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THEME ISSUE



WELCOME TO NORDREGIO NEWS ON INDUSTRIAL SYMBIOSIS

This is a theme issue of Nordregio News, offering you an overview of industrial symbiosis in the Nordic countries. By browsing through this issue you will get a picture of what it is, why has it become a hot topic, what motivates the industries to get involved and what interesting results we have found through our case studies.

In the old days local farmers not only produced the food for the cities, they also took care of their inhabitants' waste. During nights they emptied the latrine barrels and spread its nutritious content on their fields. One can say that the farmers and the urbanites practised a circular economy and lived in a symbiotic relationship.

This issue of Nordregio News is all about industrial symbiosis, more commonly known as the use of waste or by-products from one company as resources for another company. The development of industrial symbiosis is often associated with geographic proximity, but it is not a necessary prerequisite. Nor is industrial symbiosis limited to physical resource exchange. It can also include networking to enhance eco-innovation and new business opportunities.

With its long tradition of cooperation and environmental aware-

ness the Nordic Region has excellent preconditions for developing industrial symbiosis. Kalundborg in Denmark was a pioneer in the field when it started in 1961, long before the term industrial symbiosis came into use in 1989. Similarly, the Finnish Ministry of Employment and the Economy has boosted activities at the national scale, and Finnish Industrial Symbiosis System (FISS) model was developed by Finnish Innovation Fund Sitra and a Finnish state-owned company Motiva to bring together the producers and users of residual resources.

The content of this issue is based on a study carried out by Nordregio and commissioned by the Nordic Working Group for Green Growth: Innovation and Entrepreneurship under the Nordic Council of Ministers' Committee of Senior Officials for Regional Policy. Enjoy your reading. We are looking forward to your feedback and to receiving ideas regarding industrial symbiosis and other topics suitable for Nordregio News in the future.

KJELL NILSSON
DIRECTOR
CHAIRMAN OF NORDREGIO NEWS EDITORIAL BOARD
(kjell.nilsson@nordregio.se)



MEET NORDREGIO AND THE NORDIC GREEN GROWTH WORKING GROUP ON TOUR IN 2016

The year 2016 is one for knowledge sharing and concluding the Nordic green growth collaboration that began in 2013 – and for drafting the steps ahead, towards 2020.

Coming up later this spring is a green growth road show to all the Nordic countries, followed by the grand final event in Helsinki on 22–23 November 2016 at the annual Nordregio Forum.

The Nordic road show allows active knowledge exchange through a series of moderated roundtable meetings with national ministries and in Nordic regions. Key actors responsible for regional development and the transition towards green growth and the bioeconomy will be invited to discuss the working group's findings in relation to their own policy agendas and dilemmas. Nordregio staff will receive valuable feedback and get input to the coming Nordic collaboration programme in 2017–2020.

Having the Nordregio Forum as the grand final means that we devote this year's forum to the topic: From Fossil to Bio-based Economy – Innovation and Policy for Transition in Nordic Regions. Nordregio Forum allows Nordic policy-makers and regional planners to mix with international researchers, administrators, intermediary organisations and private sector actors to learn about and discuss the actions and policies needed to make the shift from a fossil fuel-based to a bio-based economy. It also gives added value in the form of further Nordic collaboration in the field. Nordic examples on how green growth and the bioeconomy will be presented at the regional level – and ideas about how to contribute to sustainable regional growth will be put forward. ★

Save the date now for a trip to Helsinki on 22–23 November 2016!

Photo: Jussi Hellsten/Visit Helsinki



NORDREGIO FORUM 2016
22-23 NOVEMBER, HELSINKI



The potential of industrial symbiosis
as a key driver of green growth in
Nordic regions

Ingrid H G Johnsen (Ed.), Anna Berlina, Gunnar Lindberg,
Nelli Mikkola, Lise Smed Olsen and Jukka Teräs

NORDREGIO REPORT 2015:1



NEW PUBLICATIONS ON INDUSTRIAL SYMBIOSIS

A new report is out! Industrial symbiosis can be viewed as one of the possible approaches to realizing a circular economy and achieving green growth. It gives an overview of the potential for growth in industrial symbiosis at the national, regional and local levels, and analyses policies related to industrial symbiosis in the Nordic countries. A Policy brief based on the report is also published in April 2016. Both publications are available on our website www.nordregio.se/publications. ★



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Each Nordregio News issue provides multiple perspectives on a specific theme of regional development. With Nordregio News you are also kept up to date with the interesting research results produced at Nordregio. Nordregio News is sent to our subscribers via email. You can also find each issue on our website.

