



NORDREGIO
Nordic Centre for Spatial Development

**Nelli Mikkola, Linda Randall
and Annika Hagberg (eds.)**

GREEN GROWTH IN NORDIC REGIONS

50 ways to make it happen



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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.

Nordic cooperation

Nordic cooperation is one of the world's most extensive forms of regional collaboration, involving Denmark, Finland, Iceland, Norway, Sweden, and the Faroe Islands, Greenland, and Åland. Nordic cooperation has firm traditions in politics, the economy, and culture. It plays an important role in European and international collaboration, and aims at creating a strong Nordic community in a strong Europe. Nordic cooperation seeks to safeguard Nordic and regional interests and principles in the global community. Common Nordic values help the region solidify its position as one of the world's most innovative and competitive.

The Nordic Council

The Nordic Council is a forum for cooperation between the Nordic parliaments and governments. The Council consists of 87 parliamentarians from the Nordic countries. The Nordic Council takes policy initiatives and monitors Nordic cooperation. Founded in 1952.

The Nordic Council of Ministers

The Nordic Council of Ministers is a forum of cooperation between the Nordic governments. The Nordic Council of Ministers implements Nordic cooperation. The Prime Ministers have the overall responsibility. Its activities are co-ordinated by the Nordic Ministers for Cooperation, the Nordic Committee for cooperation and portfolio ministers. Founded in 1971.

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Foreword by **Kaisu Annala**, Chairperson of
the Nordic Working Group for Green Growth -
Innovation and Entrepreneurship 2013-2016

This collection of regional green growth practices belongs to a series of publications, which the Nordic Working Group for Green Growth - Innovation and Entrepreneurship, under the auspices of the Nordic Council of Ministers, has been developing since 2013. The aim of the working group is to contribute to public policy development in the Nordic countries, with a particular focus on potentials for green growth in a regional context.

The working group has already commissioned two major in-depth studies exploring the potential of the bioeconomy and industrial symbiosis activities to contribute to regional growth and value creation in the Nordic regions. A third in-depth study will present the state-of-play with respect to green growth, with a particular focus on scrutinising the concept of 'green growth', the way it is perceived in the Nordic regions and how the subnational level works to endorse a greener economy. The working group's final activity for 2016 will be a synthesis report that aims to draw final conclusions based on the research undertaken and recommendations made during 2013-2016. Year 2016 will also be the year of dissemination for the working group, and besides publications and policy briefs, a series of stakeholder workshops will be arranged across the Nordic regions to disseminate our findings and to engage into a discussion with the Nordic green growth practitioners and to receive important feedback and future ideas from the regional and local actors.

This publication on Nordic Green Growth is another outcome of the working group's commissioned research projects. Throughout the working group's undertakings in 2013-2016, a wide range of interesting regional green growth practices has been uncovered. Too often these inspiring cases and valuable examples remain in the regions instead of being communicated and analysed further. This collection is an attempt to capture and promote 50 of the numerous and versatile Nordic green growth cases.

Nordic examples of green growth have received worldwide attention and there are many Nordic companies at the global forefront of cleantech, sustainable innovations and bioeconomy. In recent years, many publications have been issued to study and disseminate

Nordic green business cases. This collection of cases approaches the topic from a different angle by exploring the potential that green growth practices provide for regional development.

This compilation of cases provides insight into policy instruments and good practices across Nordic regions. Further, the factors enabling and hindering green growth in the regions have been explored. The publication aims to highlight the different solutions that are making greener regions a reality, as well as profile some of the accomplishments that have been brought about by green actions and thinking.

When the Nordic Working Group for Green Growth - Innovation and Entrepreneurship was formed, we did not exactly know where our efforts would lead. The past years have seen major developments in the Nordic green growth picture and especially in regional and national policies around concepts such as bioeconomy and circular economy.

Still, the world is not yet ready. One of the core aspirations of the working group has been to help the regional achievements to attain the publicity they deserve and to make the good practices visible and available on the greater Nordic scale.

As the term of the Nordic Working Group for Green Growth - Innovation and Entrepreneurship 2013-2016 is soon coming to an end, I would like to take the opportunity to thank Nordregio for coordinating and disseminating our work. I also want to thank the members of the working group for their engagement with the projects and the important contributions that they have made. The working group is grateful to all our partners and other stakeholders in the Nordic regions who have provided invaluable help and input to our work.

Finally, thanks to you, the reader, for your interest! We hope you find this and our other publications useful to green your region. We would also love to hear your comments for developing the next steps, so please contact us if you have ideas, comments or good examples to share.

Looking forward to the greener world!

Kaisu Annala

Green growth in Nordic regions – 50 ways to make it happen

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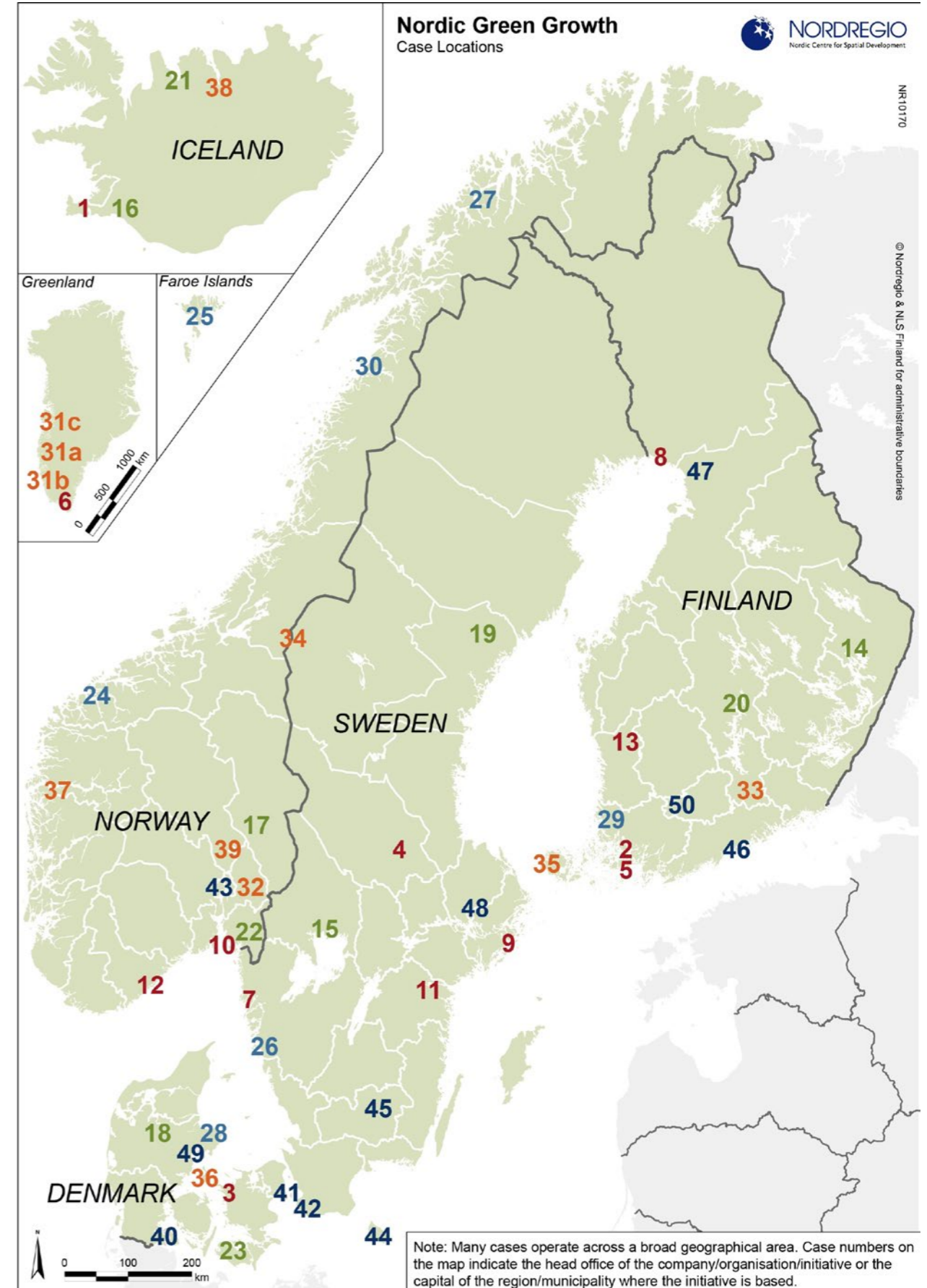
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Map: Geographical locations of the 50 regional cases

INTRODUCTION

Green growth in the Nordic countries - Why is the regional approach important?

The economic benefits of environmental action, including concepts like green growth, circular economy and bioeconomy, are of increasing interest in Europe and around the globe. This interest is largely fuelled by the ongoing impact of the financial crisis, but also relates to concern about the regional disparities that are increasingly evident in European countries. With respect to the latter, many Nordic regions are dealing with the challenges presented by the ageing population, the increasing trend towards urbanisation and scaling-down of traditional large-scale industries. Given this picture, a transition to a greener economy offers more than environmental sustainability – it can also serve as an engine for innovation, growth and resilient regions.

Building greener societies requires a holistic approach as well as collaboration across disciplines and governance levels on an unprecedented scale. In Nordic regions, many of the preconditions for a successful transition to the green economy are already in place. The Nordic regions have a strong scientific knowledge, a rich natural resource base, a firm tradition of cooperation on climate and energy, and Nordic companies are at the forefront of cleantech and bioeconomy development.

However, considerable work remains to optimise the support framework fully for a greener economy and to encourage green innovations, entrepreneurship and more sustainable ways of living. Regions are key players in creating and implementing green growth and green innovations; therefore, green-growth activities necessitate a strong territorial approach. The development of greener economies must be built on well-founded knowledge and an understanding of regional differ-

What is green growth?

In this publication, green growth is understood according to the definition by the Organisation for Economic Cooperation and Development (OECD) and Green Growth Knowledge Platform¹:

Green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. It focuses on the synergies and trade-offs between the environmental and economic pillars of sustainable development. It seeks to spur investment and innovation in ways that give rise to

new, more sustainable sources of growth and development.

Importantly, green growth does not neglect the social pillar; on the contrary, without good governance, transparency, and equity, no transformative growth strategy can succeed. Moreover, there is no one-size-fits-all strategy for implementing green growth; rather, specific policies and actions need to respond to national priorities and circumstances.

Green Growth Knowledge Platform, 2016
www.greengrowthknowledge.org

ences and competitive advantages. Green growth looks different in each region and thus its inclusion in regional development strategies should occur in a manner that considers the regional typology and strengths. Generating green growth at a regional level requires place-based actions and policies that consider social inclusion and equality while simultaneously managing the limits set by the natural environment. Social wellbeing, for example, does not automatically follow-on from the economic growth created through green initiatives. As a result, it is important to consider topics such as equality, inclusion and community engagement as an integral component of greener, more sustainable societies.

With this in mind, there is a constant need to consider a number of elements, including good governance, public-private partnerships, investment and innovation, and emphasise their role in the transition to greener economy in the Nordic regions.

Why explore green growth in Nordic regions?

The purpose of this publication is to promote green growth by highlighting examples of good practice in the Nordic countries. It also considers the regional dimension of each case by examining the contribution green growth activities can make to regional development. This collection of cases explores Nordic green growth through a wide lens, considering a broad range of examples from both urban and rural contexts to highlight the key characteristics of green growth initiatives in the Nordic regions.

Each case has been developed based on multiple sources of evidence, including previous Nordregio research, other research and reports, and interviews with experts and practitioners.

This collection of regional practices in no way promotes a 'one-size-fits-all' solution, but instead provides inspiration, tools and examples to support practitioners and policy-makers to approach the field of green growth using whatever method works best for them. The case studies presented in this collection can be used to design and implement future green growth initiatives and also provide insights to inspire adjustment of current and formulation of new policies.

Moreover, this publication seeks to promote green growth by facilitating the exchange of good practice. Case studies and comparisons across the Nordic, European and international contexts are needed to study the complex set of factors contributing to successful green growth practices. Despite the divergent institutional conditions and socio-economic characteristics between

regions and countries, many green growth practices and solutions have the potential to be implemented or replicated elsewhere.

Ways to explore this collection of regional practices

This publication consists of 50 individual case studies categorised under five broad themes, namely:

- Circular Economy
- Bioeconomy
- Blue Growth
- Cleantech and Renewable Energy
- Green Cities and Municipalities

The dynamic nature of green growth in the Nordic region makes it difficult to categorise each initiative neatly. In fact, most of the cases presented in this publication cut across two, three or even several of the above categories. As such, it is important to point out that the division of the cases into these categories is in no way an attempt to belittle their complexity. Instead, the cases are presented in this way as a means of providing the reader with a short introduction to some of the key concepts in the green growth field. The cases most relevant to each concept then follow as practical examples. It is also important to note that, although all of the cases profiled here contribute to the green economy, this does not necessarily mean that every facet of their operation is environmentally friendly. For example, a recycling operation may make a strong contribution to the circular economy while still relying on fossil fuels for transportation of waste. This is not a criticism per se, but rather a reflection that there is still work to be done in supporting the transition to a green economy.

A short background to the initiative is presented in each case study, which is followed by analyses of the enabling and impeding factors, including the role of regional policies and strategies, green businesses and active communities as drivers of green initiatives. One particularly interesting, or unique element of each case is also profiled to provide a 'case-within-a-case'. Finally, the regional added value of the case is analysed at the end of the study under a separate heading 'Regional dimension'.

What are the takeaway messages from the 50 cases?

This collection presents a diverse range of examples of green growth in Nordic regions, municipalities and cities. Though each is unique, many qualities are shared

¹The Green Growth Knowledge Platform was established in 2012 by the Global Green Growth Institute (GGGI), the Organisation for Economic Cooperation and Development (OECD), the United Nations Environment Programme (UNEP), and the World Bank to identify and address knowledge gaps in green growth theory and practice.

across the cases. Understanding these qualities has the potential to be instructive in highlighting the key enablers of green growth as a tool for regional development. Therefore, we close this Introduction with a short analysis of the overall lessons from the cases about building greener regions.

Collaborate across disciplines, sectors and borders

Creating sustainable growth and realising a green economy requires a holistic approach and unprecedented collaboration between different levels of government, disciplines, stakeholder groups and individuals. The most successful Nordic regional green growth practices are often based on the triple helix model and involve collaboration between the public sector, business and academia. When it comes to business, it is important to involve companies of all sizes as well as to encourage cooperation between actors. Small- and medium-sized enterprises can come up with important new ideas and innovations and can implement them quickly, but they often lack the resources to trial these ideas on a larger scale. Cooperation between businesses, coupled with strong support from public actors, can be a great way to take these ideas to the next level. Moreover, a common feature of cases that showed high potential for long-term sustainability was strong public support and legitimacy at the community level. Effective coordination of green growth initiatives is also a good way to maximise existing synergies and ensure the needed support is available. Thus, public authorities and cluster organisations play an important role.

Ensure a stable and encouraging funding and policy framework

Another crucial factor supporting green growth activities is the existence of a stable and predictable public support framework alongside complementary public finance instruments. It also creates a good environment in which to attract venture capital and private investments for green growth business and innovation. Almost all of the cases presented here have received public funding in some way or another. There are also many examples of cases that are well aligned with national policy priorities. Public funding schemes and incentives for R&D, innovation as well as demonstration and pilot projects play an important role in the transition towards greener economies, and should be available for different types of regional and local green growth initiatives and innovations of varying scale. Public-private partnerships have come to play an important role in en-

abling regional green growth in the Nordic regions and should be further encouraged. This support framework also has an important role in generating compelling evidence on the benefits of green growth and in institutionalising the concept of green growth.

Engage the community and empower individuals

Another key lesson arising from the case studies in this collection is the need to raise public awareness and acceptance of green growth. Understanding that the benefits of greener growth can bring about more sustainable communities is a precondition for the 'buy-in' from society. The role of passionate individuals and visionaries should not be underestimated when discussing the transition towards greener regions and sustainable growth. Driven individuals, groups and communities have realised many great ideas and innovations related to green growth and further continue to engage, facilitate and inspire others by their example. People with progressive and daring mindsets should be supported and equipped at all levels.

Learn by doing and embrace green growth opportunities

Working in an emerging field means learnings often occur through 'trial-and-error'. Things will not always go to plan, but each experience takes you closer to a positive result. Throughout this collection of green growth practices you will often hear the phrases, "first ... in Europe" or "world's first...". It takes courage to claim this title. It also means trying things without knowing for sure what the outcome will be. Many encouraging strategies, regulations and incentives are already in place in the Nordic countries and Europe that support practitioners to work in this way. Ongoing revision of these practices that consider practical experiences such as those described in this collection can be useful in ensuring that current regional perspectives are imbedded within the practices. Monitoring and evaluation tools can also be useful in supporting practitioners and policy-makers to establish visions, baselines and targets to guide their work when embarking on uncharted territory. Another aspect that many of the cases in this publication have in common is that there are clear strategies and channels through which to communicate their work to the outside world. This is useful in creating a greener image – both in terms of regional attractiveness and for company profiles. This dissemination process also facilitates the exchange of good practice by making sure that learnings are shared and lead to fruitful future partnerships.



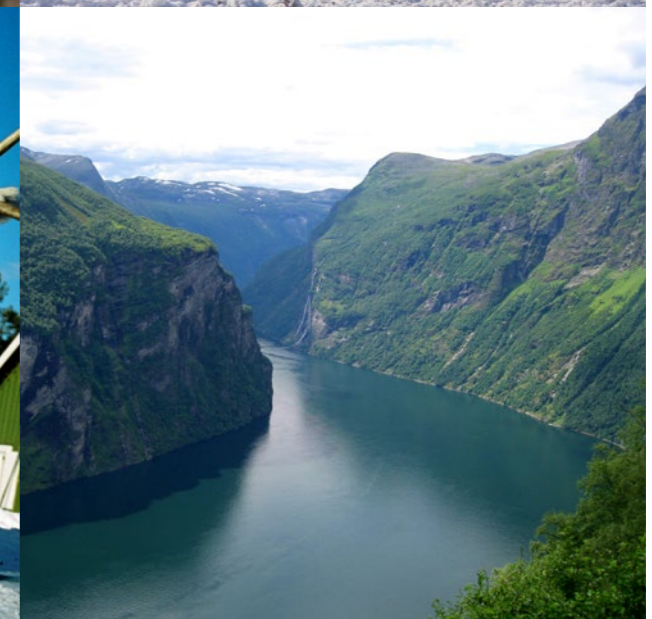
Anne Sofie Bender, Yadid Levy / Norden.org



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Karin Beate Nøsterud, Elvind Sætre / Norden.org



CIRCULAR ECONOMY

The circular economy has two key interrelated features – retaining resources in the economy for as long as possible and reducing waste. The circular economy challenges traditional linear models of consumption where products are designed, manufactured, consumed and then discarded. Rethinking this way of doing things is only possible if all those involved in the consumption chain work together. Designers and manufacturers must come up with ways of incorporating recycled materials into new products. Consumers must be self-aware and open to new modes of consumption, for example, leasing products they have previously been used to owning. The way products at their end-of-life stage are dealt with must also be open to scrutiny, scientific enquiry and, in some cases, complete overhaul.

The cases in this collection contribute to the circular economy in different ways. Some facilitate the recycling process by cooperating with other actors to collect products at their end-of-life stage and ensure to collect end of life products and ensure recycled materials are put to new uses (e.g. Case 5. An ambitious approach to textile recycling in Southwest Finland; Case 10. Starting from scrap in Øra Region). Others demonstrate how a single resource can circle through the economy in a more effective way (e.g. Case 2. The water circulation system in Southwest Finland). By far the biggest contribution to this section is made by cases that demonstrate what is commonly known as ‘industrial symbiosis’ (e.g. Case 1. Reykjanes Geothermal Resource Park; Case 3: Kalundborg industrial symbiosis; Case 8: An ecosystem of Arctic industries in Kemi-Tornio). Industrial symbiosis involves collaboration between multiple actors in order to exchange resources (i.e. by-products that would otherwise become waste) that can be used as a substitute for commercial products or raw materials. In other words, in industrial symbiosis a waste or by-product of one actor becomes a resource for another actor. The dominance of these types of case studies in this section highlights the vital role of cooperation in moving towards a circular economy.



REYKJANES GEOTHERMAL RESOURCE PARK

The Reykjanes Geothermal Resource Park (GRP), including the world famous The Blue Lagoon Geothermal Spa, is located on the Reykjanes peninsula in southwestern Iceland, some 50 km from the capital Reykjavik. Coupled with the world's first geothermal combined heat and power (CHP) plant in Svartsengi, the Reykjanes GRP is based on ideas derived from aboriginal values of harnessing nature's powers (Albertsson & Jónsson 2010), and sharing excess streams with other companies.



© Yafid Levy / Norden.org

Geothermal source for development

Beneath the barren lava fields in the sparsely populated Grindavík municipality lies a ground water reservoir, tapped for its resources by HS Orka hf since 1977. The company sees the geothermal energy as more than just energy and has found ways to extract several resources. Based on the philosophy of creating multiple sources of revenue and thereby spreading financial risk, the initial Resource Park in Svartsengi was developed as new companies were created or affiliated. Since 2007, HS Orka hf has also run a second geothermal CHP plant in the area, which is already cooperating with several other companies in a successful industrial symbiosis. Focusing on the region's main industries, the majority of the linked companies work in the fishing and tourism sector, but the diversity of businesses is growing. There is also a close cooperation with Iceland's largest university campus, and research and development is of high priority to HS Orka hf, the steaming giant in the centre of it all.

Svartsengi, the Blue Lagoon and beyond

Iceland's most popular tourist attraction, The Blue Lagoon, was accidentally created after the commissioning of the CHP plant in Svartsengi, as outlet water from the power plant formed a lagoon. The effects of brine on the porous lava rock was found to promote the healing of skin conditions, and today there is a spa, a dermatological treatment clinic, and a research centre. The three companies operate in close connection with each other and share research and development with Svartsengi. The industrial symbiosis now also includes a carbon recycling company, which turns CO₂ from the power plant into methanol; a molecular farming company, which uses water and electricity from the power plant to produce proteins and growth factors from barley; and a data centre that is fully run on geothermal energy.

With the inclusion of the second power plant in Reykjanes, the diverse family of companies also involves a tourist and exhibition centre, a fish drying facility and a fish farm. One idea is to use heated cooling water released from the power plant to cultivate algae for biofuel production, and keep a warm water aquaculture plant that could be fed with bio-waste from the algae farm (Albertsson & Jónsson 2010).

The Blue Lagoon Spa has more than 400,000 visitors per year – which is more than the entire population of Iceland.

Fuelled by informal dedication

Dialogue and communication between the actors take place on a daily basis in informal meetings, as the Resource Park has developed without formal cooperation and coordination. Flexibility, communication, openness for collaboration, and understanding of each other's needs are emphasized as crucial success factors. Sustainability is also a common focus for the companies, and the economy of Grindavík municipality relies to a large extent on the responsible exploitation of natural resources. Geothermal energy and sustainable fishing are focus areas of the local administration's green growth policy, although geothermal energy can cause emissions of mainly sulphur, heavy metals, and CO₂. The municipality encourages small-scale activities within the focus areas, and can apply for state grants in support of initiatives that are in accordance with the green growth policy and the Resource Park ideology.

Regional dimension

Connecting companies from such different sectors builds a diversity that in turn can provide strong resilience, both for the businesses as well as the municipality. The stakeholders' shared values of sustainability give them a common platform, from which the entire nation can benefit as the energy provider and strongest actor in the symbiosis strives to "enable Iceland to become the first country in the world with a totally green, zero carbon emission economy". This would provide green jobs and strengthen the economy in a country struck hard by financial recession but with vast potential to thrive sustainably.

Learn more...

