Moveo and international lab group Pharmaq, in the InnovArena ocean cluster in Nærøysund.

The common conclusion from parties involved in the development cluster in Nærøysund has been that cluster thinking has been important in engaging and developing the project into an impressive collaboration with the ability to create value through networking, communication and problem-solving. Going forward they have concluded that this should permeate all future development.

⁷⁶ The Kråkøya project – with a goal of becoming a green energy hub.

<https://www.tekfisk.no/fiskeri/gigantomrade-i-nord-trondelag-kan-bli-leverandor-av-gronn-energi/2-1-793749>

LOCAL ENABLERS:

- The collaborative strategy development of +1000 functioned as a compass for the development of the municipality of Nærøysund
- A cross-cutting organisation of the municipality has contributed to avoid silo mindsets
- Collaboration between politicians and civil servants from the municipality as well as local business owners
- Investments from both the private and public sector.

8.8 Sotenäs Symbiosis Centre (SE) – From Innovation to Commercialisation

The Sotenäs municipality set up an industrial symbiosis centre in 2015 with the aim to promote and develop industrial symbiosis networks in the municipality. The symbiosis networks in Sotenäs showcase many small and medium sized companies as well as large companies in collaboration with each other. The combination of innovation, environmental benefits, and job creation has been the driver for the municipality's strong engagement.

Municipality as the driver of symbiosis

The Sotenäs municipality has been inspired by the concept of industrial symbiosis; that working together can bring benefits as compared to working individually. For the municipality, it is both important to have strong local companies for job creation but at the same time to minimise environmental impacts. The municipality is aware that IS as a concept can meet both of these aims, hence its interest in taking a proactive facilitating role.

A dedicated symbiosis centre was set up by the municipality of Sotenäs to drive the work of industrial symbiosis. The municipality wanted to establish a network of different people/ organisations who could work together towards development of industrial symbiosis, and therefore a steering committee was set up for the symbiosis centre. The steering committee includes various stakeholders such as politicians, the director of the municipality, representatives from large companies, SMEs and a science centre and university located in the region. The municipality has worked with these actors earlier in different development projects such as competence development with the university. These already established connections allowed relatively easy formation of the steering committee.

The Sotenäs Symbiosis Centre was inaugurated in 2015. The centre is located in a building that is owned by a private company. The company did not require the space anymore as they moved a part of their operations to another area, and therefore were willing to rent it out to the municipality and to the other actors involved in symbiosis activities. The municipality could be seen as the architect of the way of working. The plan was actualized as the municipality found suitable collaboration possibilities with other actors

A unique setup that allows for flexibility, discussions, and connection-of-dots

The Symbiosis Centre is a meeting place for companies, academia, schools and the public sector. The goal is to bring people together to create innovation, entrepreneurship, education and employment. The centre features development of both industrial and social symbiosis, where social symbiosis refers to collaboration on competence development.

The financing for the symbiosis centre has mostly been obtained in the form of project work. Some of the main financiers who have supported the development of industrial symbiosis in Sotenäs are EU Interreg, the Swedish Innovation Agency (Vinnova), the Swedish Board of Agriculture (Jordbruksverket), Västra Götaland County, among others. The key to getting finance has been to, each time, apply for development of multiple projects that could be a part of the symbiosis development, and not just focus on one industrial symbiosis connection. Some of the projects, for example, focused on innovations in utilisation of marine waste. One project by itself might not result in industrial symbiosis, but the projects together contribute to development of networks. It is therefore important for the municipality to be able to connect the dots and see the bigger picture to find new opportunities.

Peter Carlsson from Sotenäs municipality describes the centre's work as follows: *"At the symbiosis centre, we try to listen to different companies and try to attract new companies that can fit into the network. We work together with different research and innovation organisations in order to strengthen the business. We see opportunities and setup meetings with the right people to make things happen. In these ways, we facilitate the symbiosis work in the municipality"*.

The centre falls directly under the management of the municipal board and therefore the decisions are prioritized at the highest level. About eight full-time people work at the symbiosis centre, but there is also collaboration with other departments in the municipality. There are people with various competencies at the centre; engineering, economics, architecture, teaching, leadership, organisational issues, administrative/finance questions as well as business development. Overall, the team is quite flexible in the roles. Two people currently are focusing on development of testbeds and a Marine Recycling Centre.