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THEME ARTICLE

Industrial symbiosis in Kalundborg.
Photo: www.stateofgreen.com

WHAT IS INDUSTRIAL SYMBIOSIS?

Industrial symbiosis has become a popular term in recent years to describe industrial activities where a waste or by-product of one actor becomes a resource for another actor. But what do we mean when we talk about industrial symbiosis and where do we find it? Why are industrial symbioses becoming an increasingly salient issue in the field of industrial ecology and green growth, and what are the benefits that can be generated through this concept?

BY JUKKA TERÄS AND NELLI MIKKOLA

In nature, symbiosis is often defined as “any relationship between individuals of different species where both individuals benefit”. The symbiotic exchanges among different entities yield a collective benefit greater than the sum of individual benefits alone.

Similar approaches can also be implemented in a human-made industrial setting. Interlinked with the concept of industrial ecology, industrial symbiosis is an innovative way to increase resource productivity and is one of the approaches to realise a circular economy (CE) and achieve green growth.

WHAT IS GREAT ABOUT INDUSTRIAL SYMBIOSES?
Industrial symbiosis is about saving money and reducing

consumption by working together to maximise the outputs that can be generated from resources. It has many economic and environmental benefits. Firstly, it provides opportunities for existing companies—both private and public—to increase their profitability and competitiveness by reducing the cost of resources. Secondly, it presents substantial benefit to the environment by reducing demand for both materials and waste.

Let us take an example from Kalundborg, Denmark, which has operated since the 1970s and is often cited as the first working industrial symbiosis in the world. The primary partners in Kalundborg, including an oil refinery, a power station, a gypsum board facility, and a pharmaceutical company, share ground water, surface water, wastewater, steam, and fuel, and they also exchange a variety of by-products that become feedstocks in other pro-



JUKKA TERÄS

is a Senior Research Fellow at Nordregio specialised in regional development, innovation environments & promotion, technology transfer, issues related to non-metropolitan regions.

You can reach Jukka at jukka.teras@nordregio.se



NELLI MIKKOLA

is a Junior Research Fellow at Nordregio specialised in the European Union and its regional policy, green growth, and sustainable Arctic development.

You can reach Nelli at nelly.mikkola@nordregio.se

cesses. The benefits of the industrial symbiosis include low energy use, CO² savings of about 250,000 tons per year, cuts of around 30% in water consumption and minimal waste for disposal.

A great example of the cost benefits generated through industrial symbiosis is the National Industrial Symbiosis Programme (NISP) of the United Kingdom, which was launched in 2005. In the UK, national companies saw a clear financial benefit in engaging in industrial symbiosis activities. Consequently, during its first 7 years, companies participating in the NISP saved over €1.3 billion in costs, generated another €1.3 billion in additional sales and simultaneously produced environmental benefits, including saving 39 million tonnes of CO₂.

Collectively engaging industries and companies has

added value in terms of knowledge creation and exchange through the symbiotic networks, which can in turn generate mutually profitable transactions as well as improved business, technical processes and innovations.

HOW TO ESTABLISH INDUSTRIAL SYMBIOSIS?

Money talks. Industrial symbioses must primarily be built on economic gains and be based on the interest and engagement of businesses. Long-term economic gain is essential to the sustainability of industrial symbiosis activities as well as ensuring that such activities promote the emergence of new businesses and innovations.

One of the promoting factors for a successful industrial symbiosis is a comprehensive mapping of material flows and side-streams on the local and regional level to secure >



Green growth:

Fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. This requires catalysing investment and innovation, which will underpin sustained growth and give rise to new economic opportunities.

Circular economy:

A production and consumption system where the majority of the products and the resources used in production processes can be reused or recycled. Circular economy seeks to decouple economic growth from resource consumption.

Industrial ecology:

Industrial ecology is the study of material and energy flows through industrial systems. Industry is seen as a human-made ecosystem that operates in a similar way to natural ecosystems, where the waste or by-product of one process can be used as an input into another process.

Industrial symbiosis:

Industrial symbiosis is the association between industrial facilities or companies in which the waste or by-products of one become raw materials for another.

Industrial symbiosis can be described as a collaboration between several different, often geographically proximate entities, i.e., companies and factories closely co-located in clusters or industrial parks exchanging resources (e.g., materials, energy, water and by-products) that can be used as substitutes for products or raw materials, which would otherwise be imported from elsewhere or treated as waste. Industrial symbiosis can also involve the joint provision of utilities and services between the actors in the network.