- Reykjanes GRP webpage: <http://www.grp.is/>
- Nordregio report: The potential of industrial symbiosis as a key driver of green growth in Nordic regions.



THE WATER CIRCULATION SYSTEM IN SOUTHWEST FINLAND

Water passing through Southwest Finland's water circulation system begins its journey at the Kokemäenjoki River. It is pretreated before being absorbed as artificial ground-water in Virttaankankaa. From there, the water travels to Saramäki rock storage in Turku. The water is then used within the municipalities of Turku, Naantali, Paimio, Kaarina, Lieto, Nousiainen, Parainen, Masku and Raisio. Following use, it makes its way to the Kakolanmäki Waste Water Treatment Plant in Turku where it is used to produce district heating and cooling. Finally, the sludge from the waste water is dried and transported to Biovakka Finland where it is turned into biogas, which can be used to produce electricity and district heating.

Planning the water circulation system

In the past, Southwest Finland used water from the Aurajoki River. This was far from ideal, with the following problems evident:

- Water varied in both quality and availability.
- Lack of integration between the waterworks of the different municipalities made it difficult to deal with disruptions in supply.
- Separate waste water treatment plants induced great stress on the drainage basins of the area.
- Waste waters were not utilised efficiently.

Developing a system on the scale necessary to address this wide range of problems took time. The initial investment required was high and there were strict regulations and legislation that needed to be adhered to. In the end, however, policymakers were motivated to pursue the project due to environmental and public health concerns. In addition, it was suspected that, in the long term, the renewal of existing plants would be more expensive than building the new system.

Implementation of the system

As a complete package, the Southwest Finland water circulation system is a pioneer in its field, engaging regional municipal companies to carry out the many different phases of this multi-scale concept. The system creates a good reference point in terms of selling the concept

The heat pump plant utilising the waste heat of the waste water by Turku Energia at Kakolanmäki produces approximately 8% of the total district heating demand of Turku.

of integrated water resource management and showing that it is more than just a good idea on paper. The Kakolanmäki Waste Water Treatment Plant's ability to efficiently cater for the 200,000–250,000 inhabitants of the region is a clear example of the success of the system as a whole. Ideas for potential start-up companies have come from the project; for example, purifying medical residues from waste waters. Two doctoral dissertations on the water production part of the system have also been written.



© Turku Region Water Ltd.

Artificial ground-water production

A special feature of the water circulation system is the manufacturing of artificial ground-water for household water use that was introduced in 2012. The raw water is taken from Kokemäenjoki River in Huittinen and pretreated by sieving, sedimentation and filtration. The sludge derived from pretreatment is dried and utilised elsewhere. After pretreatment, the water is transported to Virttaankankaa (by 30-km-long pipeline) where it is absorbed into an esker (a long, narrow, winding ridge composed of stratified sand and gravel deposited by a subglacial or englacial meltwater stream). The water flows inside the esker for three months and is then transferred to Turku and Lieto (by 60-km-long pipeline). At the end of the pipeline in the Saramäki rock storage in Turku there is a turbine that produces electricity used for water production. The water is stored in the rock storage until it is passed for usage through the Halinen waterworks. The total length of the pipeline is approximately 120 km and the cost of the whole water system was approximately €150m.

Regional dimension

The greatly improved water quality and protected water supply are good examples of the regional added value brought about by the water circulation system. Today, the water is very close to ground-water quality even though artificial ground-water is used. The better water quality is also good for the regional economy (especially for the food and beverage industries), increasing the regional sustainability and competitiveness. On a broader scale, centralising all municipal waste water treatment plants in one location at Kakolanmäki has resulted in fewer load point centres, which has had a positive effect on water quality in the Baltic Sea.

Learn more...

- Turku Region Water Ltd.: <http://www.turunseudunvesi.fi/en>
- Turun seudun puhdistamo Oy: www.turunseudunpuhdistamo.fi
- Oy Turku Energia Ab: <http://www.turkuenergia.fi/>
- Biovakka Finland Oy: <http://www.biovakka.fi/en>
- Regional Council of Southwest Finland: <http://www.varsinais-suomi.fi/en/>



KALUNDBORG INDUSTRIAL SYMBIOSIS

According to Symbiosis Centre Denmark, the industrial symbiosis in the Kalundborg municipality on Zealand is the world's first working industrial symbiosis. It is based on trust, transparency and on-going dialogue between public and private actors, and was developed with the assistance of regional strategies supporting environmental and economic sustainability. The project's five decades of experience and knowledge are now being shared nation-wide as well as internationally.

An expanding network

Large energy and processing companies, including pharmaceutical/medical and cleantech companies, are based in the industrial area of Kalundborg municipality, comprising one of Denmark's largest concentrations of industries. Eight of these private and public partners form the internationally known industrial symbiosis of Kalundborg, engaging in some 50 symbiotic exchanges of resources. The network in "The Green Manufacturing Municipality" has evolved over five decades and gained much attention from academia and practitioners. Several local and regional development strategies help shape the expansion of the Kalundborg Symbiosis and, for example, encourage more renewable energy and resource efficiency as a means to strengthen competitiveness. A target in Region Zealand's Regional Growth and Development Strategy is to increase the number of companies involved in symbioses in the entire region from 65 in 2014 to more than 200 in 2020.

Where it all started

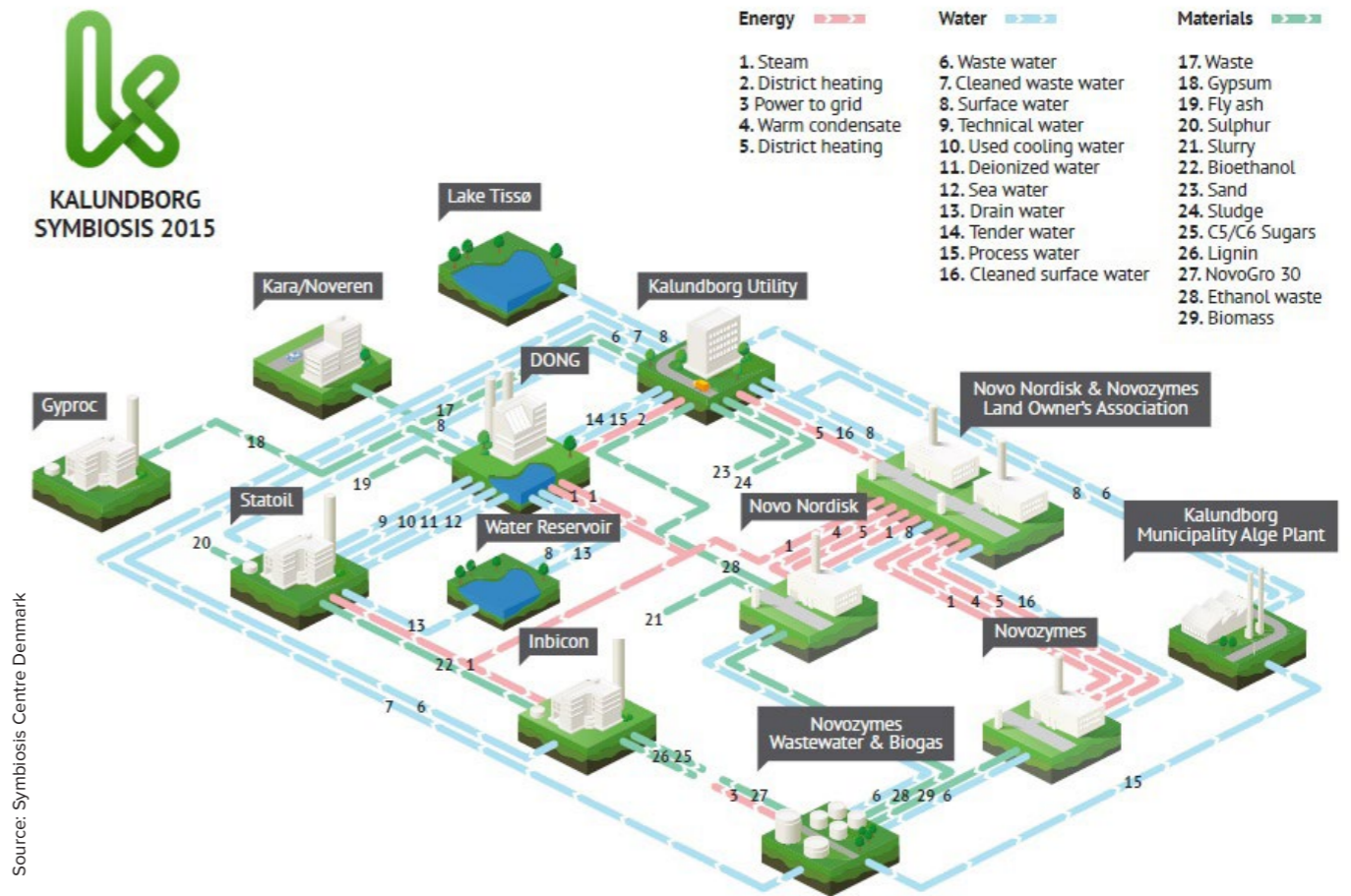
The forerunning cooperation in Kalundborg began in 1961 when an oil company needed water for its refinery and laid pipes to a nearby lake. A local gypsum production enterprise then connected with the refinery for supply of its excess gas, and soon a power plant and a pharmaceutical company also joined the grid. Over the years, more businesses were linked, and in 1989, the term "industrial symbiosis" was used to describe the collaboration for the first time. The main resources being exchanged are water in various forms, energy and waste or by-products (see figure on next page: Kalundborg Symbiosis 2015)). The companies feed each other's resource needs while lowering

National Symbiosis Centre

With the purpose of making it Denmark's leading centre of competence for the establishment of industrial symbioses, Kalundborg together with two neighbouring municipalities initiated a Regional Symbiosis Centre in 2011. During 2012-2014 the Symbiosis Centre supported more than 20 projects across the region, with objectives such as increasing the number of innovative small to medium sized enterprises, and improving energy and resource efficiency. Increasing political backing for the centre meant that in 2014, the Regional Council and Growth Forum of Zealand granted €1.6 million of its regional development funds to evolve the centre into the National Symbiosis Centre. Since 2015, the centre has had the mandate to engage in initiatives across the country to support the development of industrial symbioses. The National Symbiosis Centre works strategically with four key areas:

- developing symbioses between companies
- training and education
- branding and investment promotion
- collaboration with universities

costs and resource consumption, thereby strengthening their CSR profile, sparing nature and protecting the groundwater.



The total reduction of CO₂-emissions in 2014 from the Kalundborg Symbiosis was about 300,000 tonnes.

Regional dimension

As a result of the multilaterally positive outcomes of the Kalundborg experience, some of the municipalities in the region now have "symbiosis employees" in their environmental departments. Although it is difficult to estimate the number of new jobs the symbiosis has generated, it can be said that it has made a difference in terms of maintaining domestic jobs in the manufacturing industries. Political engagement through regional strategies and national programs has helped develop the entire region and is a format and experience that could be exported to other Nordic countries.

Learn more...

- Symbiosis Centre Denmark: www.symbiosis.dk/en
- Nordregio report: The potential of industrial symbiosis as a key driver of green growth in Nordic regions.



DALARNA NETWORK FOR SUSTAINABLE CONSUMPTION

The county of Dalarna has a long history of industrious innovators and hard-working entrepreneurs, amidst its ancient forests and meteor-created lakes. Today, Dalarna in central Sweden is home to about 277,000 people in 15 municipalities. The region is known for its proud people and beautiful landscapes – a combination that can be quite fruitful for the transition to a more sustainable society. Together with a coalition of educational organisations (Dalarnas Bildningsförbund, DBF), the Dalarna County Administrative Board (Länsstyrelsen Dalarna) has recently founded a regional network for sustainable consumption. Involving public organisations, private companies and non-profits, the purpose is to raise awareness and ambitions for sustainable consumption – and improve life quality.

Collaborate and conquer

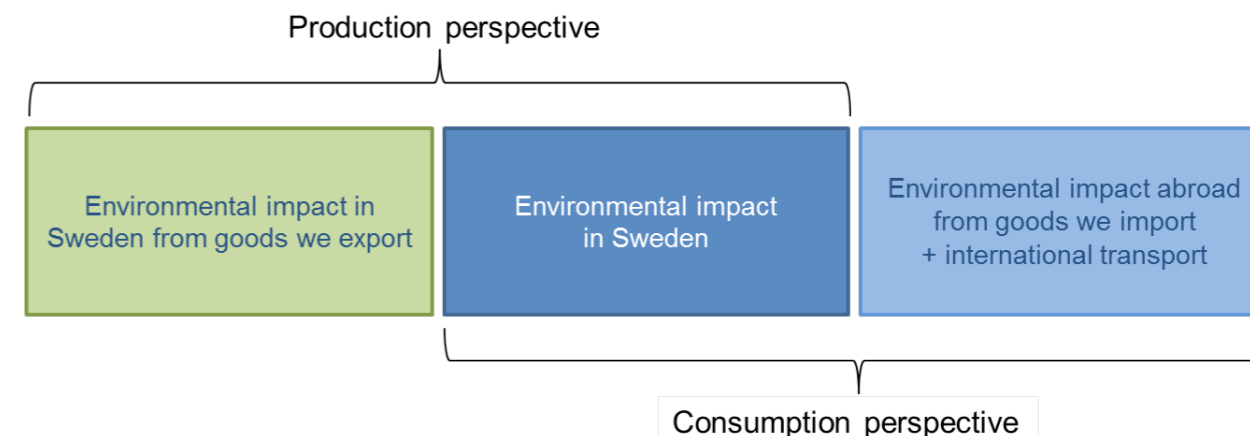
Mining in Dalarna has a longer history than the county itself, and several founders of large international companies originate from the area. Hard work, innovation and entrepreneurship are well-used labels for the people here. In current times, when sustainability challenges loom large, there are many local initiatives to address them. The Dalarna County Administrative Board and DBF called local actors to an initial meeting in December 2014, where they found that there was a lack of coordination and synchronisation of the various initiatives. Hence, a regional network for sustainable consumption was founded in June 2015. So far, local actors who have been involved include Dala Avfall (waste manager), Falu Energi & Vatten AB (energy and water provider), Falun municipality, Framtidmuseet (the Future Museum), Dalarna College, Dalarna County Council, and the Swedish Society for Nature Conservation in Dalarna. With this network platform for the exchange of knowledge and experience, the hope is to foster better internal and external communication and to promote more rapid and effective improvements.

Solid policy base for solid motivation

The founding of the regional network rests on several ambitious policies. One of them is the regional energy and climate strategy, with a vision for 2050 for Dalarna to be a place where it is easy and natural to live “ener-

One of Dalarna County’s goals for 2050 is for greenhouse gas emissions from consumption to be less than 2 tonnes of CO₂ per capita per year.

gy intelligent and climate smart”. The network has set as a goal to work towards this vision, as well as towards the Generational Goal set by the Swedish government, which includes striving for a society where “patterns of consumption of goods and services cause the least possible problems for the environment and human health” (Swedish Environmental Protection Agency). Since it is perceived as unclear what the County Administrative Boards should do concerning consumption, Dalarna helped produce a national pre-study on the role and responsibility of Boards for more sustainable consumption (2015). Despite the lack of an official mission from the government, it was found that the County Administrative Boards should co-ordinate and lead the regional



The network’s image of production and consumption perspective, shared by Maria Saxe, network convenor.

Active members show a promising start

Barely one year old, the network’s organisations already have a number of projects and initiatives up and running. For example, Falu Energi & Vatten puts on performances of the children’s play “Sopakuten” (The Garbage Emergency) as an educative tool on waste management; the County Council has set up its own internal platform for exchange of unused furniture; and Dala Avfall runs a pedagogic homepage that helps residents recycle better. Maria Saxe, energy and climate strategist at the Da-

larna County Administrative Board and convenor of the network, explained in an interview that the network’s activities are about spreading awareness and knowledge of the consequences of our consumption, and that the cooperation with DBF helps to get the message out there. The network has successfully arranged its first seminar, on food waste, and the next one will cover education for sustainable consumption.

work for more sustainable consumption. The Boards’ work would be facilitated if there was a national strategy for sustainable consumption, and if there was more financial support to offer local initiatives. Sweden is a key player for the success of the UN 10-year Framework of Programmes on Sustainable Consumption and Production (10YFP), which, among other promising policies, supports the strong motivation for this new network.

Regional dimension

Multiple benefits arise from more sustainable consumption, and although the positive effects might be slightly different for different actors, the direct and indirect benefits easily outweigh business-as-usual. Aside from im-

proved air quality, spared natural resources, less climate impact, greener jobs, saved tax money and increased revenue, it is hoped that one of the most important effects from this network is improved life quality. Lessons learned – involving better communication, coordination processes, which initiatives give better results, and what changes make people perceive a better quality of life – are intended to be shared with other municipalities and regions along the way.

Learn more...

- Dalarna County Administrative Board (in Swedish): <http://www.lansstyrelsen.se/dalarna/En/Pages/default.aspx>



AN AMBITIOUS APPROACH TO TEXTILE RECYCLING IN SOUTHERN FINLAND

Work is currently under way in Southwest Finland that will enable large-scale recycling of end-of-life textiles for the first time in the country. The project brings together various funders, city councils, waste management companies and universities, and aims to pave the way for a new and profitable textile industry. Systematic collection and sorting of textile waste began in early 2016 and processing facilities have been opened in which the use of promising new recycling technologies are being piloted.



© Sara Malve

Change through extensive collaboration

Despite the final disposal of organic waste now being illegal, most end-of-life textiles still end up being incinerated for energy (56%) rather than being reused (30%) or recycled (14%). To combat this, a year-long Finnish end-of-life textile project with an investment of €120,000 began in early 2016. The project is led by Turku University of Applied Sciences (TUAS) and Southwest Finland Waste Management Ltd in collaboration with SITRA (the Finnish Innovation Fund), the city of Turku, Tekes (the Finnish Funding Agency for Innovation), a Nordic circular economy company Ekokem and the Finnish Solid Waste Association.

Turku City Council has proposed the Topinpuisto area as a potential pilot site where various waste types can be processed. This area also has the potential to become an industrial logistics and pretreatment centre capable of receiving an international supply of end-of-life textiles. Sorted and possibly pretreated textiles could be forwarded for various utilisation purposes, chemical recycling or incineration.

The Infinited Fiber Company

The recently established Finnish “Infinited Fiber Company” turns cotton waste into new fibres for the textile industry. This new chemical recycling process (loncell-F) was developed by researchers from VTT Technical Research Centre of Finland Ltd and Aalto University, and enables the manufacture of high-quality fibre from dissolved cotton-rich textile waste, viscose, wood and other materials with high cellulose content. This process runs without carbon disulphide (a notorious neurotoxin used by some methods) or other dangerous substances, and more than halves the water and energy needed for producing cotton clothing with unrecycled cotton. There is no limit to the number of times fibres can be recycled using this process. loncell-F has recently received international acclaim after winning the Global Change Award of the H&M Conscious Foundation and receiving €300,000. The company is also one of the nominees for the best Nordic Cleantech Startup in 2016.

In 2016, the Infinited Fiber Company aims to produce 50,000 kg of new fibre with loncell-F at a pilot plant in Valkeakoski. The company hopes to collaborate with textile collecting agents in Southwest Finland and also with leading textile brands.

In Finland, ca. 70 million kg of textile waste is produced annually, and ca. 40 million kg of this is cotton.

Plans and investigations

The textile recycling program is part of a 10-year (2015–2025), €40m investment programme in the circular economy from the Finnish Government. The project shows considerable promise, although it is still in its early days. Collection of end-of-life textiles has started and the project team (led by TUAS and LSJH) has begun to gather data on the qualities and usability of different textile materials, as well as the total volume of textiles received. This will inform an understanding of the proportion of textiles that can be resold as they are, those that can be turned into new products, and those that are unusable. It is unclear at this point to what extent this sorting process can be automated in the future. Machines can recognise different materials but humans are needed to spot value and condition variation within specific textile types. Factors such as these will have an impact on the long-term economic viability of project activities.

Regional dimension

Textile collection and sorting has created low-threshold workplaces and useful information is being gathered for future uses. However, the long-term economic viability of the project’s business models needs to be determined before the regional implications of this work can be fully understood. The hope is that in the near future clothing will circulate like glass, metals and biowaste. If this is achieved, Southwest Finland has a unique opportunity to be at the forefront in creating a completely new line of business involving products made from recycled textiles. Such innovation has the potential to revive the Finnish textile industry and make a substantial contribution to the regional, and even national, economy.

Learn more...

- Infinited Fiber Company: <http://infinitefiber.com/>
- Finland Textile Removals Association (in Finnish): <http://www.poistotekstiilit.fi/>



LOCALLY SOURCED FODDER SUPPORTS SOUTH GREENLAND'S SHEEP-FARMING SECTOR

Sheep farming plays an important role in Greenland's economy, accounting for 80% of agriculture-related income. A large number of these farms are located in the southern Greenland municipality of Kommune Kujalleq. Recent work to generate fodder from local waste products and locally produced silage has greatly reduced the risks posed to the industry by the harsh winter conditions. In turn, this improved stability has increased the potential of the industry to contribute to regional economic development.



© Rasmus Ole Rasmussen

Growing the sheep-farming industry in harsh conditions

The conditions in South Greenland are harsh. Despite this, the relatively warm föhn winds generally keep the snow cover at a reasonably low level, making the vegetation available for the sheep. From time to time, these winds fail and the snow eventually becomes so deep that the sheep cannot access the food. Even more problematic is when the föhn winds only melt the surface snow, which then freezes into ice. When that happens, the sheep cannot get anything to eat and large proportions of the flocks starve. To address this problem, farmers have experimented with different kinds of winter feed comprising local products such as silage in combination with grass and fish waste. The winter feed acts as a substitute for natural forage and allows the sheep to be kept indoors in stables. Using local products in this way means that winter fodder does not need to be imported. Sheep fodder is also a valuable way to utilise waste products, which contributes to circular economic development in Greenland.

Enabling conditions from a natural and a policy perspective

Warmer global temperatures have resulted in more favourable conditions, which made the first decade of the twenty-first century the most productive in Green-

A short history of sheep farming in South Greenland

Sheep grazing was originally practiced in South Greenland by Norse settlers between 985 and 1450 (Fielberg & Høegh 2008). Modern sheep farming did not commence until 1925 and was based on year-round grazing until the 1970s, with small supplements of winter fodder and occasional stabling. In 1982, a new plan for sheep management was introduced as a means of increasing the number of sheep farms. The plan involved the Sheep Farmers' Association in collaboration with the Home Rule Government, and was expected to develop a business that could contribute to the Home Rule's overall goal of a society largely based on the country's renewable resources. The plan included stabling the sheep for seven months of the year and allowing them to graze in the outlying fields for the other five (Fielberg & Høegh 2008).

“Sheep fodder is also a valuable way to utilise local waste products, which contributes to circular economic development in Greenland.”

land's sheep-farming history (Agricultural Consulting Services nd.). At the same time, the milder climate poses challenges, including drought in the summer and an increase in periods where vegetation is covered by ice sheets in the winter and fall (Agricultural Consulting Services nd.). The use of winter fodder contributes greatly to the stability of the sector by making the second of these challenges irrelevant. Although climate is an important factor, public policy has also played a role in supporting the growth of the sheep-farming sector. A 2008 report estimated government subsidies for sheep farming at approximately DKK 10 m per year (Fielberg & Høegh 2008). To put this figure into perspective, the same report estimated the total income from sheep farming at around DKK 20 m per year (Fielberg & Høegh 2008). Government policy also acknowledges the importance of the utilisation of the entire value chain in contributing to increased earnings and improved competitiveness (Naalakkersuisut 2007, in Danish).