Testbeds and research centres that support new ideas and innovation

Most of the work at the symbiosis centre is carried out using a bottom-up approach where the municipality, together with stakeholders, develop new ideas and solutions. The centre actively works with testbeds and believes that such testbeds are valuable in testing prototypes in order to



take the ideas to commercial scale.

Testbeds are test and demonstration environments that enable efficient development and market introduction of new products, processes and services. Sotenäs is currently developing two new testbeds - one for conversion of plastic waste from oceans to new products, and another for treatment of wastewater from fish farms. The municipality has supported by renting the land themselves from a private owner, so that the actors testing their solutions at the testbed do not have to pay for the facility.

The municipality has also set up a Marine Research Centre – the focus so far has been on used fishing gears. The municipality is now a part of a team that will create a national structure for recycling of fishing gears. In addition to these initiatives, the municipality also facilitates physical space for business discussions or activities.

Communication both internally and externally helps to bring together right competencies

The Sotenäs centre believes in the power of communication, both internal and external communication. Sotenäs is a comparatively small municipality and most of the people know each other, which makes it easy to communicate internally.

External communication mostly occurs via different collaboration projects. When asked about the way to share information, Peter mentioned, *"We have been interviewed a lot and we attend a lot of seminars and conferences where we describe how we work, and our experience"*. The centre also welcomes study visits and sees this as an opportunity for inspiration.

Sotenäs Symbiosis Centre

The core of industrial symbiosis network in Sotenäs is marine food processing and wastewater treatment. Biowaste from local food industries and sludge from the wastewater treatment plant are treated in an anaerobic digestions process, with biogas as the main output. The biogas is converted into electric power and hot water that can be returned directly to the industry. The solid residues become environmentally friendly fertilizers and are used by local farmers.

There is also an emphasis on marine research, with a focus on recycling of beach debris and used fishing gear. Through the development of testbeds, the municipality creates the best possible conditions for companies and academia to test and develop their technologies and operations, in order to be able to take the step to large-scale commercialization.

Networking skills are considered important in the context of industrial symbiosis since it involves a collaboration of multiple areas of expertise. The centre finds it valuable to involve people from outside the organisation for implementation of ideas and projects. They collaborate with about 10 universities and institutes including local, national and international actors such as Högskolan Väst, Linköping University, IVL Swedish Environmental Research Institute, RISE, University of Chalmers in Sweden, Aarhus and Aalborg universities in Denmark, The University of South-Eastern in Norway. The different actors contribute with different competencies, for example, Linköping University helped with setting up the symbiosis methodology, IVL with environmental assessments, and KTH with Internet of Things.

Effective communication as a tool to overcome barriers

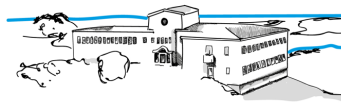
One of the main challenges so far has been a slow process for gaining environmental permits, which increases the lead time to commercialization of new technologies. The authority that is responsible for providing the environmental permit varies depending on the nature of the project. Sometimes, the application has to go through multiple levels - the highest level is the national environmental court, but sometimes it could be the local or county administrative board who has to approve first. The administration of permits therefore took more time than expected. Another challenge was with the land allocation, where the allocation process took longer than expected due to longer administrative processes. This was solved by talking to the higher decision-making level in the municipality who could take a faster decision.

There are some companies that have failed to clearly see the business potential of IS and have therefore not become actively engaged. Another challenge has been a culture in some businesses of 'doing it alone' which reduces their willingness to collaborate with other companies. The management in these companies believe that they are better off working by themselves and have no need external advice or inputs concerning how to best carry out their operations. In order to minimize these barriers, the municipality continues to work actively with communication – to show the business potential and inspire the companies to think in a symbiosis manner.