> supplies and the necessary resource diversification. Moreover, mutual trust and shared ideologies between actors are among the key determinants in a symbiotic model.

Another crucial factor for increased industrial symbiosis activities is the development of long-term public support from the state and regional authorities for circular economy and industrial symbiosis, including comprehensive and coherent strategies supplemented with binding objectives, regulations, subsidies and other economic incentives. This can in turn help to ensure sufficient private funding for activities related to industrial symbiosis.

As the awareness, expertise and capacity required for the establishment of industrial symbiosis among potential actors might be weak, a development company, regional cluster or similar organisation can play a key role in facilitating and promoting industrial symbiosis. This role may include helping companies find relevant partners, identify new synergy opportunities and develop business plans.

A common model for organising industrial symbiosis is the so-called eco-industrial park, which is built especially for the purposes of symbiotic models and recycling. Although industrial symbiosis is often defined as a place-based approach, the geographic proximity associated with industrial symbiosis is not always necessary. An alternative approach is not to tie symbiosis to any particular location, but to base it on the needs and resources of a network of companies. However, it is worth noting that the profitability and sustainability elements of industrial symbiosis can in certain cases be repelled by the costs and emissions caused by long-distance transports.

INDUSTRIAL SYMBIOSIS – A KEY DRIVER OF GREEN GROWTH IN THE NORDIC REGION?

Resource efficiency and circular economy are firmly embedded in the global agenda, and industrial symbioses are promoted by international organisations such as the United Nations and the OECD. At the same time, eco-industrial parks are being established worldwide. The European Union has recognised that industrial symbiosis has direct relevance not only to resource efficiency, but also to a broad policy agenda covering innovation, green growth and economic development. This same observation has also been made at national and regional levels in the Nordic countries.

Globally, the Nordic countries are among the front-runners in sustainability and green growth. Given all the advantages that industrial symbiosis can bring about, it is no surprise that industrial symbiosis has gained attention as an important novel component in the Nordic green growth curricula. Both the Nordic regulative and institutional frameworks as well as the Nordic companies have recently shown increasing interest and devotion towards symbiotic activities and industrial ecology.

Essentially, industrial symbiosis can provide an important competitive advantage for the traditional Nordic large-scale industries (e.g., paper and pulp, steel and manufacturing) that have been affected by the global economic downturn and industrial restructuring taking place in Europe and worldwide. Moreover, industrial symbiosis paves the way for the emergence of new and innovative businesses that take advantage of otherwise unused industrial flows.

The Nordic region already hosts numerous industrial symbioses and related national networks and associations.

Owing to the Nordic tradition in both co-operation, sustainability and environmental awareness, the region has good preconditions for promoting and hosting industrial symbiosis in terms of industrial framework and business practices. This global competitive advantage is backed by the success stories of Nordic industrial symbioses, such as Kalundborg in Denmark and Blue Lagoon in Iceland, which is not only a spa and one of the most famous Icelandic tourist attractions, but also an inspiring and economically successful example of industrial symbiosis.

Industrial symbiosis activities are already occurring in all of the Nordic countries; however, there are substantial variations in each country's approach. In Finland and Denmark, industrial symbiosis activities are stimulated through a top-down approach. This approach includes a clear vision, comprehensive strategies at both the national and regional levels, and active facilitation of industrial symbiosis exchanges by municipal and regional actors in partnership with key private companies. In contrast, industrial symbiosis initiatives in Iceland, Sweden and Norway are characterised by a bottom-up approach. In these countries, industrial symbiosis is largely absent from the policy agenda and development is instead driven by private companies and business parks.

COMPANY PERSPECTIVE

Using industrial symbiosis, firms may create competitive advantages and improve their overall environmental and economic performance.

A key motivation for companies to engage in industrial symbiosis activities has been the desire to increase profitability and competitiveness. Business opportunities are the major driving force behind the development of industrial symbiosis.

An additional benefit for companies is that industrial symbiosis strengthens their environmental profiles, which can be an important advantage in the market as customers are becoming increasingly aware of sustainability aspects related to production processes and consumption.

The main identified hindrances to industrial symbiosis development are companies' lack of time and resources to implement new business models such as industrial symbiosis, as well as a lack of industrial symbiosis expertise in the region and low awareness about the opportunities provided by industrial symbiosis. In this regard, the presence of a cluster, network or other co-ordinating body that can facilitate collaboration would help to organise exchanges between companies. ★



INFO BOX

What is in it for companies?