Regional dimension

The Greenland case demonstrates one way circular economic thinking can contribute to local industry. By utilising locally available products such as fish waste and silage as winter fodder, the sheep-farming industry, which was originally subject to a wide range of uncertainties, now offers a more stable contribution to Greenland's food security. Importantly, it does so without putting unsustainable strain on the local ecosystem and without the need to import resources. This has short-term economic benefits because it reduces the cost of production and increases the possibility for the industry to contribute to long-term regional economic development.

Learn more...

- Agricultural Consulting Services:
<http://www.nunalerineq.gl/english/index-english.htm>



SOTENÄS INDUSTRIAL SYMBIOSIS

Sotenäs municipality lies 120 km north of Gothenburg on the Swedish west coast, in Bohuslän province and Västra Götaland County. Approximately 9,000 people live in this coastal municipality, which has strong cultural connections to the sea and includes well-known old fishing villages such as Smögen. Today, Sotenäs municipality encourages circular business models and facilitates for public and private actors to form symbiotic collaborations with positive economic, environmental and social impacts. Sotenäs municipality was a partner of the project “Industrial Symbiosis for Strong Communities” (IS-COM), at Johanneberg Science Park in Gothenburg. In December 2015, Sotenäs Centre for Symbiosis (Sotenäs Symbioscenter) was established to support cooperation between local businesses, academia, the public sector and society.

Facilitation by cooperation

Because of its small size, Sotenäs often collaborates with other municipalities and actors to remain competitive. For example, Sotenäs is the host municipality of an environmental board shared with Lysekil and Munkedal municipalities since 2013. Another example is Sotenäs’s collaboration within the regional project Tillväxt Norra Bohuslän (Growth North Bohuslän). By facilitating cooperation between municipalities and actors, several projects can focus on long-term healthy growth in the northern half of the province. One of the included projects is “Industrial Symbiosis – local cooperation for sustainable business”, which has been operated by the Sotenäs, Dals-Ed and Falköping municipalities for two years. It is partly financed by Västra Götaland County and aims at increasing cooperation between business, municipality and educational institutions, with a focus on resource efficiency and green projects that lower greenhouse gas emissions and create more jobs locally. Several projects within the regional framework involve the prominent sea as a vital natural resource, such as “Clean coastline” and “Keep the sea clean”.

Important partners and policies

Sotenäs municipality has found an important partner in the Swedish state-owned venture capital company Fouriertransform. The municipality lacked substantial funds because it is a small municipality where half of the homes

belong to seasonal residents; therefore, a long-term investor can be crucial for getting things rolling. However, the willpower of local clerks like Leif Andreasson (mentioned below), boldness of politicians with sustainable visions and the solidity of policy frameworks pointing out a clear, sustainable path ahead, are also crucial parts of the equation.

Regional dimension

Part of the reason for the establishment of the Centre for Symbiosis was to attract people to move to the area. After conducting a survey, clerks of Sotenäs municipality were surprised to find that the majority of seasonal residents were young people and realised that they needed

“Companies must be part of the solution. Otherwise they are part of the problem.”

– **Lars Bäckström,**
governor of Västra Götaland County

Source: Sotenäs Centre for Symbiosis



to adapt their plans to suit this social group. A majority of Swedish companies with marine connections have a presence in Sotenäs and the research and development within sea-based businesses is of high importance for the region’s future. Establishing well-functioning platforms for networking and a strong business culture of collaboration can bring great sustainability value to the continued economic stability and improved social and environmental aspects.

Learn more...

- Sotenäs Centre for Symbiosis (in Swedish): <http://www.sotenassymbioscenter.se/>
- Sotenäs municipality (in Swedish): <http://sotenas.se/>
- Clean coastline/Ren kustlinje (in Swedish): www.renkustlinje.se
- Keep the sea clean (in Swedish): www.hallhavetrent.se

Sotenäs Centre for Symbiosis

Sotenäs Centre for Symbiosis was officially opened in December 2015. According to Leif Andreasson, development strategist at Sotenäs municipality, the journey began in 2011 when then mayor Mats Abrahamsson stated that Sotenäs needed a type of focal point for local actors with the catchwords ‘environment’, ‘renewable energy’, ‘reuse and recycling’, and ‘skills development’. After a study visit to the world-famous industrial symbiosis in Kalundborg, Denmark (see Case 3), the idea of establishing a symbiosis centre was formed. Andreasson began looking at solutions together with business representatives in the area, and today the Centre for Symbiosis in Kungshamn houses Sotenäs municipality, a college,

the governmental venture capital company Fouriertransform, and six more organisations. Studying the complex system image of the developing industrial symbiosis of Sotenäs, one finds that renewable energy, food production, and marine technology are key areas. For example, the Swedish Algae Factory (see Case 24) opened its first test bed for algae growth in connection with Smögen Salmon farm, and both companies together with Orkla Foods will be connected to a planned biogas plant. In turn, the biogas plant will produce electricity and heat for local fish-processing industries, and organic fertiliser for local farmers. Like an ecosystem, the Sotenäs symbiosis is growing slowly, organically and surely.



AN ECOSYSTEM OF ARCTIC INDUSTRIES IN KEMI–TORNIO

The Kemi–Tornio region is situated in Northern Finland and comprises the cities of Kemi and Tornio, as well as the municipalities of Kiminmaa, Simo, and Tervola. The Kemi–Tornio industrial symbiosis involves companies exchanging industrial by-products (i.e. waste) with other companies that can use them as a substitute for raw materials. The collaboration includes actors from forestry, mining and steel industry companies, industrial service companies, research and educational organisations and intermediaries.

Symbiotic activities

The Kemi–Tornio region is important for industrial refinement and exports. It is responsible for 80% of Lapland's industrial production and 7–8% of the total export value of Finland's products. Companies in the region have been exchanging materials in a manner consistent with circular economic thinking for decades. A more systematic approach, and specific use of concepts such as “green growth”, “circular economy”, and “industrial symbiosis”, began in the early 2000s. Some examples of waste being used as raw materials include:

- Riffler waste (Metsä Fibre's Kemi mill) is used as mulch in landscaping.
- Ash (StoraEnso Veitsiluoto mill) is used to fill open pits of a chrome mine after metal extraction has concluded (Outokumpu Kemi mine).
- Carbon monoxide surplus (Outokumpu ferrochrome factory) is used as fuel (SMA Mineral factory), replacing 17,000 m³ of oil annually.

Working together for sustainable natural resource management

Conditions for green growth have been favourable to the development of the Kemi–Tornio industrial symbiosis. Climate considerations are high on the agenda at the national, regional, and local levels, and sustainable natural resource use is seen as a key way to add value to Lapland's exports. Regional strategies that have been instrumental in promoting green growth in the region include:

- ERDF 2007–2013 Programme for Lapland – Promotes business and innovation.

- Lapland's Arctic Specialisation Programme – Promotes the sustainable utilisation of natural resources.
- ERDF 2014–2020 – Aims to strengthen Finland's climate change and energy ambitions through the development of a new regional plan for climate and energy.

Mapping industrial side streams

In 2014, Digipolis Technology Park in Kemi coordinated a project mapping industrial side streams in the Kemi–Tornio region. The aim of the project was to increase the utilisation of industrial waste as a substitute for raw materials by creating connections between companies in the region. It created a regional actor network through which to match companies whose raw material needs and waste were compatible. It also documented existing (unutilised) side streams with a view to paving the way for new business opportunities. Documentation of relevant side streams included recording their chemical and physical properties; analysis of the utilization grade of the side streams; and studies on markets, technology, and logistics related to the side streams. The project identified more than 1.3 million tonnes of annual by-products and waste streams (excluding the veinstone of mining activities). These have been documented in a databank of industrial side streams that will soon be opened up to companies and enterprises in the region.



Source: Poikeila 2014

Sitra, the Finnish innovation fund, along with private sector actors, for example, Digipolis Technology Park, have also been strong drivers of green growth in the region. Despite positive outcomes so far, there is a concern in the region that the full potential for green growth will not be realised without a long-term and systematic role for a competent and trustworthy intermediary to catalyse future activities.

Regional dimension

Sustaining local industries, while at the same time minimising their environmental impact, is vital to supporting the livelihood of communities in the Kemi–Tornio area in the long term (Watkins 2014). The industrial symbiosis in Kemi–Tornio also presents substantial opportunity for regional development. This is evident in two ways. First, knowledge of unutilised side streams lays the foundations for new and innovative business ideas. Secondly, the symbiosis itself can draw positive attention to the region as a unique example of a platform through which to create and strengthen an indus-

The total volume of industrial symbiosis activities in the Kemi–Tornio Region has been estimated at €200 million annually

(Johnsen et al. 2015)

trial ecosystem in Arctic conditions (see figure above: Kemi-Tornio industrial symbiosis).

Learn more...

- Nordregio report: The potential of industrial symbiosis as a key driver of green growth in Nordic regions.



SUSTAINABLE SPORTSWEAR

Unconventional in many ways, the sportswear company Houdini was founded in 1993 by skier and mountaineer Lotta Giornofelice, and is today one of the leading actors on circular business models for outdoors clothing, with the motto “maximum experiences, zero impact”. Those are ambitious words, but this Swedish company is also walking the talk. Apart from applying a circular life cycle to more than 65% of their garments and being one of the first companies to offer sportswear for rent, Houdini Sportswear is happy to cooperate with other actors to improve the sustainability performance of the entire outdoors industry. Partners include, for example, the real-estate company Vasakronan, the research network MISTRA, and the traceable wool program of ZQ Merino.



Houdini now has garments made from 100% recycled polyester.

Source: Houdini Sportswear

Starting from fleece

Initially focusing on garments produced from stretch fleece, Houdini Sportswear is built around crafting garments that can be made from recycled material and later be recycled in return. Applying progressive sustainability policies, the company has grown into a small but strong frontrunner, pulling the entire sportswear sector toward increased sustainability. The ambitious policies are the work of passionate business leaders and employees who missed finding equivalent motives among other actors in the sector. The company is now clearing the way, not only into more circular business models, but also into the sharing economy by offering garments for rent, repair, and as second-hand items. This is possible since the products are not only designed from scratch with circularity in mind; they are also made to be multifunctional, long lasting, and timelessly designed, which makes them usable over a long period by a broad spectrum of customers.

Pushing policy for more responsibility

As a company with an annual turnover of about SEK 100 million (€10.8m), political policy can both hinder and support its development. For example, Houdini Sportswear has chosen to keep 99.5% of its production chain within Europe to be able to assure acceptable labour conditions. Nationally, Houdini Sportswear is also pushing the system by asking Swedish politicians not only to tighten producer responsibility but also to make producers responsible for recycling. Policy could also help facilitate a shift in attitude among consumers as well as producers, since it is still cheaper to buy new items than repair the ones you already own. CEO Eva Karlsson thinks producers should take more responsibility in increasing transparency, so consumers can get better access to all necessary facts and thereby make better-informed decisions on their choices of consumption. Of course, the fact remains that the most environmentally friendly garment will keep being the one you never buy.

Regional dimension

By encouraging collaboration with other actors and sharing their knowledge and vision, Houdini Sportswear could be a great support for regional development in the Nordic countries considering its current Planetary Boundaries Assessment initiative – as well as the countries’ common cultures of focus on research and innovation, and the high value placed on nature and outdoors activities. Additionally, Houdini is at the forefront, work-

Outdoors with the Planetary Boundaries initiative

Since 2006, Houdini has had a closed-loop garment recycling program together with the world’s leading textile producer Teijin in Japan, and now also runs the newly started Re-project, focusing on reuse, rental, repair, and recycling of garments. In 2013, Houdini’s garments consisted of 72% recycled material, and 81% of the garments were recyclable. The same year, it also pioneered offering outdoor wear for rent. Just before the UN Climate Conference COP21 in Paris in December 2015, Houdini launched a new initiative together with the nonprofit research communication organisation Albaeco: the first-ever corporate Planetary Boundaries Assessment. Together, Houdini and Albaeco will create an open-source method for assessing business from a Planetary Boundaries perspective. The purpose is to provide businesses with a deeper understanding of their current impacts so that significant improvements can be made as soon as possible, for example, by using interdisciplinary collaborations for knowledge sharing and innovation.

Photographer: Anna Öhlund



ing to phase out all harmful fluorocarbons from its production by 2017. These are chemical substances that are long lived and have been found in snow and animals in some of the most remote wilderness areas in the Nordic countries as well as the world.

Learn more...

- Houdini Sportswear: <http://www.houdinisportswear.com/en>



STARTING FROM SCRAP IN ØRA REGION

Norsk Gjenvinning, meaning “Norwegian recycling”, is a privately owned company established in Oslo in 1926. It is one of Norway’s 150 largest companies with about 1,400 employees, 40,000 customers, and a total operating revenue of NOK 4.2 billion (€440m). Norsk Gjenvinning handles about 25% of Norway’s industrial waste, and waste from Sweden, Denmark, and the UK. From the way waste is treated, Norsk Gjenvinning can recycle 85% and resell it as secondary raw materials and fuel to industry in Scandinavia, Europe, and Asia.

Sweeping waste off its feet

Founded in Oslo 90 years ago by Adolf Jahr, Norsk Gjenvinning has developed from being a local junkyard to an international industrial waste management company worth NOK 6 billion (€630m). Step by step, the system has expanded by including glass bottles in 1930, paper in 1964, and its first sorting facility for industrial waste in 1983. Today, Norsk Gjenvinning is Norway’s largest provider of recycling and environmental services, running 90 facilities throughout Norway. Their services include, for example, recycling of metal, plastics, paper, and glass; treatment of hazardous waste; industrial services and downstream solutions; household rubbish collection; demolition; and environmental restoration. Every year, they treat 1.8 million tonnes of waste and run over 3 million collection trips, fuelled by the circular vision that “waste will be the solution of the resource problems of the future”.

Eliminating wasteful behaviour

Waste can also come in the shape of disloyalty, corruption, illicit handling, and theft – something Norsk Gjenvinning has spent substantial sums on getting rid of, not only within its own company but in the entire business sector. According to CEO Erik Osmundsen there are two main reasons for their common occurrence: it is too easy to make large amounts of money on irresponsible waste management; and it is an industry where employees are easily led into temptation due to lack of monitoring and follow-ups. Norsk Gjenvinning handled the problem by cleaning up its own house – with 40 concrete actions, new vision and values, amnesty, replacement of almost half of its management, and by building a new culture

New recycling park in Øra

With a wish to build a new cutting-edge recycling facility, Norsk Gjenvinning decided to invest in the Øra region because of its location with a harbour in the Oslo fjord; the regional multitude of industrial actors and potential partners; and the good cooperation with the local municipalities of Fredrikstad and Sarpsborg. Putting great emphasis on transparency and collaboration with the neighbours of the facility, Norsk Gjenvinning has also prioritised low levels of noise, smoke and odours from the recycling facility. At the centre of the plant is an industrial shredder that receives mainly discarded vehicles. The shredded waste is separated into several fractions, such as aluminium, copper, brass, glass, rubber, steel, etc. Depending on the materials’ qualities they are either sold as secondary raw material or turned into new products (e.g. glass fibre) before being sold. Some waste is also used to produce fuel. Norsk Gjenvinning has high hopes for the future development in the Øra region, for example by increasing vertical collaboration with regional industries along the value chain, as prices of primary raw materials will escalate parallel to the demand for recycled materials.



Source: www.pressenytt.no

among staff based on team spirit and pride in one’s work. As a result of these actions, internal costs halved in one year, and both customers and partners have paid tribute to the improved work culture. This indicates that sound values, a sense of community, and belief in what you do are important foundations for good business.

Regional dimension

Located in an industrially dense area of the country, Norsk Gjenvinning’s Øra facility has a large catchment area from which to collect waste and in which to sell recycled material. Nationally, Norsk Gjenvinning plays an environmentally important role as a responsible waste manager, providing upcycled waste as secondary raw material – it is a more sustainable alternative that can take pressure off primary resources from mining, forestry, etc. The company has also improved social and economic sustainability by providing jobs in a circular business model. It is open to new technology and new partnerships, and if supported by improved regional and

In 2014, Norsk Gjenvinning recycled 327,000 tonnes of paper – the equivalent of 4.5 million trees or 2,100 forested football fields.

national policies, it can provide an extensive infrastructure for the societal transition to circularity.

Learn more...

- Norsk Gjenvinning (in Norwegian): <http://www.nggroup.no>



HÄNDELÖ INDUSTRIAL SYMBIOSIS NETWORK

Norrköping is a coastal municipality in southeast Sweden that is home to the Händelö Industrial Symbiosis Network. The network involves cooperation between a range of public and private sector actors who have been working to reduce Norrköping's carbon footprint since the early 1990s. Symbiotic activities are largely focused on the use of commercial and household waste and other industrial side streams for energy production.

Strong partnerships developed over time

Norrköping's industrial symbiosis story begins with E.ON's combined heat and power plant, established in 1982. The plant has environmental benefits in itself, as by meeting domestic and industrial demand for heat and steam, it eliminates the need for individual boilers. Several upgrades have increased the environmental benefits even further, enabling the plant to operate on biomass (early 1990s) and domestic and industrial waste (2002, 2010). This not only reduces the carbon footprint of energy production but also provides an important means of utilising waste that may otherwise become landfill. Other partners in symbiotic activities include Argoethanol, which produces grain-based bio-ethanol with high environmental performance; Svensk Biogas, which produces fuels used for transportation; Econova, which produces a range of goods from recycled materials; and Norrköping municipality.

Economic, environmental, and political motivators

Several enabling factors are present in the Händelö case. First, the municipality has played a strong driving role in symbiotic activities. It established the district heating system, developed the combined heating and power plant, and strongly supports the use of biofuels across the municipality. Second, environmental regulations from both the EU and the Swedish Government have necessitated creative solutions to both waste management and energy production. Third, private sector actors have been motivated by the many economic benefits of cooperation. These include tangible benefits such as cheaper means of waste disposal and tax incentives for reduced CO₂ emissions, but also intangible benefits such as a "greener" company profile. Economic benefits may not always be clearly evident from the outset, but

can instead emerge through cooperation between partners. For example, E.ON offset the higher operational cost of a CHP plant running on waste-derived energy through a "gate fee" that is still considerably lower than other waste disposal options.

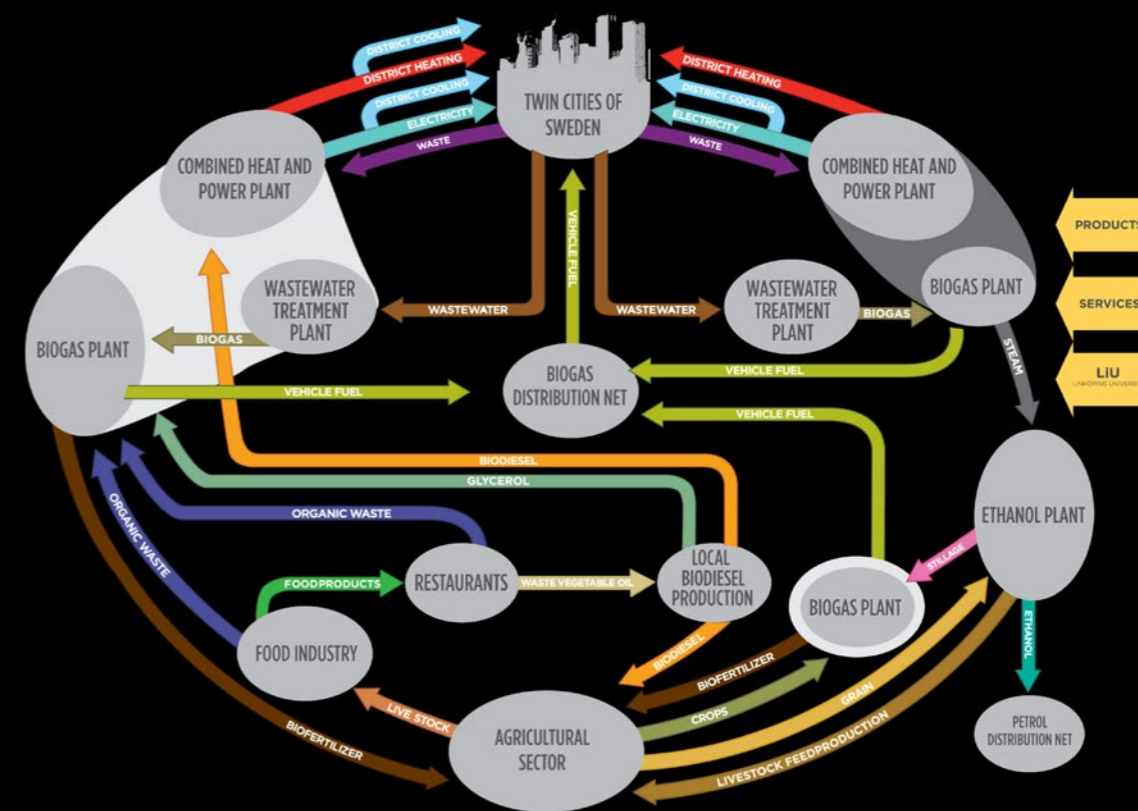
Regional dimension

Industrial symbiosis activities have had a substantial effect on the region as a whole. Most notable is the decision of Agroethanol, a company owned by the Swedish

Urban industrial symbiosis

A port city known originally for its textiles industries, Norrköping continues to host important logistics services and industries working with agriculture and forestry products. Historical and current links between industry and the city make Norrköping an ideal place to consider the idea of urban industrial symbiosis. Urban industrial symbiosis is a concept that links industrial ecology with sustainable urban development. It considers, for example, establishment of zero waste companies in new living areas and possibilities to exchange resources between residential and industrial areas. It also explores the opportunities that industrial symbiosis can provide for innovation and in the form of spin-off projects that contribute to societal well-being in urban regions. Urban industrial symbiosis is a relatively unexplored concept, but has received some attention from researchers at Linköping University through the "Sustainable Norrköping" project.

Description of an urban industrial symbiosis network



Source: Linköping University

Agriculture Cooperative which produces grain-based bio-ethanol, to locate in Norrköping. Access to low CO₂ steam from E.ON is thought to have been a key factor in this decision, and the partnership has in turn been instrumental in creating further synergies. Symbiotic exchanges also support and promote existing eco-friendly business activity. One such example is Econova, a company that specialises in producing useable products from industrial and domestic waste.

Learn more...

- Industrial Symbiosis in Sweden: <http://www.industriellekologi.se/symbiosis/norrkoping.html>
- Nordregio report: The potential of industrial symbiosis as a key driver of green growth in Nordic regions.

“The concept of urban industrial symbiosis considers the establishment of zero waste companies in new living areas and possibilities to exchange resources between residential and industrial areas.”



EYDE CLUSTER

The Eyde Cluster (EYDE) consists of 27 members: 11 are major process industry companies, nine are key suppliers of technology and services, six are research or education institutes including one university, and one is an innovation incubator. EYDE is located in the Agder region in the south of Norway, and comprises 30 municipalities with a total of almost 300,000 inhabitants in the two counties, Vest- and Aust-Agder. Vest-Agder is Norway's largest per capita export county, and the region has been home to process industries for over a century. Today, EYDE aims to maintain and develop its position as a "World Leading Cluster for Sustainable Process Industry" in an area with strong political ambition of becoming a leading international region for the production and distribution of renewable energy by 2020.

Finding connections between value chains

Norway is a relatively expensive country for industrial processing and manufacturing, and has also tightened its environmental regulations over the last decades. Hence, pressure built by international investors motivated the forming of EYDE in 2007 by CEOs in the regional processing industry. The large multinational member companies share intense consumption of energy and raw materials, and can together cut expenditures through cooperation with the other members, despite belonging to different value chains. EYDE was initially formed as a network based on the "Vision 2050" report by the World Business Council for Sustainable Development (WBCSD), which focuses on methods for resource efficiency. Having evolved from the aim to establish projects between the member companies, the cluster is now an important arena for technology development projects, both investing in and promoting research and development for increased energy efficiency and improved production processes and products. All member organisations, ranging from SMEs and research institutes to multinational companies, are also part of the Eyde Environment Program and sharing the same innovation and sustainability strategy.