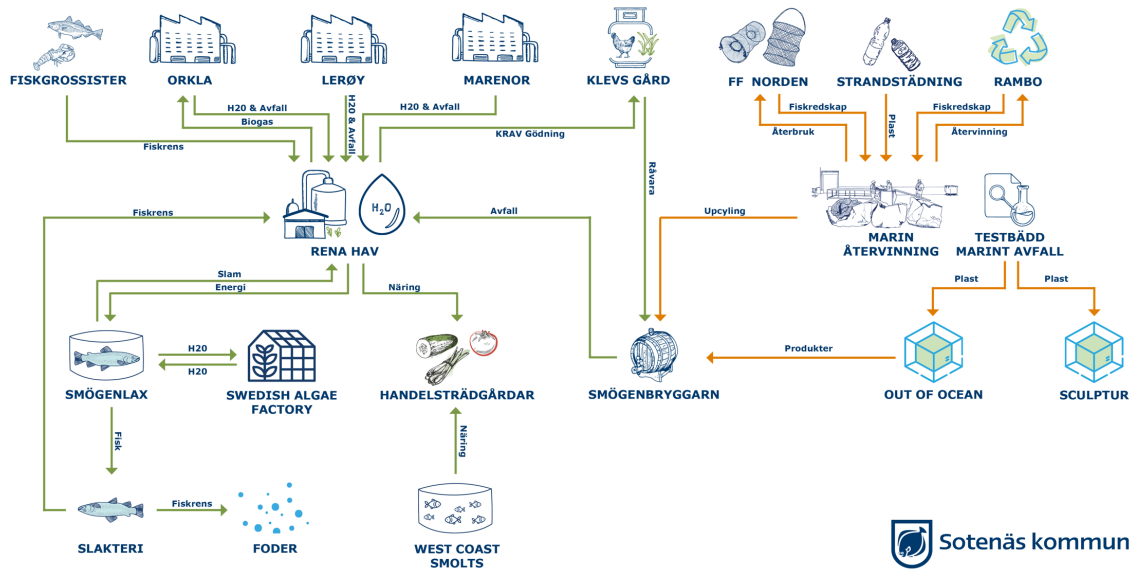
The latest development project in Sotenäs is a large land-based fish farming company. One of the reasons the company preferred Sotenäs as the location was because of the municipality's work with industrial symbiosis. The Sotenäs Symbiosis Centre hopes to welcome more of these type of companies who can see the potential of industrial symbiosis whilst creating local job opportunities.

LOCAL ENABLERS

- Long-term engagement which allows for development of projects
- Political- support at the local level
- External funding for development projects
- Willingness of local companies to engage in industrial symbiosis networks
- Strategic partnerships with other organisations and the ability to "put together different competences together in the same room"



SYMBIOSCENTRUM
KNOW HOW - FACILITATOR - KATALYSATOR



Sotenäs kommun

Figure 2: Sotenäs Symbiosis (Sotenäs Symbios Centrum, 2020)

8.9 Gotland Industrial Symbiosis Park (SE) – towards Sustainable Industrialization

The island of Gotland has been chosen as a pilot region for Sweden's transition to a future sustainable energy system. Within a framework of ambitious sustainability goals and a desire for increased industrial activity on the island, the municipality has begun investigating the potential for an industrial symbiosis park.

Sustainable growth and industrialization

Gotland is the largest island in the Baltic Sea. The number of inhabitants today is about 60,000 and the aim is to grow to 65,000 by 2025. The municipality is keen to enhance the business environment on the island in order to create more jobs and attract new residents. At the same time, as a part of Sweden's objective of zero net emissions by 2045, Gotland has been selected by the Swedish government as a pilot area to showcase the transition to a sustainable energy system⁷⁷. This combination of the need for increased industry activity and sustainability objectives motivated the municipality of Gotland to investigate industrial symbiosis possibilities on the island.

An initiative from the industry

The municipality of Gotland was approached by a few local private companies in the beginning of 2018 with the idea to build a cluster of companies that would work primarily within circularity and sustainability. These companies inspired the municipality to begin in earnest at examining the potential for such a cluster to form an 'industrial symbiosis park'.

Gotland Industrial Symbiosis Park

The island of Gotland currently has a small industrial symbiosis network, where biogas is produced using biowaste from a dairy processing plant and from a slaughterhouse. The biogas is then upgraded for use as vehicle fuel.

Together with Tillväxt Gotland², the municipality has taken steps to start up a pre-study that will explore the possibilities for expanding symbiosis networks and establishing an industrial symbiosis park on the island.

The hope is that companies from within Gotland, but also from other regions, can be attracted to the park. The vision is sustainable industrialization on the island and to become a showcase for carbon neutral emissions.

The motivating factor for the municipality is the approach of creating synergies while reducing environmental impacts. Visby, the main city in Gotland, lacks an industrial area. The municipality has been responsive to a wish from the industry/business community to identify and develop more industrial areas in Gotland and began identifying possibilities of where an industrial park with symbiosis elements could be established. In 2019, the municipality shortlisted an area of land for such a park.