Industrial symbiosis can:

- Reduce raw material and waste disposal costs
- Generate new revenue from residues and by-products
- Divert waste from landfill and reduce carbon emissions
- Open up new business opportunities
- Strengthen environmental profiles

“RESOURCE EFFICIENCY AND CIRCULAR ECONOMY ARE FIRMLY EMBEDDED IN THE GLOBAL AGENDA”



“THE FUTURE POTENTIAL OF INDUSTRIAL SYMBIOSIS ACTIVITIES IN THE KEMI–TORNIO REGION IS SIGNIFICANT.”

Photo: Tarmo Saari / Stora Enso

What propels industrial symbiosis in the Kemi–Tornio region?

The Kemi–Tornio region in north Finland is important for industrial refinement and exports. It is responsible for 80% of Lapland's industrial production. The region represents a junction where two regions in different countries, Finland and Sweden, operate together. Its industrial system has a large number of mines and metal producers, pulp and paper mills, cardboard factories and also fertiliser and fine chemicals producers.

BY KARI POIKELA

The industrial ecosystem in the Kemi–Tornio region is dominated by large-scale industrial operations, such as the Outokumpu stainless steel plant, the Metsä Group forestry industry plant, the Stora Enso forest industry plant and the Outokumpu Kemi chrome mine. The primary metal-based and forestry industries play an important role in the environmental quality of the area. A cross-sectoral approach and good cooperation between companies are key components of industrial symbiosis.

In 2012–2013, Lapland prepared the Arctic Specialisation Programme. According to its vision for 2030, Lapland will enjoy a leading position in exploiting and commercialising Arctic natural resources and conditions. Lapland will also be the centre of international Arctic transport, information and telecommunications. From the point of view of Lapland's future, the aspects to be highlighted are the sustainable utilisation of natu-

ral resources and natural conditions and the addition of value to Lapland's exports. The most important Arctic spearhead sectors in Lapland are the mining and metal industries, tourism and the bioeconomy.

Companies meet common goals

The future potential of industrial symbiosis activities in the Kemi–Tornio region is significant. The companies in the processing industry in the region make active attempts to minimise their wastes and increase material efficiency by developing new products from their production by-products, residuals and wastes. As a continuum, small and medium sized companies can develop novel industrial symbiosis products and services for the processing industry.

The key elements of the industrial symbiosis in the Kemi–Tornio region include forest industry, mining and steel industry companies, industrial service companies, research and educational organisations and intermediaries, especially Digipolis.

An important event in the development of industrial



KARI POIKELA

works as a project manager on the Arctic Business Design and By-product Flows of Arctic Industries, and as Task Leader in one of the EU's European Innovation Partnership Smart Cities Commitments related to Circular Economy, and also as Project Leader of the European Cluster Observatory (ECO)'s Model Demonstrator Region Lapland. Recently, he has been charged with the responsibility of managing the future Arctic Business Concept, which is a development project on mining and industrial services in co-operation with the process industry and mines in Lapland.

You can reach Kari at kari.poikela@digipolis.fi



INFO BOX

A few examples describe some of the main industrial symbiosis ideas and activities in the Kemi-Tornio region:

- Utilisation of wastes at the StoraEnso Veitsiluoto mill: The ash from StoraEnso processes has been used to fill the open pits of the Outokumpu chrome mine after metal extraction ceased.
- Utilisation of wastes from Metsä Fibre's Kemi mill: "Riffler waste is created in the wood room. It can be used as mulch in landscaping and, after screening, as fuel. Ashes from the bark-burning boiler can be used in earth construction. Ash and ash mixtures can replace soil in certain earth structures such as in earth filling, protective layers and road structures" (Marika Alapoikela, the environmental manager for Metsä Fibre's Kemi mill, 2014).

INTERVIEW

Impacts in Kemi-Tornio



MIKA RIIPI

is County Governor at
Regional Council of Lapland.

What impact has industrial symbiosis in the Kemi-Tornio region had on Lapland as a whole?

Examples of industrial symbiosis in the Kemi-Tornio region have been the basis of our Arctic cluster work and further implementation of our Arctic specialisation program. I sincerely believe that without these examples we would not be so successful in our work, especially in the context of European Union model work.

Lapland recently and mentioned our work in smart specialisation as an excellent example for all of Europe. Because of our example, she hoped that Finland would take a leading role in further implementation of smart specialisation in the Arctic areas.

What are the most important learnings from the industrial symbiosis in the Kemi-Tornio region?

One of the most important findings is that concepts like circular economy or resource efficiency are not just 'phrases' or theoretical goals in our region. They exist and their actual potential is very practical. Examples in Kemi-Tornio have proved to us that we can seek similar connections and synergy between different types of industries everywhere.