The support of regional development policy

In the EYDE case, it is evident that regional policy and funding opportunities have offered important support to the network's determination to improve energy effi-

The Eyde Cluster member companies have a combined annual turnover of approximately €1.15bn and together employ over 3,000 people.

ciency and decrease the use of fossil fuels and raw material in order to lower emissions and costs. Both Vest- and Aust-Agder counties have planning strategies that support renewable energy and energy efficiency in industry, and the Regional Development Plan for the Agder Region is a ten-year strategy focusing on supporting climate-friendly industry initiatives; collaborations between the industrial, academic, and public sectors; and giving high priority to business development addressing climate challenges. There are also regional funds for development and for research consistent with the regional policies. For example, the cluster has received substantial grants for the Eyde Biocarbon initiative and the Eyde 0 Waste program from the Norwegian Research Council, Innovation Norway, Regional Research

Funds, Enova, the EU association SPIRE, and the Competence Development Fund of Southern Norway. The willingness of the member companies to cover the remaining costs shows a promising determination, and also builds a sense of ownership important to the success of the plans.

Regional dimension

By developing to adapt to current challenges and meet future conditions, the member companies of EYDE increase their chances of surviving long term in a climate-friendly society. Thereby, they support the welfare of the region in general and safeguard regional livelihoods in particular, especially by developing the plans to source biomass and produce biocarbon products locally. On a research level, they help push the development of cleantech and sustainable business models, which can be shared to benefit the global transition to carbon neutrality. With the initial openness to companies from various value chains, more actors from different sectors could be invited to join.

Learn more...

- Eyde Cluster: <http://www.eydecluster.com/english/>
- Nordregio report: The potential of industrial symbiosis as a key driver of green growth in Nordic regions.

Eyde Biocarbon

Eyde Biocarbon aims to find sustainable economic solutions to replace coal and petroleum coke with biocarbon produced from regionally sourced wood. The large member companies Alcoa Carbothermic, Elkem, Eramet, and Saint-Gobain run the initiative, as they wish to replace the large amounts of fossil fuel they use with renewable alternatives. The initiative is at an early stage of laboratory testing, assessing the qualities of different processes to turn regional forest biomass stock into biochar, bio-oil and biogas. Biochar can substitute for the coal and coke used by Elkem and Saint-Gobain as a carbon source in melting processes; bio-oil can be upgraded to fuel oil or used as a feedstock for biodiesel production; and biogas can substitute for the natural gas used by Alcoa to melt recycled aluminium. The current laboratory testing is planned to be succeeded by the establishment of a pilot plant in 2018, followed by full-scale industrial production in 2020 – as long as the results show that the predicted net carbon emissions reductions from replacing fossil fuels with biocarbon can be achieved in practice and made profitable.



Source: Eyde Cluster



KIRKKOKALLIO INDUSTRIAL PARK

Honkajoki, located in the Satakunta region, is a small municipality of app. 1900 inhabitants but with ambitious goals in sustainability and green energy production. In the area lies the eco-industrial park of Kirkkokallio, demonstrating unique industrial symbioses of bioenergy and food production corporations in an almost self-sufficient closed system. Organic waste produced by its greenhouse and convenience food businesses is processed inside the park. It is turned into new products and biogas which is burnt for heat and energy, while additional electricity is generated by nearby wind power plants.

Food production with wind power

The Kirkkokallio area has been growing since the 1980s. The first company was Honkajoki Ltd, which presently processes and/or recycles most of Finland's abattoir by-products. Several large greenhouse entrepreneurs, such as Honkatarhat Ltd and KKK Vihannes Ltd, as well as the convenience food producer Lihajaloste Korpela have since started operating in Kirkkokallio. Honkatarhat produces about one third of Finland's potted herbs and vegetables while KKK-Vihannes produces one third of Finland's organic tomatoes.

The municipality of Honkajoki commissioned an investigation on the area's potential for wind power in 2009. The resulting report stated that it would be possible to place a total of 22 plants in the area. The nine wind power plants of Kirkkokallio have been operational

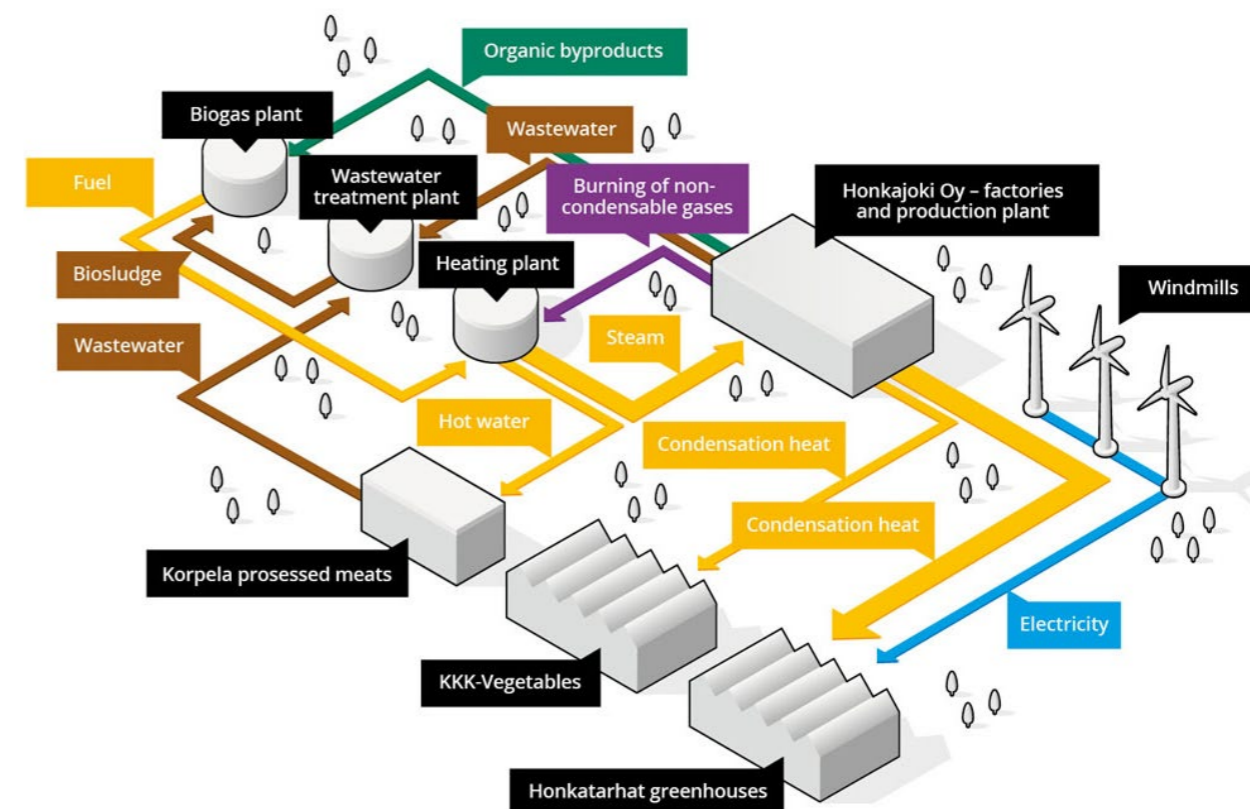
“The world needs examples like this. The Kirkkokallio region is a pioneer in its field and a wonderful example of circular economy, an operational model of the future.”

–Jyri Arponen, SITRA

The beginning of an extensive collaboration

The Honkajoki wind power plants marked the beginning of a large contract involving large-scale international collaboration. The wind park was the first project of the investment company Taaleri's (formerly Taaleritehdas) larger frame contract with the German supplier Nordex Energy GmbH. This contract is worth over €300m (the share of Honkajoki being about €40m) and consists of constructing up to 111 turbines in Finland. The plants of Honkajoki were ready ahead of time, and representatives of Nordex and Taaleri have expressed mutual satisfaction over their collaboration. The EU obligates Finland to increase the use of renewable energy sources, and the goal set by the government is to generate 6% of total required electricity (or 6TWh) with wind by 2020. The industry is growing rapidly: total wind power capacity increased by 40% during 2014 and almost doubled during 2015 (from 627 to 1005 MW). On the other hand, the lack of official, binding goals by the government for 2030 might cause uncertainty for future investors and slow down progress.

since the summer of 2013, and provide energy to nearby residents in addition to the park. The plants are 120m tall 2.4MW Nordex N117 turbines, totalling to 21.6MW in capacity.



Honkajoki Ltd

Circulation and recycling

Honkajoki Ltd collects animal-based raw materials from the meat industry to be processed in their factory. These materials are recycled into fodder, protein feed, rendered fat (for e.g. biodiesel production) and fertilisers. The company provides self-sufficiently the energy needed for its operations, and the energy balance of the recycling process is in fact positive. Surplus heat is stored in water which is then circulated to heat the greenhouses of Honkatarhat Ltd and KKK-Vihannes Ltd, totalling up to 7.1 hectares.

The €8.5m biogas plant owned by the cleantech company Gasum Biotehdas Ltd generates biogas from organic waste reclaimed from Honkajoki Ltd and other local businesses. The plant can process an annual biowaste amount of 60 000 tonnes. About 32000MWh of this biogas is delivered each year to the electricity company Vatajankosken sähkö Ltd, to be utilised in the

area's 3MW engine power plant to provide heat and energy for the park's operation.

Regional dimension

The green solutions of the park save money and resources for the companies and have received both national and international interest from businesses and institutions. The park brings together many large-scale businesses to Satakunta, and presents a platform for expansion and future growth. By now, revenue of the companies has reached €100m and the park employs more than 200 people.

Learn more...

- Project website: <http://www.honkajoki.fi>

BIOECONOMY

In a bioeconomy economic activity is based on sustainable use of renewable resources, and therefore it is widely considered as a component of circular economy. The bioeconomy has attracted substantial interest from policy-makers in recent years – not surprising when considering the numbers. In 2014, the broadly defined European bioeconomy field employed 22 million people and had an estimated annual turnover of approximately €2 trillion (Teräs et. al. 2014). In the Nordic context, the bioeconomy is of interest for both its environmental benefits and its ability to contribute to regional development. It contributes to local value creation, for example by generating energy and food locally, which in turn keeps revenue and jobs in the region. Bioeconomy is also about finding innovative ways to use natural resources, invigorate or revive traditional industries facing decline and increase the value of local production.

The cases that have been selected for this section are characterised by high levels of cooperation (e.g. Case 14. Growing the bioeconomy in Europe's forest region; Case 19. Public-private commitment for bioeconomy in Örnskölvik; Case 23: Multi-stakeholder approach advances the bioeconomy in Lolland municipality). They also highlight the role of the bioeconomy in increasing the resilience of regions by strengthening their ability to be self-sufficient and competitive (e.g. Case 15. The Paper Province, Varmland; Case 17. Biotechnology, the “new oil” in Hedmark; Case 20: Regionally driven bioeconomy development in Central Finland). Lastly, the focus is set on bioeconomic development in sparsely populated regions (Case 16: The bioeconomy in sparsely populated South Iceland).



GROWING THE BIOECONOMY IN EUROPE'S FOREST REGION

North Karelia is a predominantly rural region in the province of Eastern Finland. With the exception of Joensuu, the only urban centre, the region's 165,941 inhabitants are sparsely distributed (7.7 inhabitants per square kilometre). North Karelia is a forerunner in renewable energy, largely thanks to innovations emerging from its robust forestry industry. Renewable energy accounts for 63% of total energy use in North Karelia (28.5% in Finland as a whole), with 82% of this supply produced by wood-based sources. Besides bioenergy, the regional actors are increasingly focusing on the full scale of forest-based bioeconomy as a driver for regional well-being and resilience.

Powering ahead

North Karelia is often referred to as Europe's forest region. Almost 90% of its total area is covered by forest and the forestry industry makes a substantial contribution to the regional economy. The bioeconomy accounts for a large portion of this contribution. An important component in advancing the regional forest-based bioeconomy has been the long term strategic work undertaken by the Regional Council of North Karelia in close collaboration with the local actors, forest owners and companies and citizens. To give an example, four Bioenergy Programmes have been implemented in North Karelia since the 1990s. Today, forest bioeconomy is one of the three spearheads of the Regional Smart Specialisation Strategy, and besides bioenergy the regional actors are increasingly focusing on wood mobilisation and developing new products and services from the forest and for the forest industries. These ambitions are stimulated by North Karelia's strategy aiming at a completely fossil-free region by 2030.

Vision of North Karelia 2025

Following the inclusive approach for growth, a regional forest bioeconomy cluster now serves an important economic driver in North Karelia. According to the estimates by the Regional Council, this cluster involves about 500 companies, has generated 6 000 jobs and has an approximate turnover of €1,7billion. Moreover, this network engages around 600 specialists working with bioeconomy-related R&D, education and public administration.

By 2025, North Karelia is envisaged to be a world-leading forestry region and Joensuu as the European for-

63% of total energy use in North Karelia comes from renewable energy, with 82% of this supply produced by wood-based sources.

estry capital are acting as the forerunners of a bioeconomic society. The expertise cluster in Joensuu and the entire region attracts businesses, investments and industry experts from around the world. In close international cooperation with other bioeconomy-focused regions and actors, the region offers solutions that help to achieve national growth targets (Regional Council of North Karelia 2015).

Local drivers fuel industry growth

Several factors have contributed to North Karelia's green growth and progress in the bioeconomy sector. A profound factor has been the long-term strategic work undertaken by the Regional Council with a focus on the development of local value chains, R&D and innovation activities and attracting investments. In addition, the



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local universities and research institutions are strongly linked with business in North Karelia through a substantial regional innovation network. This ensures that research objectives evolve in response to specific needs within the region, which contributes directly to the competitiveness of the forestry industry. At the same time, untapped regional potential exists in developing also other sectors of bioeconomy, such as agriculture and food.

It is also worth noting that the development of North Karelia's forest-based bioeconomy and renewable energy production have some decidedly local components. First, the natural conditions present a unique combination of cheap wood, cold temperatures and high-cost energy alternatives. Second, a large portion of the companies that make up North Karelia's forestry industry are locally owned by co-operative private firms, individuals and municipalities. Together, these factors provide a strong financial incentive to develop the local bioeconomy and renewable energy as a means to increase the local value creation and reduce the cost of energy while at the same time ensuring that the profits generated from energy sales remain in the local economy.

Regional dimension

North Karelia's bioeconomy sector makes a substantial contribution to regional development. It provides development opportunities for local businesses, creates jobs, contributes to regional energy security and reduces energy costs. In addition, it improves the competitiveness of the forestry industry, the majority of which is locally owned. Most importantly, these benefits are achieved in a cooperative, consensus-oriented manner between the regional actors and with a minimal impact to the landscape and environment, which is a vital asset in the region's tourism industry. This in turn ensures that the development of bioeconomic North Karelia is built on sustainable basis.

Learn more...

- Regional Council of North Karelia: <http://pohjois-karjala.fi/web/english>



VÄRMLAND AND THE PAPER PROVINCE

The Värmland Region is located in the west of central Sweden. It borders the Swedish counties of Dalarna, Örebro, and Västra Götland and Norway to the west. Värmland has a population of around 272,000 inhabitants, with some 87,000 concentrated in Karlstad, the region's capital city. The industrial development of Värmland has been traditionally dependent on the region's natural resources, particularly its vast forests.

Bioeconomy in the region

Some 200 companies dedicated to the pulp and paper industry are the result of a long history of forest exploitation in Värmland. These include forest companies and sawmills, which provide jobs to some 12,000 employees. Many of these are small and medium-sized companies, but the region also hosts global giants that play an important role in the development of technologies used worldwide. The decline of the paper and pulp industries, followed by severe structural challenges in Värmland during the 1990s, motivated Karlstad Municipality and other regional actors, both public and private, to join forces and establish "The Paper Province" cluster organisation. The Paper Province was later reorganised into an economic association, which today has more than 100 member companies.

Policy support for the bioeconomy

The Paper Province initiative has been established and financed in a triple-helix arrangement. Besides private companies, various other partners from the public sector, research, and civil society have supported the initiative. These include universities (mainly Karlstad University) and public actors, i.e. municipalities: Region Värmland, VINNOVA, and the Swedish Agency for Economic and Regional Growth (Tillväxtverket). VINNOVA, the Swedish Governmental Agency for Innovation Systems finances 50% of Paper Province activities while the remaining 50% is co-financed by all the other public and private partners. Although the Paper Province member companies compete with each other, their cooperation is an added value, which allows for the development of the bioeconomy in the region (by concentrating knowledge and expertise and allowing regional growth) to benefit all.

The Paper Province was awarded a prize for being one of the "Top European Clusters in High Innovation Regions" in 2007 and for being a "European world-class cluster" in 2010.

Regional dimension

From a regional development perspective, the success of the development of the bioeconomy in Värmland, despite the global decline of paper and pulp industries, can be explained by:

- 1) The effective mobilization of critical mass from several sectors and improved expertise (of the Paper Province cluster organisation and the Värmland region);
- 2) More systematic assistance from Karlstad University and increased cooperation between researchers and industry;
- 3) The close collaboration among actors, even competitors; and



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Clustering around forest

The Paper Province is a unique business cluster of forest-industry companies as it connects all parts of the forest value chain with university, public organisations and civil society in a search for new bio-based solutions, thereby creating a platform for gathering stakeholders. Among its members are various world leaders in packaging material and packaging solutions, specialty paper, cardboard, paper and pulp and tissue machines, coating machines, and barriers (e.g. Stora Enso, Valmet Paper, SOMAS, and BTG). There are also a large number

of SMEs, which provide the sector's largest share of employment and turnover, and provide key competencies. Värmland has effectively moved from orthodox pulp and paper operations into adopting a bioeconomy approach, with the aim of becoming a global leader of the forest-based bioeconomy and an example of best practice. Despite the worldwide decline of paper production, Paper Province companies have had a growth rate three times higher and 6.8% higher profitability than the Swedish average over the last six years.

- 4) The presence of effective institutions and an institutional setting that facilitated and cofunded the process through innovation systems and funding programs. These positive conditions for regional development are expected to be reinforced, as the Paper Province will use VINNVÄXT funds to support research, and the development and commercialisa-

tion of new forest-based products and services over the coming years.

Learn more...

- The Paper Province: <http://paperprovince.com/en>



THE BIOECONOMY IN SPARSELY POPULATED SOUTH ICELAND

South Iceland is a geographically large region (30,966 km²) with a relatively small population (26,000 inhabitants in 2012) and considerable diversity in the characteristics of its populated areas. Agriculture, fisheries and tourism are its main industries. The development of South Iceland's bioeconomy is mostly focused on increasing efficiency and generating higher-value uses from existing resources.

Process and product innovations at the core

South Iceland's bioeconomy is largely driven by Matís Ltd, a government-owned, independent research company that specialises in '[v]alue creation within the bioeconomy and the development of policy and infrastructure in areas in need of understanding and training in the food production'. For the most part, the focus is on small-scale innovations in both products and process. Examples of existing projects include developing new types of lobster packaging to enable more efficient transport, experimenting with fish waste as a fertiliser, and developing different types of small-scale food products to be sold to tourists and visitors.

The bioeconomy as a national policy priority

The development of the bioeconomy has been a national policy priority in Iceland since the early 2000s. Bioeconomy activities are prioritised for R&D funding and, since 2002, there has been a particular funding instrument dedicated to increasing the value of marine products. As noted, Matís Ltd, which was founded in 2007 through the merger of three public research companies, is a key player in supporting the development of the bioeconomy and in promoting cooperation between actors. Although its head office is located in Reykjavík, the company also has a regional presence, allowing it to work closely with industry professionals on the ground to develop new ideas and innovations. Other key enabling factors include the easy access to natural resources, the availability of funding, and the existence of obvious synergies between sectors. Remaining challenges include geographic barriers to attracting appropriately skilled personnel and a lack of funding in the intermediate stages of development.

85% of the workplaces that make up Iceland's bioeconomy are located outside of Reykjavik.

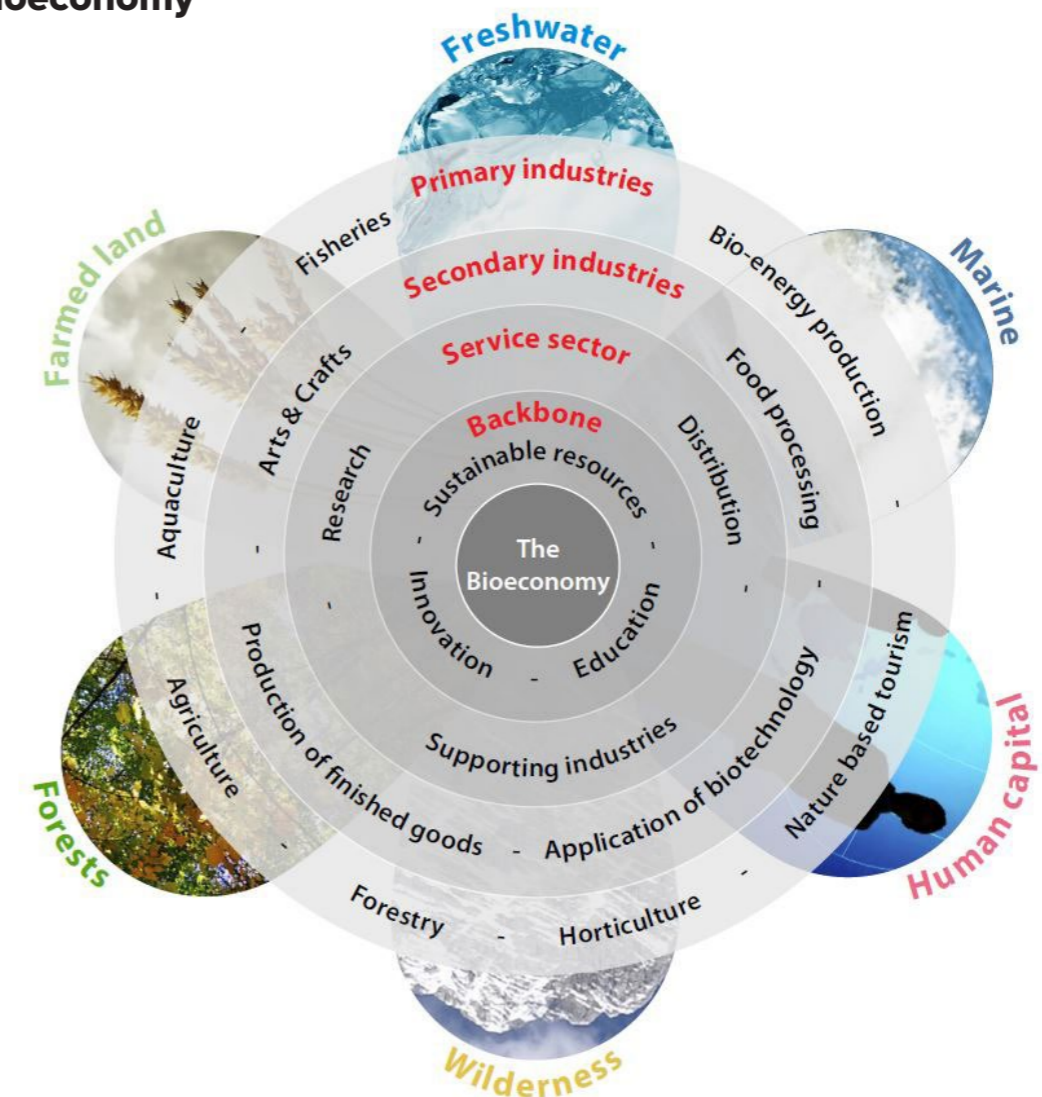
Regional dimension

The bioeconomy is seen as a strong tool for developing Iceland's regions as a whole and companies within the bioeconomy make up a significant portion of the total workforce in regional areas. Of particular interest in South Iceland is the potential for synergies between the bioeconomy and tourism sectors. Tourists are an ideal market for food products perceived to be uniquely Icelandic. Many of the existing innovations in food products are already sold to tourists and there are many opportunities to strengthen this link.