Prioritising land for an industrial park despite many conflicting interests

The island is an attractive destination for tourists. There is a perceived risk that an increase in industrial activity on the island might threaten the unique natural environment and hurt the tourism industry on the island. In addition, Gotland has been facing acute water shortages in the recent years. Despite such conflicts, land for an industrial symbiosis park was prioritised in the municipality, since industrial symbiosis presents an opportunity for sustainable industrialization on the island. The municipality is now developing a detailed plan for the selected land area. A pre-study has been initiated together with *Tillväxt Gotland*⁷⁸ and IVL Swedish Environmental Research Institute to evaluate the conditions for the park that will provide first recommendations on how the land use could be optimised within this area.

⁷⁷ Energy Pilot Gotland is a roadmap to enable Gotland to become a pilot for a sustainable energy system. The roadmap and a feasibility study can be found at: <https://www.gotland.se/energipilot>

⁷⁸ *Tillväxt Gotland* is a cooperative organization for business issues in Gotland. The association brings together the business community, the municipality and other actors on the island to contribute, with a long-term perspective, so that Gotland becomes a good place to work, reside, and live in. The association therefore contributes to regional sustainable growth and establishment of new businesses on the island. Source: <https://www.tillvaxtgotland.se/>

The next step will be a discussion on who should acquire this land. Direct allocation of land, i.e. without a public tender process, is possible if there is a cluster organisation that is willing to buy the land. This cluster organisation, for example, could consist of the companies who are interested to locate their operations at the park and to exchange resources with one another. If there is no consensus between organisations and a single private company wishes to buy the land, the municipality would have to go through a public tender process for the land. In such a case, the land would be open to alternative uses, and the bidders would be allowed to bid for purposes other than industrial symbiosis as well.

Communication within the municipality and with other stakeholders

Johann Malmström, Business Strategist in the “Sustainable growth” department in the municipality, has overall responsibility for the development of industrial symbiosis in Gotland. Johann works closely with another colleague in the same department who is responsible for the ‘Energy Pilot’¹ project. He also works together with colleagues from the Community Building department, in order to discuss issues around land area. In the near future, Johann plans to collaborate with colleagues in the waste, water and energy sectors who have good knowledge and capacity for looking at symbiosis opportunities between companies.

Dialogue with existing industry and businesses is a key issue for the municipality. Johann’s role in general involves development of strategies that improve the business environment on the island. By having the main responsibility for industrial symbiosis, he can ensure that the companies’ needs are accounted for in the development of the park. Roger Hammarstöm, Operations Manager at Tillväxt Gotland², appreciates that the municipality has listened to the companies’ needs for industrial area and responded effectively so far through shortlisting the land area and suggesting the pre-study.

Communication both internally and externally is regarded as important by the municipality. The report from the pre-study of the industrial symbiosis park will be available for citizens and other stakeholders to review and comment on.

Financial Support from the Municipality

The municipality of Gotland manages funds from the European Regional Development Fund (ERUF) where organizations and business clusters can apply for co-financing for projects such as the industrial symbiosis park. There are also possibilities for financial support from the national level, which in general target companies focusing on business development and new markets. This support, however, is regulated by the Swedish Agency for Economic and Regional Growth in terms of to what extent the costs can be covered. Usually, the companies can only get a certain percentage of the total cost as external financing under this scheme. The municipality is also looking into the possibilities for financial support for the companies who would like to develop technologies for sustainable production.



Themes for potential symbiosis

Waste management currently falls under the responsibility of the municipality and therefore they would like to assess the potential of further optimisation in terms of either new systems or new business models for waste management. Development of new technology within water and energy sectors is highly relevant for Gotland and the municipality would be interested to work on such a project together with interested companies. Water is relevant because water supply is a major issue for Gotland, and the energy sector is important from the perspective of the Energy Pilot project.

The vision for the industrial symbiosis park is to have a few existing companies from the island who can further develop their operations in the park, but also to attract

new companies who would like to establish themselves in Gotland. Through emphasising industrial symbiosis as the goal for the industrial area, the municipality hopes that Gotland will become an attractive place for companies to establish themselves and to run businesses.

LOCAL ENABLERS

- A national political aim of becoming Sweden's first carbon-neutral region
- A strong local vision of enhancing the industrial/business environment but on a sustainable notion
- Political support on the local level
- Industrial Symbiosis as a focus area in the municipality's future plans
- A willingness from the private sector to work towards circular economy
- Strategic co-operation with national environmental research institute from the early stage itself

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