What is the regional importance of the nomination of the Lapland region as a European Model region in 2014, with a focus on industrial symbiosis?

At the regional level, the nomination has enabled us to network and benchmark industrial symbioses, which contributes to sharing knowledge between different regions in Europe. I sincerely believe that this work also has national importance. Commissioner Corina Crețu visited

Besides Kemi-Tornio, which other industrial symbiosis opportunities exist in the Lapland region?

There are several opportunities. One great example is the potential synergy between mining and tourism in northern Lapland where there is huge potential in labour force issues and image marketing. Another interesting example is bioeconomic activities from a holistic point of view, such as connections between traditional forestry, rural energy production and reindeer herding.

What is needed to get these additional industrial symbioses up and running in Lapland? What stands in the way?

Different stakeholders in the field need information and co-ordination. We need resources to create arenas for discussion and sharing knowledge and experiences. The car is already running – we just need to make sure that there is enough gas in the tank! ★

COMMENT

THOMAS
LÄMMER-GAMP

is Director, European Secretariat for Cluster Analysis, c/o
VDI/VDE Innovation
+ Technik GmbH

Lapland – Much more than just elks and Father Christmas

The first thought that comes into the minds of central Europeans when talking about Lapland is: "It is a beautiful place somewhere up North and the home for elks and Father Christmas." Lapland is one of the most beautiful places in Europe. However, there is much more to Lapland than just elks and Christmas. Lapland is engaged in the exciting endeavour of developing an industrial cluster that aims to utilize Arctic natural resources sustainably by developing eco-innovative and resource-efficient solutions. A community of committed stakeholders from industry, academia and politicians are driving the process. They are eager to

transform their region into a landmark on the European map of the circular economy. Having visited Lapland several times as a member of the European Cluster Observatory, I must say that their prospects are more than favourable.

Lapland and its economy might be small, but there are plenty of buzzing initiatives and many more ideas awaiting realization. It is amazing to see what is happening there. Lapland sends a message to other regions, that "you might be small and there might not be much in your region, but there is always something that has the potential to develop into something big. You just have to seize the opportunity!" I am convinced that we will hear much more from Lapland in the near future. ★

Industrial Symbiosis in

KALUNDBORG

One of Denmark's largest concentrations of industrial companies outside Copenhagen is located in Kalundborg. Large energy and processing industrial companies and some pharma/medico and cleantech companies are based in this industrial area. Some of these companies are part of the internationally well-known Kalundborg Symbiosis. Kalundborg has built its local development strategy on being the "Green Manufacturing Municipality". This is because Kalundborg is one of the few places in the country that has managed to maintain its manufacturing industry, which is the most important industry for the local economy.

BY LISE SMED OLSEN



The Story of Kalundborg Symbiosis

The network in Kalundborg has developed over the course of five decades. It began in 1961, when Statoil (then Esso) needed water for its refinery near Kalundborg. The first conduit pipes in the Kalundborg Symbiosis were laid between Statoil and the nearby lake, Tissø. In 1972, Statoil entered into an agreement with Gyproc, a local gypsum production enterprise, for the supply of excess gas from Statoil's

production to Gyproc.

Gyproc used the gas (today, natural gas) to dry the plasterboard produced in their ovens. In the following year, 1973, Dong Energy (then the Asnæs Plant) was connected to the Statoil water pipe. Thus, what would later come to be known as the Kalundborg Symbiosis then had three partners. Over the years, more businesses were linked into the Kalundborg Symbiosis, and in 1989, the term "industrial symbiosis" was used to describe the collaboration for the first time. The Kalundborg Symbiosis now has eight private >



LISE SMED OLSEN

is a Research Fellow at
Nordregio specialised in
business development and
regional innovation policy,
EU Cohesion Policy.

You can reach Lise at
lise.smed.olsen@nordregio.se

THEME ARTICLE

> symbiosis was the mapping of the by-product flows of industries in the Kemi-Tornio region, which was implemented in 2013–2014. The Digipolis technology park in Kemi co-ordinated a project on the mapping of industrial by-products and residues in the Kemi-Tornio region in 2014. The main purpose of the mapping project was to create a network of regional actors and encourage match-making, in order to utilise more efficiently the industrial by-products in the region. The project aimed to reveal new business opportunities in utilising the industrial residues. Documentation of relevant by-products and residues included recording their chemical and physical properties, analysis of the utilisation grade of the by-products and studies on markets, technology and logistics related to the by-products.