Learn more...

- Matís Ltd: <http://www.matis.is/english/about/>
- Nordregio report: Bioeconomy in the Nordic Region: Regional case studies

The Icelandic definition of the bioeconomy



Source: Matís Ltd

The value of human capital in sparsely populated areas

Human capital can be a double-edged sword in sparsely populated areas. The relatively small number of players makes it possible for one highly motivated or visionary individual to have a huge impact. However, the absence of such a person can be a real problem. The lobster cluster in South Iceland is an illustrative example of this. Joint R&D activities within the cluster were driven by a highly active employee at the Regional Association of Local Governments (SASS). Following this employee's resignation, the

cluster's activity declined dramatically. Attracting appropriately qualified and experienced people to account for outmigration can be a challenge. Communities in sparsely populated regions are small and, as is the case in South Iceland, education levels are often below the national average. Although outside experts can fill this gap to some extent by providing technical expertise and short-term assistance, these actors generally lack the time and local knowledge necessary to provide holistic, long-term support.



BIOTECHNOLOGY – THE NEW OIL IN HEDMARK?

Hedmark, with its long tradition in food cultivation and animal farming, is commonly regarded as one of the largest agricultural counties in Norway. Perhaps less well known is the extensive biotechnology industry emerging in Hamar, the principal city of Hedmark county. Hamar is located on the eastern shores of Lake Mjøsa, Norway's largest lake, and is home to 30,000 inhabitants. It also hosts many exciting businesses that use biotechnology to develop innovative products and services in line with the regional agricultural tradition.

Agricultural ambition fuels technological discovery

The biotechnology sector in Hedmark County emerged from a need to increase the quality and efficiency of agricultural production—particularly with respect to livestock. To address this challenge, companies and institutions in Hedmark formed the Heidner Cluster in 2012, bringing together approximately 30 regional actors working on technologies for breeding and producing farm animals, aquaculture, and plant cultivation. An important venue for cluster collaboration is the Hedmark Kunnskapspark (Hedmark Knowledge Park), which is located in Hamar. The Hedmark Kunnskapspark serves as an intermediate institution, promoting knowledge-intensive industry through innovation. The shared ambition of the cluster members is to create a world-class bioeconomy centre for innovations in sustainable food production.

Collaboration fuels innovation

The Heidner Cluster is part of the Norwegian Innovation Clusters programme, which is managed by Innovation Norway, The Research Council of Norway, and SIVA, the Norwegian public funding agency for innovation. In 2015, Heidner was awarded an additional two years of funding through the programme. In addition, the Cluster has received €100,000 in funding from Innovation Norway for the development of innovative projects with a green profile. Arena funds have enabled the realisation of many projects for further growth in the bio-industry, including the establishment of the Biosmia Innovation Centre. The Hedmark Innovation Cen-

The Hedmark Innovation Centre has been benchmarked by the European Cluster Excellence Initiative (ECEI).

tre is the cluster management organisation for Arena Heidner and is responsible for cluster facilitation. This arrangement contributes to formalised and coordinated regional collaboration and enhances regional innovation potential by stimulating cooperation between a range of public, private, and academic actors. A strong focus is also placed on applied research and the quick implementation of innovative solutions.

Regional dimension

In Hedmark, the development of the bioeconomy, particularly regarding biotechnology initiatives, is based on innovations grounded in the region's agricultural traditions. Combining the existing regional traditions, expertise, and access to raw materials with investments in R&D and network creation has resulted in the development of new technologies and exciting opportuni-



Creative commons

Biosmia promotes market-driven bioinnovation

A key component of the Heidner Cluster's work is the Biosmia Innovation Centre, which has been described as an "integrated part of the Cluster's innovation ecosystem, designed to bring forth ideas and accelerate the Cluster's innovation activity... namely forging new bio-based innovations and companies" (Heidner 2016). The aim of the Centre is to stimulate market-driven bioinnovations that contribute to the sustainability and international viability of Norway's agriculture-based bi-

oeconomy, which is expected in turn to contribute to the creation of new jobs and grow the bioeconomy both regionally and nationally. The Centre offers laboratories and demonstration venues, support for research and development activities, and advisory services for product commercialisation and internationalisation. With the aim of catalysing the growth of new businesses, the Centre also supports innovation through market surveys, project development, and investor forums.

ties for companies in the region. The modern breeding methods developed in Hedmark have contributed to the cost-effective and efficient production of livestock, aquaculture products, and food crops, making the regional agriculture and related businesses competitive in both national and international markets. The strategies of selecting the bioeconomy as a clear regional focus area, allocating efforts and resources to its development,

and stimulating cluster collaboration have all paid off through the creation of regional added value and competitiveness in Hedmark.

Learn more...

- Hedmark Kunnskapspark: <http://www.hkp.no/english/>
- Heidner Cluster: <http://heidner.no/>



REGION MIDTJYLLAND, A SPROUTING GIANT

Region Midtjylland (Central Denmark Region) is home to 1.2 million people (approximately 22% of the national population) in 19 municipalities in the central part of the Jutland peninsula. With the aim of supporting education, innovation and entrepreneurship, Region Midtjylland also houses giants such as Vestas and Siemens, as well as many SMEs. Some 68,000 private enterprises operate in the region, employing over 450,000 full-time employees and with a total annual turnover of DKK 670b (€90b). The region is currently developing as a bioeconomy with an industrial focus on, for example, renewable energy and foodstuffs – and especially biomass.

Germinating focus on biomass

Covering a considerable area of Denmark, Region Midtjylland includes the nation's second city, Aarhus, with its large university, two international airports, Denmark's largest industrial harbour, and digital and physical infrastructure of a high standard. Region Midtjylland is also Denmark's largest agricultural area. For over ten years, the region has been developing the entire biomass value chain, from the production of biomass to the industry for processing and refining. Inspiring examples from the area are the project BIOM that aims to increase the production of bioenergy without compromising the production of food; the Algae Center Denmark produces biogas from farmed algae (see Case 26); and the national innovation network for biomass, INBIOM, established by the region. Given these many focused efforts for more sustainable products and production, the EU's Bioeconomy Observatory has appointed the region a "Bioeconomy Frontrunner".

Focusing regional development on circularity

Covering such a large area with over a million people and tens of thousands of businesses, Region Midtjylland has a vast potential to steer a large portion of Danish industry and the economy towards sustainability. For example, two-thirds of Danish industrial exports in the energy and environment sectors emanate from the region. Much of the strategy making for regional development is carried out by the Growth Forum, which is a partnership between businesses, the region, municipalities, education and research institutions, unions and employer

The EU Bioeconomy Observatory has appointed Region Midtjylland as a 'Bioeconomy Frontrunner'.

organisations. In the Growth Forum's Business Development Strategy for 2010–2020, although there is room for more emphasis in their ambitious growth targets on sustainability in general, Region Midtjylland appears to be channelling its sustainability efforts by strongly promoting circular business models and the bioeconomy. Region Midtjylland has initiated, and in many cases already completed, a number of projects based on more sustainable business models. One successful example is "Rethink Business", a three-year regional project advising SMEs and municipalities on how to operate with a more circular framework.

Regional dimension

Apart from supporting the region's sustainable development of especially the energy, environment and food sectors, and thereby securing jobs and natural



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Biocluster.dk

The region's transition into a bioeconomy depends on, for example, innovation and new business opportunities. To offer inspiration, access to knowledge, and a forum for networking, and to communicate the region's international centre of excellence in bioeconomy, the cluster initiative Biocluster.dk was formed. The cluster includes Region Midtjylland, Aarhus University, the Danish Agriculture and Food Council, Viborg municipality, the Viborg Region Business Council, and the Agro Business Park. Biocluster.dk has five employees and started as a two-year pilot project in 2013–2015. Functioning as a type of geographically

concentrated business network, Biocluster.dk includes actors in the entire biomass value chain, but has a special focus on how its organisations can "optimise, develop and sell bio-based high value products within six markets", namely, pharmaceuticals, biochemicals and bio-based materials, food, energy, feed, and fertiliser. The cluster facilitates cooperation between its members and invites new actors; it runs pilot facilities for the extraction of plant protein and hosts the world's largest biogas test plant; and it aims to reduce the risks and costs for actors wanting to try more sustainable business models in the bioeconomy.

resources for future generations and taking responsibility for the region's additions to climate change and unsustainable resource use, Region Midtjylland is also investing in various social sectors. Although education and skills training are a high priority, the region also acknowledges the need to broaden its diversity by attracting and retaining professionals from outside the country. This is necessary and beneficial to the region's long-term development. It is not only in ecological systems that biodiversity strengthens resilience and long-term survival, but also in human society.

Learn more...

- Central Denmark Region: <http://www.rm.dk/om-os/english/regional-development/>
- Biocluster.dk: <http://biocluster.dk/en/>
- Rethink Business project: <http://en.rethinkbusiness.dk/p/about-rethink-business>



PUBLIC–PRIVATE COMMITMENT FOR BIOECONOMY IN ÖRNSKÖLD SVIK

Örnsköldsvik municipality is located in the Västernorrland region of Sweden, some 550 km north of Stockholm. The approximately 55,000 inhabitants in Örnsköldsvik are fairly evenly distributed in countryside communities, rather than being concentrated in the central town. Trade and heavy industry have dominated the regional economy; however, the municipality's vast forests have allowed for major industrial ventures based on bioeconomy.

Bioeconomy in the region

Bioeconomy in the Örnsköldsvik region has a long tradition, originating from pulp mill activities in the early 20th century (e.g. pulp mill in Domsjö established by Mo and Domsjö AB). Initially the production consisted mainly of paper and pulp, and to a lesser degree, energy. In the 1930s, production expanded to include chemicals chlorine and ethanol, with the establishment of an early version of a biorefinery. MoDo was one of the first companies to combine pulp production with ethanol and other chemicals. During the 1990s, the Örnsköldsvik region suffered a serious decline when several businesses closed, downsized, or relocated. Despite this, local actors engaged in building up a cluster and a technology park based on a novel biorefinery initiative. In 2003, Processum started to gather local and regional forces into a joint clustering initiative. In 2005, Processum received funding for the development of the “Biorefinery of the Future” under the first round of VINNVÄXT, a government program that seeks to promote regional growth through dynamic innovation systems.

Policy support for the bioeconomy

The Örnsköldsvik region has shown a strong private–public long-term commitment to sustainable regional growth. Municipalities, firms, and universities have teamed up to brand the region and are focusing on the social, technical, and economic aspects of the regional bioeconomy. For many years, Örnsköldsvik has promoted sustainable development with energy as a focal

point. It has done so by adopting the first ethanol buses and cars, and providing municipal heating in the suburbs. Furthermore, the municipality itself supports the bioeconomy cluster with an annual grant of SEK 500,000 and it has a member on the board of directors for the cluster. The municipality is also an actor in the cluster through some of its municipal firms (an energy firm and an ethanol producer). Moreover, bioeconomy initiatives and R&D in the region have been made possible with support from the VINNVÄXT program, which promotes sustainable growth in the regions. In turn, the success of the bioeconomy in Örnsköldsvik's regional development has inspired policy making in Sweden and influenced similar initiatives in other regions.

Regional dimension

The good accessibility to natural resources and the concentration of human and physical capital in the Örnsköldsvik region represent the basic elements needed for the development of the bioeconomy. However, the alignment of knowledge and resources has been made possible by the close cooperation that exists among the regional actors in Örnsköldsvik. The joint forces among the public and private sectors and academia led by Processum have allowed for a coherent approach to regional development, with their focus on biorefinery initiatives. Moreover, the 10-year funding from the VINNVÄXT programme has been strategically important in attracting new private actors to get involved and invest in the region. The investments made within the bioeconomy sector have directly and indirectly generated new jobs and increased trade with other regions. This in turn

Biorefinery of the Future project partners



Source: Processum

Biorefinery of the Future

The “Biorefinery of the Future” project, led by the Processum cluster company and co-financed by VINNVÄXT, is the flagship project of the Örnsköldsvik bioeconomy. The Örnsköldsvik Biorefinery of the Future cluster has 20 member companies. Most of the cluster companies are in some way connected to the forest industry, the chemical industry, or the energy industry (see figure: Biorefinery of the future project partners). Some of the most representative industries are: M-Real's (formerly MoDo), pulp mill in Husum, Domsjö Fabriker's cellulose mill in Örnsköldsvik, and Svensk Etanol kemi's ethanol production based on cellulose. The purpose of the

Biorefinery of the Future is to accelerate development in the field of biorefining woody biomass. By improving the existing pulp and paper mills, the intention is to maximize production and to create products of greater value. Thus, the cluster member companies, academic partners, and the local community come together to create, promote, and invent products (e.g. chemicals and new materials) and processes based on lignocellulosic feedstock in a triple-helix setup. To do this, 80% of the project funding is devoted to R&D and 20% to building the innovation system. In this way, substantial resources are being devoted to scaling up promising projects.

may potentially trigger a greater regional impact as it spills over into other sectors and economic activities.

Learn more...

- <http://www.processum.se/en/>
- Nordregio Working Paper: Bioeconomy in the Nordic region: Regional case studies

“Everything made from oil can be better made from wood”

– Processum



REGIONALLY DRIVEN BIOECONOMY DEVELOPMENT IN CENTRAL FINLAND

The Central Finland Region consists of its capital, Jyväskylä, and 22 municipalities and cities. The area, which has 80% forest cover, hosts traditional forestry and machine production industries as well as new technology and bioenergy companies. Bioeconomy is a lead word in the development of the region, and even though measuring the exact economic impacts of the bioeconomy has proven challenging, it is undisputedly one of the most important economic sectors of the region.

Knock on wood

Although facing challenges such as increasing unemployment and an ageing and decreasing population, the forest region of Central Finland is experiencing a deepening devotion to bioeconomy. This type of economy is based on biomass and is one of the strongest sectors of Central Finland's economy. Biomass is harvested directly from forests, peatlands and fields, industrial by-products and residues, biodegradable fractions of waste, and to some extent also inland water. The use of biomass resources covers the production of pulp, paper, cellulose, cardboard, and wood products, as well as food and energy production. About 1,000 companies, ranging from massive industries to small-scale businesses, are operating within the sector. The bioeconomy provides roughly 15,000 jobs across the region and Central Finland has good preconditions for developing top-level regional bioeconomy expertise.

Supported by policy and projects

Despite the vast availability of renewable resources, green economic growth depends on humans' choice of action. In this case, extensive cooperation between leading academic institutions, the public sector, and private actors is an important factor, generating a high level of know-how and innovative thinking. Bioeconomy has been defined as one of three flagships of the Central Finland's Strategy for 2040, and rural and urban planning, taxation, and the granting of licenses and permits have taken bioeconomy aspects into consideration. The development has been stimulated by financial instruments and set high on the political agenda as a means to

Central Finland's 2040 Strategy highlights the importance of the bioeconomy as a regional economic driver.

achieve environmental sustainability, economic growth and wellbeing. This guarantees bioeconomy a strong political impetus and consistent goal setting for the upcoming decades. Additionally, Central Finland was recently included in the EU-led BERST project, which aims to identify the bioeconomic potential of EU regions and to solve related issues.

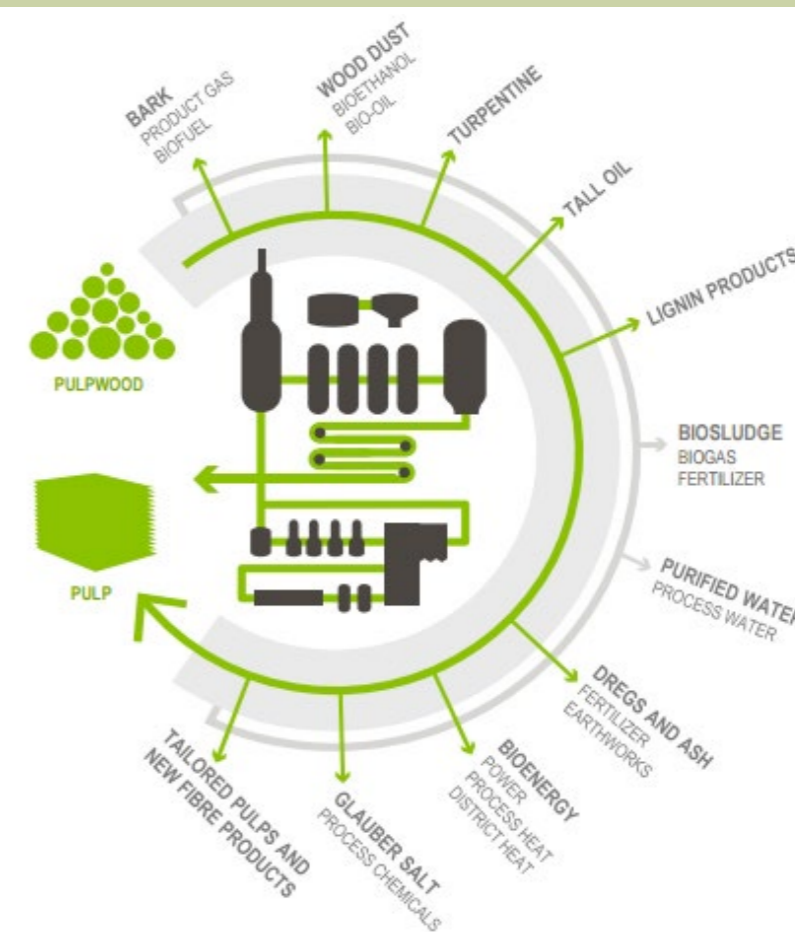
Regional dimension

The spreading bioeconomic focus of Central Finland depicts a growing economic resilience, and is to a large extent based on cooperation and knowledge exchange locally, regionally, nationally, and internationally. Universities in the region play a key role as drivers of initiatives and projects, while regional strategies provide a common trajectory, opening up for industrial symbioses. Bioeconomy has been successfully integrated into the regional educational strategies, and local universities are

The new Äänekoski bioproduct mill

Several leading bioeconomy companies – both national and international – operate and undertake research and development in Central Finland. One of these is the Metsä Group, which is about to replace its current pulp mill with a next-generation bioproduct mill in Äänekoski (see figure below). The new mill will generate 1,800 GWh/year of electricity and 680 GWh/year of heat and steam from wood, and is the biggest investment in the history of the forest industry in Finland; it is estimated to cost €1.1 billion. The mill should create over 2,500 jobs in the entire value

chain, but would also more than triple the current wood demand of the production site and increase traffic flow. Spillovers and new opportunities are expected for small-scale businesses in the region, with the hope that they will create an encouraging atmosphere among Central Finland's bioeconomy actors following the recession. The bioproduct mill will also assist in fulfilling the regional climate strategy plan, which contains targets for renewable decentralized energy production, and increase the share of renewable energy at the national level by approximately 2%.



Source: Metsä Group, 2014

educating experts for the future. Projects have emerged as a response to a regional bioeconomic vision, providing green jobs in an area otherwise threatened by a decline in human resources.

Learn more...

- The next generation bioproduct mill: <http://bioproductmill.com/>



SKAGAFJÖRÐUR'S TRANSITION TO A KNOWLEDGE-BASED BIOECONOMY

Skagafjörður, in northern Iceland, has 4,500 inhabitants (1.5% of the national population) and is considered the “food fjord” of Iceland. The largest population centre in the area is the town of Saudarkrokur, with approximately 2,600 inhabitants. The wide and fertile valley of Skagafjörður is the backbone of prosperous agriculture and food production in the area. It is home to one of the country's largest and most advanced seafood companies, the second largest dairy production facility, the largest slaughterhouse, and several shrimp and meat processing plants.

Sveinn Margeirsson, Hörður G. Kristinsson, Björn Aðalbjörnsson, Sæmundur Elíasson & Arnljótur Bjarki Bergsson, Matis Ltd., Iceland

Industry changes in fuel bioeconomy development

In 2007, the Icelandic Government cut the total allowable cod catch by roughly 30%. This drastic reduction was predicted to exacerbate the already concerning issue of depopulation of rural areas and to have irreversible consequences for local communities. In response, the Icelandic Government introduced countermeasures designed to ease the pain of communities that relied heavily on cod-related industries. In Skagafjörður, these resources were used to develop infrastructure that would support the growth of a knowledge-based bioeconomy. Skagafjörður was in a strong position to embrace the bioeconomy, with a wealth of raw materials and a diverse range of companies in close proximity to one another, providing hundreds of interconnected jobs.

Regional dimension

The Skagafjörður case perfectly illustrates the way in which a shared long-term commitment by private and public sector actors can enable sustainable and efficient approaches to a region's technological advancement. The decision to establish Verið Science Park in response to the negative impact anticipated from the reduction in fisheries activities has been a major success. It has led to substantial collaboration across different bio-based industries, inspired new and innovative companies and bio-based products, and created new jobs requiring higher

“I hope that this award [...] will encourage companies in the fishing industry to increase their cooperation with entrepreneurs. Innovation leads to better quality harvesting and processing, an improved image, more varied market opportunities and increased value.”¹

– Dr. Hólmfríður Sveinsdóttir,
Director IceProtein and Protis

education. The result is a diverse labour market profile in Skagafjörður, a region once dominated by agriculture and fisheries. The education level of the workforce in Skagafjörður has also increased and is notably higher than the education level in the surrounding area (northwest Iceland), which has the highest proportion of the population without a secondary education in the country



Johannes Jansson, Norden.org



Verið Science Park

The Verið Science Park has been the key vehicle of the development of the knowledge-based bioeconomy in Skagafjörður. It began as a limited company, jointly owned by FISK Seafood, the Municipality of Skagafjörður, and Skagafjörður's utility companies. Verið Science Park is home to R&D in biology and biotechnology, including the Faculty of Aquaculture and Fish Biology at Hólar University College, the Matís biotechnology laboratory, and the IceProtein pilot plant. It is partially funded by the Icelandic Government, with the majority of these funds invested in infrastructure intended to increase the competitiveness of the region's bioeconomy through R&D activities. The now advanced capabilities of the Verið Science Park have resulted in a high level of competitiveness for R&D funding at the Icelandic, Nordic, and European levels. Furthermore, the park's unique capabilities have attracted contract research funding from international companies, resulting in significant international contacts and collaboration.

Learn more...

- Saudarkrokur Biotechnology Centre: <http://www.matis.is/english/about/locations/saudarkrokur/>
- Verið Science Park (in Icelandic): <http://www.veridehf.is/>

¹Statement made after receiving Fisheries Iceland's Motivation Award in 2016 (Matis Ltd. 2016).

IceProtein and Protis

IceProtein, a company that specialises in the development of ingredients and bioactive compounds from seafood by-products, is unique in the Icelandic context. It was founded as a pilot project in September 2005 when Icelandic Fisheries Laboratories aggregated its R&D efforts associated with the utilisation of previously discarded marine proteins. IceProtein's pilot scale operations were supported in 2008 when Matís Ltd., Icelandic Fisheries Laboratories' successor, opened a fully operational biotechnology laboratory in Skagafjörður. The company was further strengthened when FISK Seafood entered into a joint ownership with Matís, eventually gaining full ownership of the company in 2012. Under its new ownership, IceProtein built up activities aimed at servicing internal growth, quality control and R&D within FISK Seafood and related companies in Skagafjörður's bioeconomy, along with the focus on value creation from underutilized raw materials. In 2015, the first product lines were launched by Protis, a new company founded to manage IceProtein's production and sales. Their product range currently consists of three proteins, which are sold in most stores in Iceland. The award-winning work of these combined companies has drawn significant talent to the area and helped retain educated locals who would have otherwise moved away.



NORWEGIAN WOOD TO GROW THE BIOECONOMY IN ØSTFOLD COUNTY

Borregaard is a Norwegian multinational company originating from the paper and pulp industry in Østfold County a hundred years ago, but now focusing mainly on the production of biochemicals. Østfold County lies in the southeastern corner of Norway bordering Sweden, and has approximately 285,000 inhabitants. Most people live in the urban areas of Fredrikstad and Sarpsborg, the latter being where Borregaard has its headquarters. With extensive local sources of forest biomass, Borregaard is a core player in the development of Østfold County's bioeconomy, aspiring to apply sustainable land use to produce and convert biomass into a range of food, health, fiber, and industrial products, and energy.

Growing resilience from adaptive diversity

Initially founded by a British company, the wood industry in Østfold quickly developed into Norway's largest industrial employer in the early 1900s. It expanded with the construction of mills, a carbide plant, and a hydro-power plant, before being bought by Borregaard in 1918. In modern times, the biggest competitor, Norske Skog, has had to close down its local plant because of the high costs of running industry in Norway. Borregaard, on the other hand, has diversified its product base over the decades from only cellulose for paper to also including lignin, vanillin, and second-generation bioethanol. The company spends 6–8 times as much of its turnover on research and development than do other traditional wood-processing industries, and focuses on keeping knowledge-intensive operations in Norway. Today, Borregaard is a global company with over 1,000 employees in 16 countries, and a turnover of almost NOK 5 billion (€500m).

Norwegian wood will not grow faster

Transforming industries from being fossil based to building on biomass is not a golden, one-size-fits-all solution to business-as-usual. As expressed in an article on bioeconomy in Europe written by McCormick and Kautto in 2013, the challenge of including sustainability

“In 2014, the European bioeconomy had an annual turnover of approximately €2 trillion and employed 22 million people”

(Teräs J. et al, 2014, p 13).

in all policies remains and, parallel to “going renewable”, there is also a need to work hard on energy efficiency, transform business models, and add to the sustainability transition of the entire market.

Regional dimension

The wood-processing industry is a competitive industry requiring large investments in facilities and research and development. For Østfold County, Borregaard is a



Source: Borregaard

Financial support vital for development

Step by step, Borregaard has worked to realise its idea of building a biorefinery to produce second-generation bioethanol. This would have been very difficult without financial support from government schemes. In 2009, Borregaard received public funding together with Østfold Research to conduct a life cycle assessment study of cellulose, ethanol, lignin, and vanillin. From the Research Council of Norway, Borregaard received NOK 19 million (€2m) for a five-year project titled Biomass2Products, where the company was expected to develop a biorefinery concept together with research partners for the production of marketable products and cost-efficient processes for production from biomass. It also received NOK 35 million (€3.7m) in EU EP7 funding for two project

proposals sent in response to the Joint Biorefinery Call. Then in 2010, Innovation Norway granted Borregaard NOK 58 million (€6.1m) as support for the actual construction of the BALI Biorefinery Pilot plant, after it developed new technology to produce biofuels and valuable green chemicals from forest waste, straw, and wood chips. In 2014, an additional NOK 18.8 million (€2m) was granted as project support by the Norwegian Research Council within BIONÆR, a national research program on Sustainable Innovation in Food and Bio-based Industries. For example, some of the funding has been used to build the BALI plant, showing that national and regional funding structures in support of the development of new technology and systems are essential.

large employer and has a strong influence on the competence development of the region by attracting highly skilled academics from abroad, training and employing local technicians, and investing in local development projects. Kunskapsfabrikken (“the Knowledge Factory”) and the Ispiria science centre are two such projects, aimed at encouraging local youth to understand and study science and technology, and perhaps choose a future career at Borregaard. Borregaard has also established a trainee program with the NTNU in Trondheim,

and cooperates closely with local forest owners and networks at national and international levels. This multinational company seems less inclined to collaborate with other regional actors.

Learn more...

- Borregaard: <http://www.borregaard.com/>
- Nordregio report: Bioeconomy in the Nordic Region: Regional case studies



MULTI-STAKEHOLDER APPROACH ADVANCES THE BIOECONOMY IN LOLLAND MUNICIPALITY

Lolland is a rural island in the south of Denmark and is part of Region Zealand. It has a population of approximately 43,000 inhabitants. The municipality was renowned for its strong agricultural industry, including sugar beet production, as well as its shipbuilding industry. The region experienced deindustrialisation and the economic downturn in the 1990s, which triggered the transformation of the local economy. From the beginning of the 2000s, industries in the fields of renewable energy and agro-industry started to emerge, leading the region out of recession through the creation of jobs and business opportunities.

A world leader in bioeconomy development

Lolland is among the world's leading examples of 'green regions', capitalising on agriculture and livestock production and the existing network and experience developed through the Lolland Community Testing Facilities (CTF). Local politicians saw early on the potential of a bioeconomy for the economic development and job creation that triggered the first investments and support activities. Lolland has several small and large-scale biogas production projects, biofuel production including rape seed oil and bioethanol from agricultural residues, and R&D projects in the field of algae biomass. The current focus in the region is on accelerating the production of second-generation biofuels from agricultural waste.

Cooperation a key ingredient of success

Lolland's success in realising a bioeconomy can be attributed to close cooperation between the different stakeholders, including the community, and the evolvement of innovative cooperation structures. The latter has been facilitated by meetings and networking, cluster development, innovation platforms and industrial synergies. Several instruments have been developed in the region to support the collaboration, develop ideas and realise new bioeconomy projects, such as the Regional Sparring

Lolland has several small and large-scale biogas production projects, biofuel production and R&D projects in the field of algae biomass.

Group on the Bioeconomy and the Green Committee. Among other enabling factors has been the strong political support from the regional government, and visionary planning from local and national government, as well as access to funding for R&D, preparatory activities (e.g. establishing bioenergy plants), training of SMEs, project development and other support activities.

Regional dimension

The development of the bioeconomy in Lolland not only provides practical and innovative solutions for



Source: Christensen 2008

local and regional problems, but also represents a significant export potential and international recognition for the region. An increased focus on green growth has catalysed the development of bio-based businesses in Lolland and attracted new firms and funding to the region through CTF activities.

Learn more...

- Nordregio report: Bioeconomy in the Nordic Region: Regional case studies

Innovative collaborations for bioeconomy development

The establishment of an environment for green innovation in Lolland has been supported by a number of initiatives and projects in a quadruple helix set-up. Among the enabling factors has been the presence of R&D centres and extensive experience in the field of energy and industrial ecology (for instance, see Case 3 on the Industrial Symbiosis initiative in Kalundborg). The establishment of the Lolland CTF in 2007 paved the way for the large-scale initiatives promoting green growth in the region. CTF provide the opportunity for industries to test and demonstrate innovative projects and renewable energy technology on a full scale. The mission

of CTF has also been to strengthen the synergies and cooperation between different stakeholders, including the local governments, research centres and local businesses. Partly due to the presence of an institution such as CTF, Lolland has been able to attract innovative installations and businesses to the region and strengthen the R&D activities in the field of renewables. CTF is financially supported by both the local and central government, and the revenues from the installations are fed into public support for renewable energy. Lolland also hosts the Green Center and the Algae Innovation Center, which foster innovation within the food and agro-industry.

BLUE GROWTH

Water covers over 70% of the Earth's surface, yet its potential to contribute to economic and regional development remains relatively under explored. The European Union is attempting to address this through "Blue Growth", a "long term strategy to support sustainable growth in the marine and maritime sectors as a whole" (European Union 2014). The strategy takes a broad definition of the blue economy, and identifies the following five value chains as having the greatest potential to deliver sustainable growth and jobs: blue energy; aquaculture; maritime, coastal and cruise tourism; marine mineral resources; and blue biotechnology (European Union 2012).

It is important to acknowledge that not all activities that make up the blue economy can automatically be considered to contribute to green growth. The cases selected for inclusion in this collection mostly fall under the categories of aquaculture (e.g. Case 29: Sybimar Ltd.'s closed circulation concept for aquaculture), biotechnology (e.g. Case 27: BioTech North makes Tromsø "the hot spot for cold biotech"; Case 24: Legasea biomarine cluster) or a combination of the two (e.g. Case 26: The Swedish Algae Factory). "Blue energy" initiatives can be found in the section on cleantech and renewable energy.



LEGASEA BIOMARINE CLUSTER

Legasea is a cluster of biomarine companies aiming to become ‘a global industrial leader in the sustainable and profitable use of marine bioresources and residual raw materials’ (Legasea 2015). The cluster has its headquarters in Møre and its membership represents the complete biomarine value chain including: 14 marine ingredient producers, 5 fishing companies, 25 deep sea vessels, 9 onboard ingredients plants, 3 fish farmers and fish industry, 2 research organisations, 1 university college, and 1 innovation company.

Toward 100% utilisation of marine biomass

Møre is home to some 500 marine sector companies and the total annual turnover of sea-based industries in the region is around NOK 100 billion. Although the area is already highly productive, scope remains for increased production of high-value products from fish trimmings (the parts of the fish that are discarded in the production of fillets or steaks). Fish trimmings mainly consist of oils (e.g. omega-3) and proteins (e.g. fishmeal or liquid concentrate). Calculations suggest that by 2050, the trimmings will amount to 4.4 million tonnes annually (0.9 million tonnes in 2010). Through cooperation between industry and institutions focused on research, education, and innovation, Legasea hopes to take the production of high-value marine products to the next level. The ultimate goal is 100% utilisation of the marine biomass produced.

Cooperation and a favourable policy landscape fuel industry growth

The Norwegian marine ingredients industry is predicted to generate over NOK 70 billion in 2050. This figure is based on anticipated growth of approximately 7% per year. During 2013 and 2014, Legasea companies grew by 16% and 10%, respectively. This suggests that, through cooperation, the potential for growth could be increased substantially.

The push towards sustainable development, in both national and international policies, is an important driver of Legasea activities. The Norwegian marine industry is well placed to function within this policy framework, as a large portion of its fish is already MSC certified and the production of oils and proteins occurs in a transparent and efficient manner. National policy favouring innovation has also been helpful. Legasea has

Marine products in a global context

Legasea’s focus on the production of high-value marine products is highly strategic. It capitalises on regional strengths while at the same time thinking on a global scale. The effectiveness of marine oils and proteins in addressing health problems related to lifestyle factors is well documented (see figure: Health benefits of marine ingredients), and the market for these products – most notably the Chinese market – is growing rapidly. At the same time, in the face of an increasing global population,

seafood is an ideal, protein-rich, low climate-impact food (see figure: Carbon footprint of food production). As the second largest seafood exporter in the world, Norway is in a unique position to capitalise on both trends and become a world leader in generating sustainable marine products. At the national level, the work of Legasea also has the potential to play an important role in Norway’s transition from an oil-based economy to a bioeconomy.



Source: Legasea

been named a “Norwegian Innovation Cluster” under the Arena Programme¹, making it eligible for financial and technical assistance to support its development.

Regional dimension

The brains behind Legasea think big, and so much of the conversation about development potential has focused on the national economy. Nonetheless, the cluster has obvious implications for the region, particularly with respect to development of the region as an innovation hub. Campus Ålesund (<http://www.nmcc.com>) is being pitched as “a power centre for blue ocean industries”. It is home to the Norwegian University of Science and Technology (NTNU), the Norwegian Maritime Competence Centre (NMK), Ålesund Technical School, Fagerlia Secondary School, and Sunmøre District Museum as well as over 20 companies. Combined,

Møre is one of the most important seafood regions in the world, producing some 650,000 tonnes of seafood annually.

Learn more...

- Legasea: <http://www.legasea.no>

¹ The Arena Programme is a collaboration between The Research Council of Norway, Innovation Norway, and SIVA.



GROWING POTENTIAL IN THE OCEAN RAINFOREST

Ocean Rainforest is a limited company located in the Faroe Islands. It is engaged in the production of marine biomass from macroalgae in open-ocean cultivation installations. As of 2016, it is the single largest macroalgae cultivator in Europe and North America, and the largest in the world deployed in a deep open-sea environment. The aim of the company is to become a leading supplier of sustainable cultivated macroalgae in open-ocean environments.

Cultivating seaweed in the open ocean

Fisheries and aquaculture are the single most important contributors to the Faroese economy, contributing over 91% of its total exports in 2012 (Statistics Faroe Islands 2015). In addition, a large portion of the Faroe Islands' biological resources are found in marine environments, and significant opportunities for biorefining seaweed that is cultivated and processed offshore have been identified. Ocean Rainforest undertakes ambitious and advanced development in this field, and has developed a method to cultivate seaweed in the open ocean. The company has 13,500 meters of seaweed seed lines in the Faroese waters, where a continuous current and a stable sea temperature provide the perfect conditions for seaweed farming.

The road ahead

Public funding and national and international interdisciplinary collaborations have been key enablers in developing Ocean Rainforest and taking the concept closer to large-scale commercial applications. Ocean Rainforest is involved in several research projects, and is already selling seaweed for food and cosmetics production in Europe. The company is committed to expanding knowledge on the biorefining of seaweed, seeing this as the most commercially viable way to produce biomass from seaweed. The next phase in the company's journey will be to undertake product and market testing based on the techniques and applications developed through numerous R&D projects. This work will require an investment of €1 million.

Incremental progress towards a higher goal

Ocean Rainforest first obtained its licence for pilot testing in 2009. The cultivation rig was deployed the following year at the aquaculture test site north of the Faroese village of Funningur. The installation demonstrated its ability to withstand the physical strains of the stormy North Atlantic conditions early on, withstanding winds of up to 62 m/s and waves 7.8 m high. Since then, Ocean Rainforest has consistently undertaken development work supported by public funding. This has led to next-step development projects in international consortia. For

example, the MacroBiotech Project, which was funded by the North Atlantic Cooperation Forum (€300,000), has contributed to knowledge about the technical and commercial viability of cultivating macroalgae in the open ocean. Similarly, the International Macroalgae Biorefinery Project, which was funded by the Danish Innovation Fund (€3.3 million), includes a consortium of Danish and international experts who focus on cultivating and utilising macroalgae in sustainable and climate-friendly ways (see Case 26).



Erik Christensen, Porkeri, norden.org

Regional dimension

Despite Ocean Rainforest's relatively small size, the progress it has made during its first decade of existence is promising. The company's operations are based on a range of activities occurring along an unbroken chain—from seeding, cultivation, harvesting and processing to storage and sales to the business-to-business market. As a result, the initiative offers substantial potential for the creation of a range of employment opportunities when operations are eventually scaled up. Successful commercialisation of seaweed production, coupled with international demand for the related products, could see Ocean Rainforest's activities make a substantial contribution to job creation in the Faroe Islands.

Ocean Rainforest is on the road to becoming the most reliable provider of high quality seaweed in Europe.

Learn more...

- Ocean Rainforest: <http://oceanrainforest.com/>



THE SWEDISH ALGAE FACTORY

“To solve the environmental challenges, we must work according to the laws of nature”. Sofie Allert, CEO and cofounder of Swedish Algae Factory (SAF), has clear priorities regarding sustainable business – and is walking the talk. SAF, working with diatoms in Gothenburg since 2014, is still in an early stage of development, but has plans to use circular business models with companies sharing the same values. The aim is to have 100 algae farms running by 2030, and potential partners so far span the spectrum from fish farming and agriculture, to production of renewable fuel, plastics, textiles, insulation materials, and photovoltaics. “The next step is to take it out of the lab – and make it financially sustainable”.

Growing at the speed of algae

Sofie Allert wrote her bachelor thesis in biotechnology on creating a renewable substitute for fossil fuels using algae. During her master's education at the Chalmers School of Entrepreneurship, she met Angela Wulff, a professor in marine ecology. Professor Allert had noticed early the challenge for algae growth in the cold and dark Nordic countries, but during polar expeditions Wulff had found algae that were thriving despite these conditions. They developed a business concept around these types of algae, teamed up with more researchers, and in 2014 founded the company. They soon received a SEK 3 million (€320,000) grant from Swedish innovation agency Vinnova, and have already won several prizes and awards, such as the Green Mentorship Award worth SEK 1 million (€107,000) from Skype founder and innovator Niklas Zennström.

The future is tiny

The company is still operating on a small scale, but plans are developing quickly, thanks to the interdisciplinary CEO, who is not only educated in natural sciences and engineering but also in entrepreneurship. This type of cross-sectorial background teamed with holistic and sustainable business values can also be seen as a promising trend among the young generation of sustainability professionals. In an interview, Allert explained that, while the development of the Swedish Algae Factory is not dependent on certain aspects of public policy, political instruments and decisions in support of a circular economy could definitely help them. Even without political encouragement, growing interest from other companies to partner with them, and a general and increasing awareness of

“Every second breath you take contains oxygen produced by algae”. – Sofie Allert, CEO

the value of sustainable business models gives Allert hope for her company.

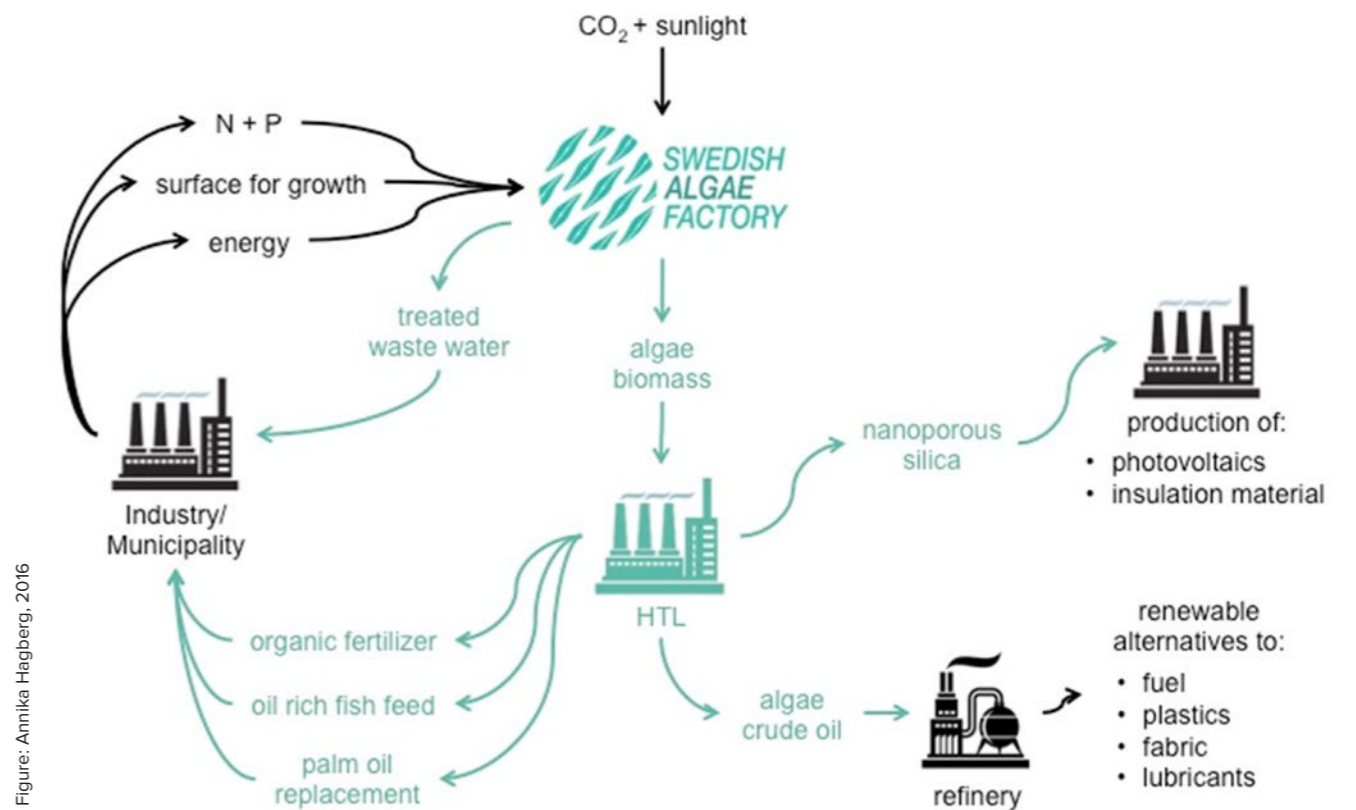
Regional dimension

With the growth potential of algae farming and its diversity of products, expansion of the business sector can well become regional, national, and international. By turning the algae oil into a renewable alternative to fossil fuels, the production of fuels can be decentralised and regions could become their own fuel producers. Additionally, the diversity of products and functions derived from algae farming could allow for regions with different circumstances to adapt the production to their own needs. Regions with declining population and reduced job opportunities could also see the new green jobs in algae farming as a tool to regain some of their vitality.

Learn more...

- Swedish Algae Factory: www.swedishalgaeafactory.com

Swedish Algae Factory's example of a circular business model based on algae's natural life cycle



Algae research

Research is being conducted worldwide to identify potential products from algae. SAF is one of a small number of Swedish entities that conducts research on around 30 types of algae. The algae need sunlight, nitrogen, phosphorus, and carbon dioxide to grow. SAF extracts oil, nano-porous silica, and nutrient-rich biomass that can be utilized as fertiliser. The oil can be used as a replacement for fish oil and palm oil or further processed to a renewable crude oil and used to make commodities such as fuel, plastics, and lubricants. The nano-porous silica can function as a good insulating material, and as a thin layer that improves photovoltaic efficiency by up to 30%. The fertiliser can be used

as an organic fertiliser on farmland. Since nitrogen and phosphorus are contained in water runoff in agricultural areas, there is a large potential for circular business models involving farms and food producers.

The first partner of SAF will be a land-based organic salmon farm just north of Gothenburg on the Swedish west coast. Algae will grow in layers as a roof above the fishponds to make use of existing space and not take up new land. The fish farmer will provide nitrogen and phosphorus through the wastewater from the ponds. In return, the algae will clean the wastewater and some of the algae biomass will be turned into fish feed.



BIOTECH NORTH MAKES TROMSØ “THE HOT SPOT FOR COLD BIOTECH”

BioTech North is a triple-helix biotechnology cluster involving 38 enterprises and R&D organisations located around the northern Norwegian city of Tromsø. The cluster aims to become ‘[t]he leading centre for research and commercialisation of marine bioactive compounds from the Arctic’ (Biotech North, 2013). It also seeks to improve professional competence in the region, improve the economic conditions for biotechnology and increase the attractiveness of the region for companies and institutions.

A co-operative approach to value creation

Local actors were motivated to start BioTech North as a means of inspiring increased value creation in the industry. They concluded that although the past 40 years had delivered some solid outcomes, there was still substantial untapped potential with respect to value creation. This is problematic because without the creation of high value products, marine industry contributions to the bioeconomy may be hampered by their lack of financial viability. The cluster gives members access to infrastructure such as laboratories, testing and production facilities through which to develop new ideas and, most importantly, bring them to fruition. The BioTech North cluster is funded by Norwegian Innovation Clusters, which is an initiative supported by the Norwegian Government.