It is a challenging task to estimate the volume of industrial activities in the Kemi-Tornio region. Based on interviews in 2015, a rough estimate would be in the range of EUR 200 million annually. A total of more than 1.3 million tonnes of annual by-products and residues were identified (excluding the waste rock of mining activities). The Digipolis project resulted in a databank of industrial by-products in the Kemi-Tornio region. The databank includes real-time information on actors, references and potential new applications. The recent mapping of by-product resources together with the positive mindset in the region regarding industrial symbiosis pave the way for future activities. ★

KALUNDBORG
SYMBIOSIS 2015

> and public partners and involves approximately 50 symbiotic exchanges.

The Kalundborg Symbiosis was developed based on commercial agreements between the partners. The early development of the network was based on the initiatives of the companies themselves, especially Statoil's steps to find a solution for the water supply to its refinery. There are several industries located within a short distance, which made it feasible to install pipes for water and energy exchange. The companies are not key competitors with each other, which made mutual trust easier to gain. This trust was essential in the development of the network.

Kalundborg Symbiosis led to an international knowledge centre

The Symbiosis was 'discovered' in the early 1990s by local high school students, who identified and modelled the symbiotic exchanges in Kalundborg during a school assignment on sustainability. The international press and then academia picked up the story through the multinational companies involved in the Kalundborg Symbiosis. In the following years, the Symbiosis received increasing international attention from academia (especially Yale University) and practitioners wishing to work with industrial symbiosis. To manage the international delegations visiting the network in Kalundborg, the Symbiosis partners established a visitor service in 1996.

Since 2010, the visitor service has become integral to the development department of Kalundborg Municipality. The Symbiosis partners established an association that provides funding for the visitor service. The organisation of the Symbiosis centre was developed with support from two projects co-financed by the European Regional Development Fund. Based on increased political will, the centre was renamed Symbiosis Center Denmark. Since 2015, Symbiosis Center Denmark has engaged in initiatives across the country to support the development of industrial symbiosis. The national centre has a mandate to work strategically in four key areas: developing symbioses between companies, training and education, branding and investment promotion, and collaboration with universities.

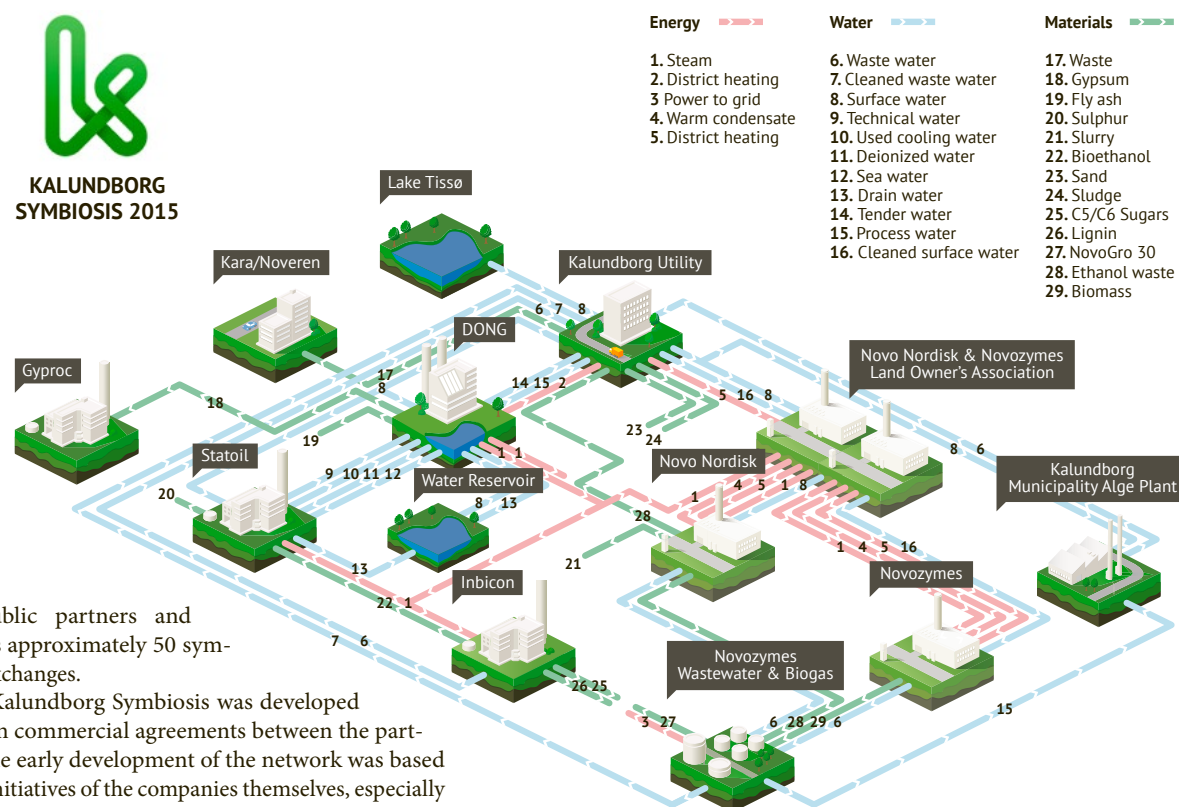
Symbiosis Center Denmark collaborates in branding and investment promotion with the investment promo-