Balancing the “green” and the “growth”

The establishment of the BioTech North cluster is timely from a policy perspective. The Norwegian Government is attempting to move the country from an oil-based economy to a bioeconomy and has developed several policies designed to support activities like BioTech North, which include the “National Strategy for Biotechnology: For the future of value creation, health and the environment.” This strategy is designed to drive Norwegian biotechnology activities over the period 2011–2020. There is also a strategy more specifically focused on biomarine activities: “Marine bioprospecting – a source of new and sustainable wealth growth”. This strategy seeks to ‘stimulate research and business development in stra-

“Approximately 500 researchers at approximately 10 institutions are engaged in biomarine research in Tromsø”

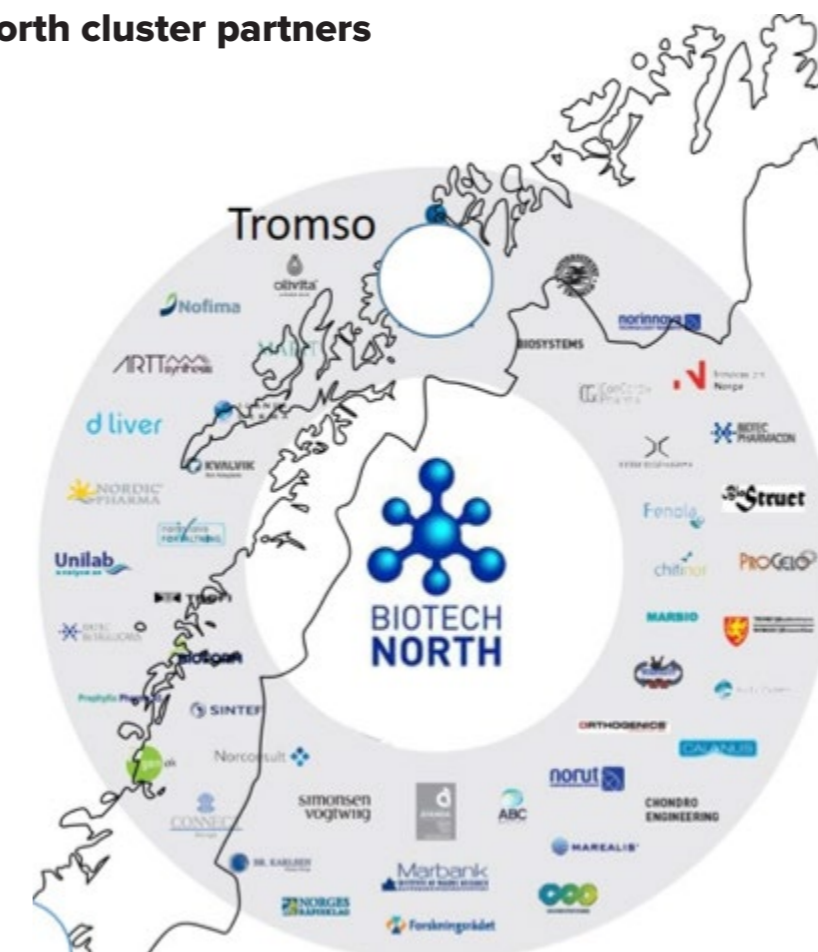
(BioTech North, Tromsø Kommune & Mabit 2012).

tegic areas with high potential of wealth growth, and where Norway has a good opportunity to assert itself in an international competition’ (Norwegian Ministries of Fisheries and Coastal Affairs, Education and Research, Trade and Industry and Foreign Affairs 2009, p. 9). Government commitment to the industry is encouraging. Continued work to ensure economic and environmental goals go hand-in-hand will be important in ensuring a genuinely green approach to growth.

Regional dimension

Tromsø has been branded “The hot spot for cold biotech” (BioTech North, Tromsø Kommune & Mabit 2012) and is internationally recognised as an important site of world-class biotechnology research. This positioning is designed to attract investment from industry. It also has important implications for population growth and de-

Biotech North cluster partners



Source: Biomarine.org

Biotechnology in the context of green growth

Biotechnology encompasses all technology that uses plant and animal cells and microorganisms to create new or improve existing products. Marine bioprospecting is a biotechnology activity that systematically explores marine organisms to discover new compounds, components or genes that might be used in a range of applications, for example, medicines and biofuels. Biotechnology and marine bioprospecting have relevance to green growth for several reasons. First, scientific enquiry can be used to generate new uses from what was previously con-

sidered waste. This reduces waste and the need for new raw materials, making an important contribution to the circular economy. Second, cultivation of new marine organisms for biofuels helps to reduce reliance on fossil fuels. While the technology for this work already exists, the financial viability of production is contingent on finding higher value uses that can occur alongside biofuel production. Third, biotechnology and marine bioprospecting present an opportunity for new discoveries that can contribute to a more environmentally friendly future.

mography. In 2014, the portion of Tromsø’s population aged 25–64 years with a tertiary level education (52.8%) was significantly higher than the European average (29.3%, Grunfelder, Rispling & Norlén 2016). In addition, the regional potential of the Troms region as a whole increased more than any other Nordic region. Although it is difficult to gauge the direct impact of biotechnolo-

gy activities on this performance, it is worth noting that both “labour force potential” and “economic potential” made a strong contribution.

Learn more...

- BioTech North: <http://biotechnorth.no>



UNLOCKING THE POTENTIAL OF THE SEA AT ALGECENTER DANMARK

Algae is considered a good source of raw material for the production of environmentally friendly energy, animal feed, food and cosmetics. With European research in algae cultivation and utilisation still in its early stages, AlgeCenter Denmark is a pioneer in the field. AlgeCenter Denmark has made some promising findings regarding algae cultivation and utilisation, and is currently at the forefront of European research seeking breakthroughs to increase the viability of algae-based biofuels from an economic perspective.

Macroalgae for sustainable growth

Estimates show that the world is running out of arable farmland for food and energy production. Given that seas and oceans cover over 70% of the Earth's surface, improved utilisation of seas and oceans as viable farming areas provides a possible solution to this problem. Macroalgae in particular have proven useful in both food and energy production. Danish waters contain over 300 macroalgae species. Worldwide, this number is far higher—over 10,000 species—and many of these species are highly nutritious. AlgeCenter Denmark was

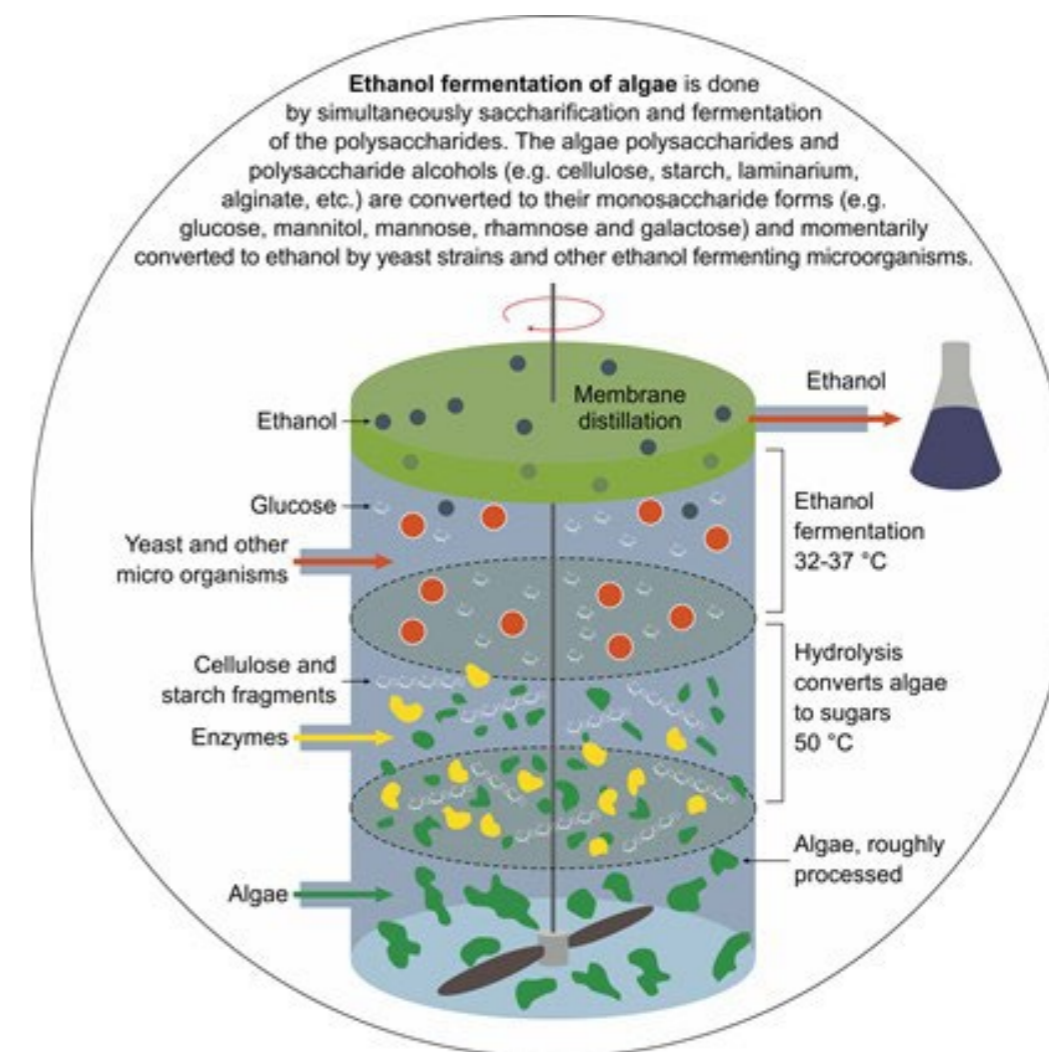
Worldwide there are over 10,000 species of macroalgae.

founded in 2011 in Grenaa, Denmark, with the main objective of researching the utilisation of algae in energy, food, and medicine production.

MacroFuels advance the case for algae-based biofuels

AlgeCenter Denmark is a key partner in the consortium behind MacroFuels, a European project involving six countries that is seeking breakthroughs in the production of advanced biofuels from seaweed and macroalgae. Previous research, including that conducted by AlgeCenter Denmark (2013), has demonstrated that, from a technical perspective, seaweed is suitable for biogas production (see figure: Producing biogas from algae). MacroFuels seeks to build upon this work, making it viable from both a practical and an economic perspective. Currently, the high biomass yield required, coupled

with high production costs, means that large-scale production of algae for biofuels is not economically viable. Through technical and process-oriented breakthroughs, it is hoped that these barriers can be overcome and that algae based biofuels can become a genuine alternative to both fossil fuels and land-based biofuel sources that compete for scarce cropland. The project is funded by the European Union's Horizon 2020 Research and Innovation Programme, and includes 12 partners from across Europe.



Source: Algecenter Denmark

Algae research in Grenaa Denmark

AlgeCenter Denmark is consortium of four partners: the Danish Technological Institute, Aarhus University Department of Bioscience, Ocean Centre Denmark, and Kattegatcentret. Its stated purpose "is to find out how algae can be used as a new resource in a world where traditional resources are under pressure" (AlgeCenter Denmark 2016). Potential examples include sustainable energy, food, medicine and food ingredients. Research into algae cultivation is still in its infancy in Denmark, but this has not slowed the progress of AlgeCenter Denmark. Numerous research projects are being carried out simultaneously at AlgeCenter Denmark, most of which at the Grenaa Harbour plant, which is equipped with 12 algae cultivation tanks.

Regional dimension

AlgeCenter Denmark's activities have both short- and long-term consequences for regional development. In the short term, research activities provide local jobs that support the knowledge economy and stimulate cross-sectorial collaboration on the national and international levels. In the long term, the findings of this research have the potential to generate thousands of jobs and stimulate new and innovative business ideas across the entire value chain.

Learn more...

- AlgeCenter Denmark: <http://www.algecenterdanmark.dk/>
- MacroFuels: <http://www.macrofuels.eu/>



SYBIMAR LTD.'S CLOSED CIRCULATION CONCEPT FOR AQUACULTURE

Sybimar Ltd. was founded in 2005 and is based in Uusikaupunki, Finland. The company's key activities include producing fish in dry-land fish farms using circulating water technology and producing biofuels from fish waste and food industry by-products. Sybimar Ltd. also sells the technologies and products it develops to other companies. Long-term thinking and smart local solutions are central to Sybimar Ltd.'s work.

From fish harbour to recirculating aquaculture

Sybimar Ltd., originally named, Rovina Ltd. was founded in 2005 for the purpose of providing economically and environmentally sustainable uses for fish processing industry side streams. The company then went on to merge with Ramirakenne Ltd. to become Sybimar Ltd. and now works across the agricultural and food sectors finding innovative and environmentally friendly ways to reuse side streams. Sybimar is an active participant in the Carbon Neutral Municipalities project (see Case study 46 of this Handbook).

Sybimar Ltd.'s closed circulation concept reduces the amount of new water required for the fish farming process by almost 80%.

Modular concept and innovations

A 2014 report from Nordic Innovation suggested three key factors that have supported positive outcomes for Sybimar Ltd (Rönnlund et. al. 2014). First, the company is well established in, and has extensive knowledge of, the fish industry. Second, changes to environmental regulations have restricted increases to open-sea fish farming, thus enhancing opportunities for operations on dry land. Third, the public funding that Sybimar Ltd. received from the Ministry of the Environment has allowed scope for investment in pilot operations. This support at the early stages is quite important as, fish farms take several years to reach full production capacity and to show a return on investment.

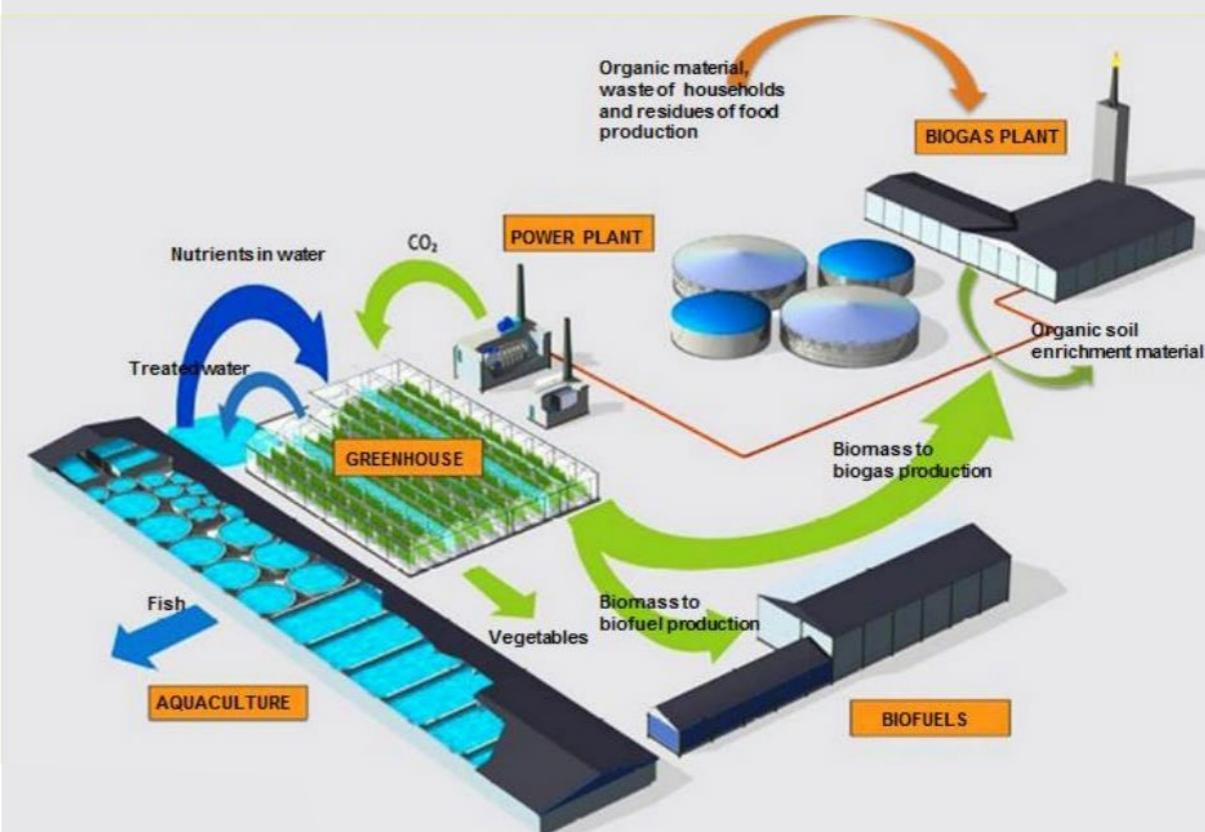
Regional dimension

In 2010, Sybimar was awarded a commendation in a competition that sought new business concepts, processes, and technologies to tackle climate change on the municipal and local levels across the Baltic Sea Region and the Nordic countries. The jury praised the closed circulation concept solution and were particularly impressed by the level of cooperation between private and public sectors and by the creation of new jobs. The regional development potential of Sybimar Ltd.'s work is further strengthened by the opportunity for other companies to purchase elements of their systems.

Learn more...

- Sybimar Ltd: <http://sybimar.fi/en>

Sybimar's closed circulation concept



source: Sybimar Ltd.

Sybimar Oy
Energy Solutions

The closed circulation concept

“The closed circulation concept” is an important innovation from Sybimar Ltd. This technology uses and recycles waste, energy, heat, nutrients, and carbon dioxide to produce energy and food and aims to make the production chain as carbon neutral as possible. The technology works by combining food production and energy production (see figure: Sybimar Ltd. closed circulation concept). Heat and energy are generated (primarily using biogas) in a

plant that can operate on multiple types of fuel. The plant's carbon dioxide emissions are then directed to a greenhouse where they support biomass growth, and excess heat is used to heat the water in the fish farm. Nutrient-rich waste water from the fish farm is recycled to irrigate the greenhouse. Finally, organic waste from the greenhouse and the fish farm are used as biofuel or raw material for biogas production.



A CIRCULAR APPROACH TO BLUE GROWTH FROM NOFIR

Every year approximately 640,000 tons of fishing equipment is dumped or lost at sea worldwide (Nofir 2016). An estimated 10% of this waste occurs in Europe, with Norway alone contributing 15,000 tons. Nofir is a Norwegian company that seeks to address this problem by collecting and recycling materials from the fishing and fish-farming industry. Nofir is now working across Europe to build a sustainable system to deal with end-of-use fishing and fish-farming equipment.

From Norwegian beginnings to a European focus

Nofir was founded in 2008 when a fish-net producer and a waste-management company joined forces to solve a common problem – the lack of environmentally friendly methods for disposing of discarded plastic equipment from the fishing industry. The original purpose of the company was to establish a nationwide system for collecting discarded fishing equipment in Norway. At the time, the cost of disposal was high and burning or dumping used fishing equipment was common practice. In 2011, UAB Nofir was established in Lithuania, where the majority of the equipment collected by Nofir is now dismantled. Following support from the European Union through the Eco-Innovation Project in 2012, Nofir expanded its activity across Europe, including offices in Poland (2013) and Turkey (2015).

A full-service approach

When Nofir was first established, several companies were already collecting discarded plastics from fishing equipment along the Norwegian coast. Generally, these competitors were interested only in the high-value fractions, which resulted in the less-valuable parts being dumped or burned. The unique aspect of Nofir is that it is building a sustainable system to deal with all types of plastic used in fishing and fish-farming equipment. Another key component of the organisation's success is its outreach model. In the early days, it became clear that the fishing and fish-farming industries did not have a culture of investing money, or even energy, into the disposal of equipment that had reached the end of its working life. Nofir overcame this challenge by arranging pick-up services at both fixed and flexible locations.

Regional dimension

Nofir's head office is located in Bodø, in the Nordland region. Although the majority of Nofir's collection activities still occur in Norway, its activities are increasingly international. The company now collects materials from all over Europe, dismantles materials in Eastern Europe and Turkey and sells the dismantled material all over the world. As a result, it is difficult to assess Nofir's economic impact at the regional level. There is perhaps scope for Nofir to develop its own activities with respect to the

EUfir

EUfir was a €684,562 project co-funded by the European Commission's Eco-Innovation Project and the Executive Agency for Competitiveness and Innovation for a three-year period from September 2012. The goal of the project was to establish a European system for collecting and recycling discarded equipment from the fishing and fish-farming industry. Over the course of the project, the consortium collected a total of 909 tonnes of fishing and fish-farming equipment and operated in Iceland (501t), Scotland (340t), Ireland (14t), Denmark (22t) and the Netherlands (33t). This work was performed in addition to the Nofir's regular operations in Norway, which is still by far the country where the company is most active (4985t collected in 2015). EUfir was a collaboration between Nofir AS, UAB Egersund Net, UAB Nofir and Qualchem Zrt.



Since 2011, Nofir has collected approximately 20,234 tons of fishing and fish-farming equipment from across Europe.

development of new products from recycled materials. For example, in 2015, Nofir co-operated with a company that produced 1,000 pairs of socks from recycled fishing equipment. Again, the degree to which such activities would contribute to regional development would vary depending on production and distribution models. The environmental benefits for Norway itself are dramatic – since 2011, Nofir has collected approximately 18,555 tons of fishing and fish-farming equipment in Norway alone.

Learn more...

- Nofir AS: nofir.no



CLEANTECH AND RENEWABLE ENERGY

The Nordic Region has a well-established position as a world leader when it comes to developing and implementing technology for renewable energy (Weber & Donald Smith 2016). In all five countries, both policy and funding landscapes are favourable to maintaining, and even strengthening, this position. In 2014, it was estimated that 38% of the total primary energy supply in the Nordic Region came from renewable sources (Weber & Donald Smith 2016). As a result, a comprehensive review of renewable energy initiatives in the Nordic countries is well beyond the scope of this publication. Instead, we focus on a small selection of initiatives that demonstrate the potential for renewable energy initiatives to contribute to regional development.

The cases highlighted here include larger-scale projects that have the potential to make a significant impact on overall implementation of renewable energy at a national level (e.g. Case 34: Green Highway linking Östersund and Trondheim), projects that are particularly novel (e.g. Case 33: Kymijärvi II, the world's first gasification fuelled power plant; Case 35: Generating biodiesel from fishwaste in Åland), and examples where renewable energy makes a substantial contribution to local communities (e.g. Case 31: The future of energy production in Greenland; Case 32: Lillstrøm, big things happen in small societies).



THE FUTURE OF ENERGY PRODUCTION IN GREENLAND

The lack of electricity transmission between urban settlements in Greenland necessitates a place-based approach to energy production. In keeping with this, this case from Greenland is intentionally laid out differently to the others in the collection. Rather than highlight only one case, we explore three quite different examples of innovative approaches to energy production that together contribute to increasing the reliability and sustainability of Greenland's energy system as a whole. These include turning fish residues and other waste into district heating (Sisimiut), individual use of renewable energy to revitalise a forgotten place (Saarloq) and generating hydropower using glacial meltwater (Ilulissat). It is important to acknowledge here that renewable energy initiatives in-and-of-themselves are not necessarily examples of green growth. However, it is not difficult to argue that access to locally sustainable, reliable energy sources in an environment such as Greenland are an important foundation for regional economic development.

A short history of energy production in Greenland

Historically, Greenland's primary source of energy has been imported fossil fuels. However, times change and 55–60% of Greenland's energy in recent decades came from renewable resources. Greenland has five hydroelectric power plants and also uses heat from waste incineration plants operated by municipalities to provide

heating in several of the towns in Greenland. A major challenge in Greenland is the lack of a coherent energy transmission system, which means that the Greenland energy supply system is based on individual island operation systems, with a need for backup capacity in every community. This set-up presents challenges when relying upon unpredictable sources of energy such as solar and wind. It is also difficult to utilise surplus energy in other locations. However, things are changing

Case study #1: Turning fish residues and other waste into district heating

The town of Sisimiut focused on the development of a district heating system from an early stage. Sisimiut's district heating is powered from two main sources. The first of these is waste, which includes household waste and cardboard boxes used in connection with the transport of food from outside Greenland. Waste material from the building industry is also included, as most houses in Greenland have concrete basement foundations, on top of which are wooden house structures. The second source of Sisimiut's power is fish residues and fish oil. Sisimiut has an extensive processing capacity related to fisheries. During the 1990s, it became obvious that waste from the industry could become an important energy source. In particular, the processing of Greenland halibut residues meant that they could deliver a substantial amount of fish oil that could be included in the district heating system. This enabled higher temperatures to be maintained in the incineration process, which ensured better heating energy and reduced pollution in the local environment.

on this front; since January 1, 2014, renewable energy generators may receive a subsidy based on the cost of having to supply the equivalent amount of energy by non-renewable means.