tion agencies, State of Green, Copenhagen Capacity and Invest in Denmark, which are interested in the potential for attracting investments based on Danish expertise. This involves attracting investments from the delegations who visit the Symbiosis Center Denmark to learn about the Kalundborg Symbiosis.

Industrial symbiosis has become a strategy for regional development

The "Regional Growth and Development Strategy 2015–2018" for the Zealand region underlines the development of industrial symbioses, with a particular focus on resource efficiency, as a tool to enhance the competitiveness of companies. Further regional development funds were granted for the establishment of the information centre, Symbiosis Center Denmark, in Kalundborg in December 2014. Developed in collaboration with 17 municipalities, the "Common Regional Climate Strategy 2015–2018" for the Zealand region also incorporates industrial symbiosis. One of the objectives of this strategy is "More renewable energy and better use of resources" and enhancing the development of industrial symbiosis between companies in the region is one of the ways in which this strategy should be implemented. Regional municipalities are showing increasing interest in this area, and some have started to employ "symbiosis employees" in their municipal environmental departments. ★

Diagram: www.symbiosecenter.dk



"THE KALUNDBORG SYMBIOSIS WAS DEVELOPED BASED ON COMMERCIAL AGREEMENTS BETWEEN THE PARTNERS."

INTERVIEW

Industrial symbiosis: Impacts in Sweden based on research

1. What is the ideal role for public sector actors in promoting industrial symbiosis?

We believe that different public sector actors can support industrial symbiosis developments in different ways. For example, municipalities can set ambitious local policies demanding improved waste management and/or reduced emissions, creating the context for symbiotic exchanges. Municipalities can also be highly effective relationship and information brokers, creating vital conditions for communication, familiarity and trust among regional actors. Their planning, permitting and procurement functions can also be adapted to create more fertile contexts for the development of symbiotic relationships. Last, but not least, particularly in the Nordic context, municipalities can be important operational partners within industrial symbiosis networks.

2. What types of policy instruments are most effective in stimulating industrial symbiosis activities?

There is no scientific consensus on this topic. For example, we know that EU and national level policies making disposing of waste in landfills either impossible or more expensive have also diverted significant waste fractions into more productive uses, and some of these uses are in the form of local synergies. Similarly, renewable energy policies coupled with CO2 taxes have increased incentives to use alternative fuels in power and heat production, as well as utilizing residual heat. At the local level, local authority policies regarding energy and mobility services, and emission and waste management targets have also been instrumental in driving urban synergies. There are pro-

missing signs that some of the more recent and direct local policy interventions, in the form of developing local industrial symbiosis programs or competence centres, will also make big contributions. It is also worth noting that an effective support context arises when the right combination of national/regional/local policies are present simultaneously.

3. How does industrial symbiosis contribute to regional economic development?

Industrial symbiosis enables existing and new industries, as well as communities, to access more competitively priced resource inputs and reduce their waste management and emission control costs. More resource inputs are turned into marketable products, which further enhance resource productivity and provide economic benefits. Sometimes symbiotic relationships bring new processing or transfer needs, which stimulate new business development and employment. Finally, it improves regional eco-innovation capabilities, with profound implications for more sustainable regional development.

4. Regarding your own research, could you highlight an example of promising research projects?

We are interested in multiple dimensions of industrial symbiosis; therefore, it is hard to single out only two examples. One of our main research focuses is on the role of industrial symbiosis in the emergence of bio-based economies. It offers a solid foundation upon which several operational and expanding regional biorefinery networks are built in Sweden. We are improving our understanding of the diverse range of benefits it provides in these networks;

INTERVIEW ANSWERS

Answers are compiled by Assistant Professor Murat Mirata with contributions from Professors Leo Baas and Mats Eklund, all from Environmental Technology and Management at Linköping University.

e.g., cost reduction, resource productivity, and eco-innovation capabilities. We are also investigating key factors and processes that support or hinder symbiotic relationships relevant to biorefinery networks, with particular focus on the influence of the policy framework; the nature of inter-firm business models and governance mechanisms; and the role of public-private partnerships. Among other examples, research in these areas will provide more substantial answers to the questions we discussed above. Expanding the scope of this research to the Nordic context will be very interesting.

5. What are the biggest barriers to increased industrial symbiosis activity in Sweden?

Lack of awareness about the, potentially strategic, business and development value of industrial symbiosis and limited management attention given to concept are key motivational barriers. These can be overcome by helping decision makers understand the importance of industrial symbiosis and the value it can offer in their context. When actors are motivated, the next important barrier will be related to identifying opportunities. On the one hand, creating local dynamics/platforms that intensify communication among actors is one effective way of addressing this barrier. Further support can be provided by systemic 'need' and 'capacity' assessments. On the other hand, the barriers to implementation can be diverse. The rate of return of required investments, access to finance, regulatory requirements and concerns about operational disruptions are commonly encountered barriers. Some of these barriers can be addressed by public sector interventions. ★

NORDIC WORKING GROUP FOR GREEN GROWTH – INNOVATION AND ENTREPRENEURSHIP 2013-2016

The Nordic working group for green growth – innovation and entrepreneurship is one of the four working groups working under the Nordic Council of Ministers' Committee of Senior Officials for Regional Policy (EK-R). During 2013–2016, the working group has contributed to public policy development, with a particular focus on innovation and entrepreneurship. By conducting research, organising events and producing material, the working group has created new knowledge, synchronised existing insights and gathered case study examples about green growth in the Nordic countries.

The working group focuses on green growth, innovation and entrepreneurship from a regional policy perspective. In the first two years, the working group compiled a knowledge overview on green growth in the Nordic countries. Following this, the working group conducted an in-depth study about the bioeconomy in the Nordic countries in 2014 and produced a policy brief for the regional actors. A report on the potential of industrial symbiosis as a key driver of green growth in the Nordic regions came out in 2015, and in spring 2016, the working group will publish a handbook with 50 regional green growth case studies from the Nordic countries. In 2016, another in-depth study will be carried out. This final study is called Green growth in Nordic regions: State of play, practices and needs, and will be based on a digital survey aimed at officials at regional levels in the Nordic countries. All the publications are available online.

Gathering case study examples, conducting research and producing material is a big part of the mandate of the working group. The most vital element of the work, however, is the dissemination of results. The working group will go on tour in 2016 to each of the Nordic countries to hold roundtable meetings and discuss the findings and where to go from here. The road show will end with an open event, Nordregio Forum 2016, in Helsinki, where the research findings, cases and the networks will be presented. Save the date, 22–23 November! ★

NORDREGIO'S PUBLICATIONS ON INDUSTRIAL SYMBIOSIS

Nordregio's report 'The potential of industrial symbiosis as a key driver of green growth in Nordic regions', including comparative Nordic case studies and policy recommendations, was published in 2015.

More examples of Nordic industrial symbioses and regional solutions related to circular economy will be compiled by Nordregio into a Nordic Green Growth Handbook, coming out later this spring. Stay tuned for 50 good Nordic regional green growth practices!

Together with the Nordic working group for green growth – innovation and entrepreneurship, Nordregio works continuously with the potential of green growth (e.g., bioeconomy and industrial symbiosis) as a driver for regional growth in the Nordic countries by conducting applied research and providing policy recommendations.

More: www.nordregio.se/greengrowth ★



NORDREGIO
Nordic Centre for Spatial Development

Visiting address
Holmamiralens Väg 10,
Skeppsholmen, Stockholm
Sweden

Phone +46 8 463 54 00

More information at
www.nordregio.se



*Nordregio is situated on beautiful
Skeppsholmen, an island in the heart
of Stockholm, Sweden.*

ABOUT NORDREGIO

Nordregio is a leading Nordic research institute within the broad fields of regional development and urban planning. We undertake strategic research and provide policy relevant knowledge with a Nordic and European comparative perspective. We specialise in international comparative and collaborative research. Using our leading-edge skills, we carry out quantitative and qualitative analyses on many different geographic scales: Nordic, Baltic, Arctic and European. Our main target groups are planners and decision-makers at the international, national and regional levels. Main areas of research include regional development - urban and rural, city regional planning, demography, governance and gender, innovation and green growth, and sustainable development in the Arctic. ★