Case study #2: Renewable energy supply in remote places

The village of Saarloq was abandoned as a fishing village over 20 years ago, but many of the houses have been revitalised and converted into residences so that school classes can access the wilderness for education. The church has also been restored completely and several houses are now individually or family owned summer houses. Because the houses are mainly used in the summer season, some of the owners have started experimenting with solar panels, heat pumps and windmills for energy. Most of the energy and heating can be provided using these installations, which ensures that otherwise derelict places are used and maintained on a regular basis. This is an ideal solution for remote locations without any link to a larger energy system.

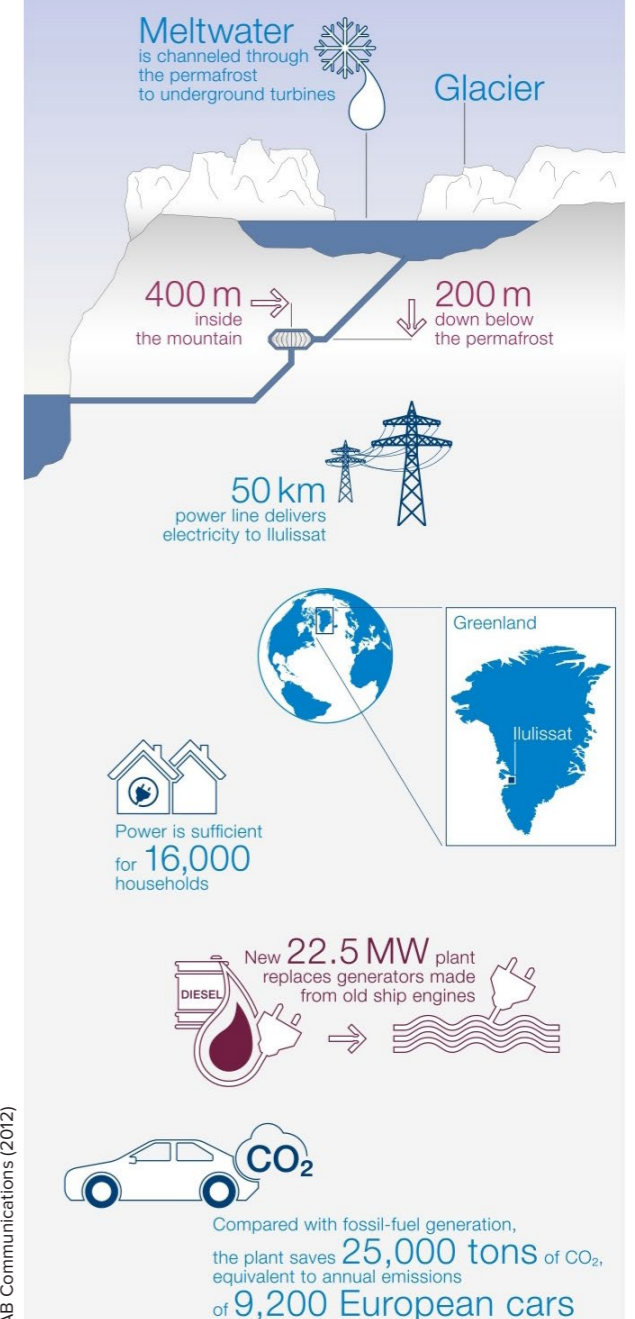
Case study #3: Generating hydropower using glacial meltwater

Ilulissat is the third largest community in Greenland and home to an unmanned hydropower plant that uses glacial meltwater to produce electricity (see figure: Generating hydropower with glacial meltwater). The plant's turbines are located 200 meters below the surface and are fed through a tunnel that connects to a meltwater lake (Knap 2012). The plant is incredibly difficult to reach and, as such, is completely automated and designed for off-site operation. The 22.5 megawatt plant replaces an existing diesel-driven power plant and provides enough electricity to power the whole town.

©: Rasmus Ole Rasmussen



Generating hydropower with glacial meltwater



AAB Communications (2012)



LILLESTRØM – BIG THINGS HAPPEN IN SMALL SOCIETIES

Bordering Oslo, Skedsmo municipality has a population of more than 51,000, of which about 14,000 live in the town of Lillestrøm. Despite its size, Lillestrøm hosts one of the country's busiest railway stations, one of Norway's foremost areas for research and technology, and more jobs than inhabitants. The region is one of the fastest growing in the country. Over the last decades, Lillestrøm has grown to become a substantial business hub, especially for cleantech and renewable energy companies driving the development of more sustainable energy for the entire Oslo region.

From sawmills to woodchips and hydrogen

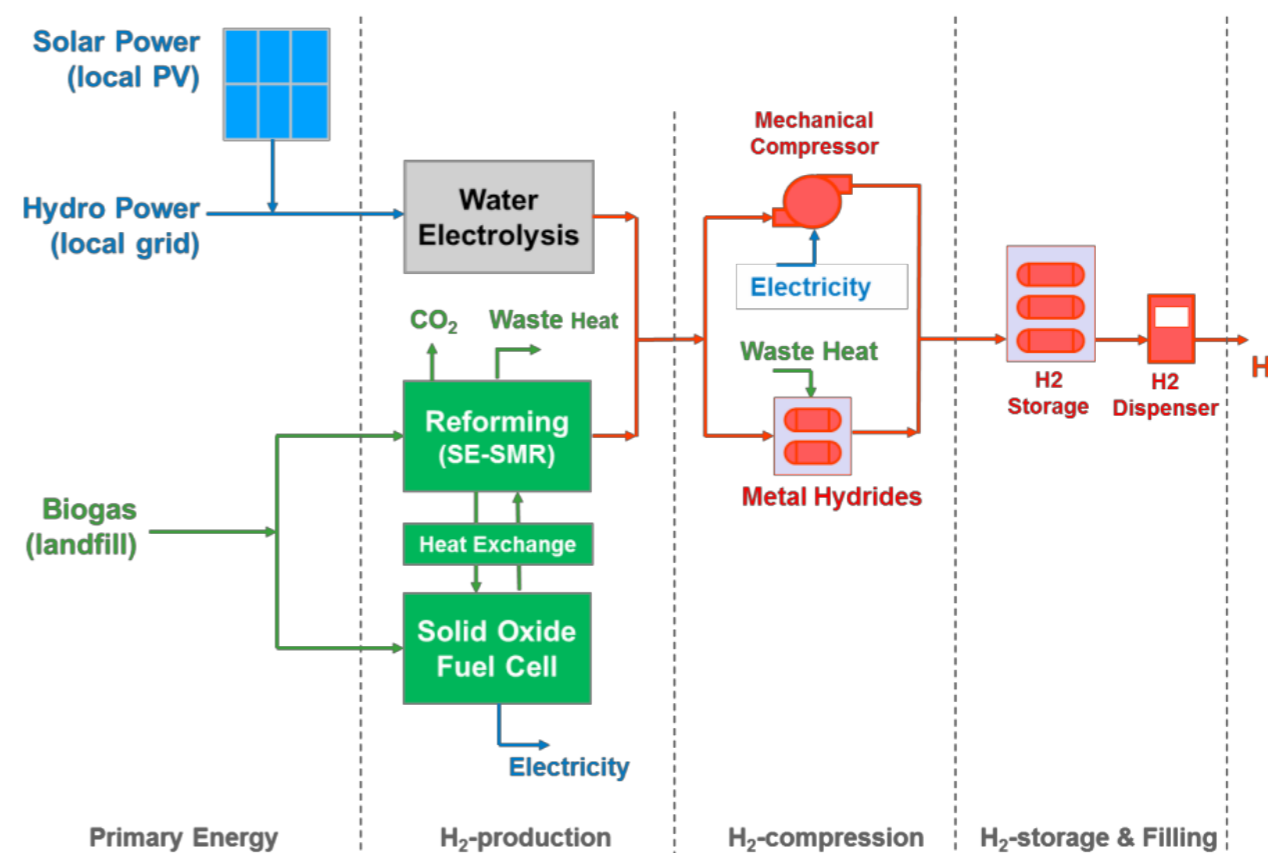
People have been living in the Lillestrøm region for millennia; however, the first population boom came with the industrialisation of the sawmills and the arrival of the Norwegian railway in the mid-1800s. The population grew tenfold in about 50 years and firmly established the local industrial society, situated only 20 km from the capital. Nowadays, Lillestrøm brings together local, regional and national actors in especially the cleantech, energy and environment sectors. One example is Akershus Energy Park, which houses one of Europe's most modern district heating stations, running solely on renewable energy. Woodchips, landfill gas, a heat pump and biooil fuel the plant, in addition to Norway's largest

The two woodchip-fired boilers at Akershus Energy Park that serve the district heating system have a total capacity of 20 MW and consume about 20,000 tonnes of woodchips per year.

A city of knowledge

It appears that the common denominator of many industrial actors in Lillestrøm is Kunnskapsbyen (Lillestrøm Centre of Expertise). For example, LCE is part owner of Hynor Lillestrøm mentioned on the next page; it hosts the secretariat for the Norwegian Hydrogen Council and has fostered the Oslo Renewable Energy and Environment Cluster (OREEC) launched in 2006. Located in Lillestrøm Science Park, Kjeller, LCE today has over 120 member organisations, which together total 6,000 employees and 17,000 students. LCE was established by Skedsmo municipality as a way to address a lack of communication between the key actors in the region that had been identified. The

centre aims to bring together companies, research and educational institutions, and Akershus County Council to contribute jointly to economic development. LCE members prioritize three strategic areas: renewable energy and environment technology; civil protection and security; and urban and regional development. LCE is funded by membership fees, project funding and base funding from Akershus County and Skedsmo municipality. As a driving force for improved communication, interaction and cooperation between its members, LCE's vision is to "make the region the first choice for research-driven and knowledge-based economies".



solar water heating plant covering 10,000 m². Hynor Lillestrøm, established in 2009, is one of the first companies in the world to produce hydrogen from landfill gas. They have been operating a hydrogen filling station at Akershus Energy Park since 2012, and another at Oslo Airport Gardermoen since 2015; these facilities represent pieces in the growing Norwegian infrastructure for hydrogen-fuelled cars.

Where there's a will, there's a way

As one of the world's oil-exporting countries, it is promising to see Norway's focus on R&D in cleantech and renewable energy sources (e.g. hydropower, bioenergy, solar power, geothermal and wind energy). Physically small, the dedication of Skedsmo municipality to promoting an arena for greener businesses and a platform for interaction between industry, educational and research institutes, and public actors is inspiring. It is also essential for Norway's potential to reach its national sustainability goals. Akershus County Authority adds financial support to the equation and is an active participant in, for example, efforts to establish a network of hydrogen stations.

Regional dimension

The presence of so many companies, research and educational institutions, and public actors in such a geographically small area as Lillestrøm seems to make the entire difference for Lillestrøm as a society. Job creation, a growing population and increasing tax revenue have made the society and region economically thriving. Yet the research, development and entrepreneurial processes occurring here have the potential to make a vast difference to Norway as a nation. What Lillestrøm can share is a broad spectrum of experience in social competences, such as communication and interdisciplinary cooperation, as well as scientific processes and findings, which it is hoped will help move more societies faster towards a sustainable future.

Learn more...

- Kunnskapsbyen/Lillestrøm Centre of Expertise: <http://www.kunnskapsbyen.no/engelsk>
- Hynor Lillestrøm: <http://hynor-lillestrom.no/english/>



KYMIJÄRVI II: THE WORLD'S FIRST SRF GASIFICATION POWER PLANT

Launched in 2012, Lahti Energy's Kymijärvi II power plant is the world's first gasification power plant to use waste-based solid recovered fuel (SRF) and waste wood to generate electricity and district heat. The fuel is made from plastic, wood and paper waste collected from industrial, commercial and household sources. The 160 MW plant has the capacity for up to 250,000 tonnes of SRF and waste wood per year, which amounts to about 170,000 tonnes of coal and produces about 280-300 GWh of electricity as well as 680-700 GWh of heat annually. Kymijärvi II produces 110,000 tonnes of carbon dioxide annually, whereas the same amount of energy generated with coal would produce 410,000 tonnes more.

Experimenting with gasification

Lahti Energy has used gasified biofuel and SRF as complementary fuel in their coal-fired Kymijärvi I since 1998, with positive results. At that time, the local company Päijät-Häme Waste Management was looking for ways to reduce landfill waste and started to provide waste for Kymijärvi's new gasifier. Waste incineration plants (that can only utilize waste) are exempt from carbon dioxide emissions trade, which in part encouraged the company to specialize more in developing gasification technology. After some innovative measures, the idea of Kymijärvi II was born. Lahti Energy started promoting it as a new kind of demonstration plant, and applied for aid from the EU and the Finnish state in 2006. The €160.5 million project received €15 million from the Ministry of Employment and the Economy as well as €7 million from the EU. Construction started in 2009.

Complex automation controls eco-gas production

The preparation of SRF includes excluding unsuitable materials, such as aluminium and biowaste, and shredding the waste into small strips. SRF is prepared by waste management companies in Southern Finland and sent to Kymijärvi II. The SRF is gasified, and then the gas is cooled and cleansed. The resulting "eco-gas" is nearly equivalent to natural gas in purity.

Because the energy content of the SRF varies, a complex automation system provided by Metso Ltd was

Unparalleled capacity with gas cooling and filtration

Crude waste-based gasification gas contains various impurities, such as metals, sodium and chloride, which, in addition to their environmental impacts, can damage plant machinery. The equipment corrosion problem generally related to waste-based fuels was solved in Kymijärvi II with an unprecedented gas cooling and filtration process. The gas coolers and cleaners are new technologies that enable gasification of SRF at unseen scales.

After gasification, the temperature of the gas is lowered from 900 °C to 400 °C, which causes its impurities to solidify into ash. The gas is led to ceramic filter pipes in which unwanted particles stick to the pipe walls. During regular intervals, the sediment is removed using so-called nitrogen pulses. After this, the resulting pure eco-gas is ready to be sent to an ordinary natural gas boiler to be combusted. The purification process has had some problems, which is why the plant has not been able to generate energy at full power.



constructed. The automation keeps the electricity and heat generation constant with about 200 guided motors, almost 1,000 measuring points and a price tag of nearly €10 million. In addition to SRF, the plant uses some actual natural gas, e.g., to start up the gasifier, and ignite the burners of the boiler as well as during situations when the plant malfunctions.

Regional dimension

In 2012, the Forum for Sustainable Development selected Kymijärvi II as the "Climate Deed of the Year", praising its innovativeness and replicability. The plant also won a special commendation in the Nordic Energy Municipality Competition during the same year. Energy solutions have an important role in the strategy of the city of Lahti, which includes halving the carbon dioxide emission levels of 1990 by 2025. Kymijärvi II has reduced the use of the older Kymijärvi I combustion plant, which will soon become obsolete. Before long, Lahti Energy will fully

Presently, Päijät-Häme Waste Management utilises and recycles 94% of all waste in the Lahti area and only 6% ends up as landfill.

replace Kymijärvi I and increase the usage of renewable energy, mainly biofuels from wood, with the coming Kymijärvi III.

Learn more...

- Lahti Energy: <http://www.lahtigasification.com/>



GREEN HIGHWAY LINKING ÖSTERSUND AND TRONDHEIM

Green Highway is a 450 km long stretch of road that promotes fossil-fuel-free transportation and aims to boost investment in green technology. It connects Östersund with Sundsvall (both in Sweden) and Trondheim (Norway) and consists of 222 electric vehicle charging points (13 rapid chargers and 209 standard chargers), stations selling renewable fuels (biogas, ethanol, and rapeseed diesel) and testing facilities for “green vehicles” (OECD 2012b; Tepecik Diş 2012).

One road, many partners

Green Highway was initiated as a means of meeting government targets for 150,000 electric cars in Sweden by 2020. It is a cross-border initiative driven by the municipalities of Östersund, Sundsvall, and Trondheim. Jämtkraft, Sundsvall Energy, and several other municipalities are also among the partners. Green Highway is part of the EU Interreg Sweden–Norway programme and is supported by the Trans-European Transport Networks (TEN-T). Other funding comes from several sources, including Jämtkraft, Sundsvall Elnät, and Mittuniversitetet (SEK 16.6 million for charging infrastructure) (Svensk Energi 2013) and the Swedish Energy Agency (Energimyndigheten; SEK 7.4 million). The current phase of the project (2015–2018) focuses on the development of liquefied biogas (LBG), promoting electric transportation and hydrogen-fuel cells, and establishing a sustainable business hub.

Playing to regional strengths is a winning strategy

Perhaps the most interesting aspect of the Green Highway is the way that has turned a potential weakness into a regional strength. The places linked by the Green Highway are generally low-density, small- to medium-sized towns with long commuting distances between them. Rather than fight the naturally resultant car dependency, this project has embraced it, with incredible results. Other factors that have been integral to the success of the Green Highway include:

- A political climate in which carbon neutrality is a policy priority, both in the countries concerned, and in the EU as whole

The value of spin-off projects resulting from the Green Highway has been estimated at around SEK 40 million

(Thalen 2014)

The Green Route

Thanks to the Green Highway, Östersund became the testing ground for the “Green Route” (Grön Rutt in Swedish), an innovative project from Postnord that aims to contribute to a reduction in its carbon emissions of 40% by 2020. Project manager Per Lundqvist explains the concept to Green Highway Magazine: “It’s really ridiculously easy. By moving the letterboxes and rubbish bins to one side of the street, we could reduce the distance travelled by 30 per cent” (Thalen 2014). The trial was undertaken through a partnership between Postnord, Tidningstjänst, Grön Trafik, the municipal waste management services, and the Swedish Transport Administration – and it worked! There are now approximately 400 households in the Östersund area on the “Grön Rutt” and several other Swedish municipalities have adopted the concept.

- Favourable conditions for renewable energy in the region
- Strong cooperation between many partners from different spheres (e.g. public authorities, private enterprises, and high-tech companies)
- Use of an action-oriented approach focused on achieving results along the way.

The success of the project is evident in the substantial increase in green vehicle use in both Östersund and Jämtland since the inception of the Green Highway (see figure below: Number of electric cars and plug-in hybrid electric vehicles in Östersund municipality and Jämtland County).

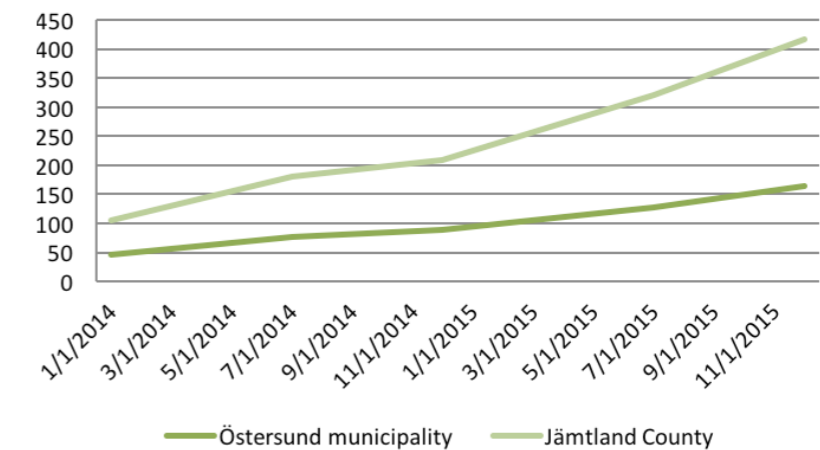
Regional dimension

The Green Highway has further strengthened cross-border collaboration as well as creating strong links between the municipalities it connects. As demonstrated in the Postnord case study, the Green Highway has also made the region desirable as a testing ground for green transport initiatives. Other examples include green vehicle testing and electric taxis. Finally, the Green Highway has become a destination in itself, thus increasing the potential for green tourism in the region.

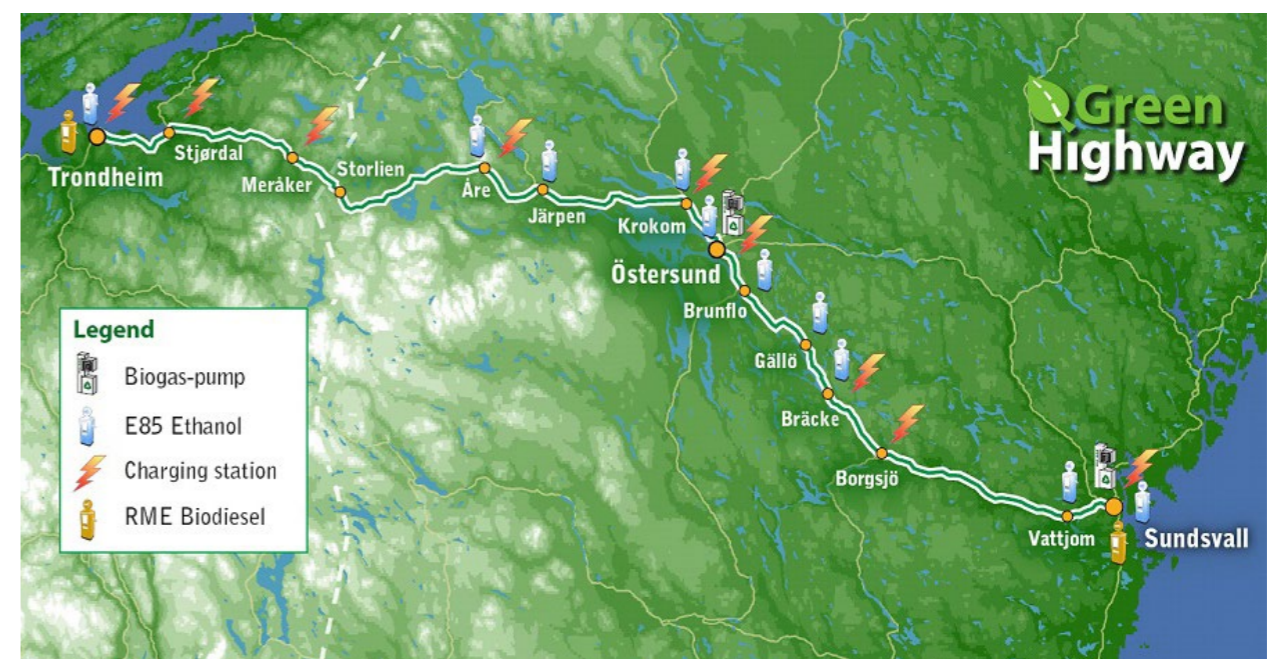
Learn more:

- Green Highway: <http://www.greenhighway.nu/>

Number of electric cars and plug-in hybrid electric vehicles in Östersund municipality and Jämtland County



Data source: Östersund municipality, 2016





GENERATING BIODIESEL FROM FISH WASTE IN ÅLAND

Fish biodiesel is a novel green energy solution that has been used by a fish farm in Åland, Finland, for several years. The biodiesel is produced using fish oil generated from fish waste. The farm has been able to successfully utilise the produced biodiesel in its own operations as well as in the public transport system in Mariehamn.

Greener and more sustainable energy with fish biodiesel

As non-renewable, environmentally harmful energy sources are estimated to run out during the coming decades, it is important to develop new, more environmentally friendly renewable energy sources. Biodiesel made from fish waste is one of these potential sources. In addition to providing carbon neutral and fossil-free biodiesel, this technology also provides a productive way to dispose of fish waste. In Eckerö, Åland, a fish farm named Storfjärdens Fisk AB has been turning fish waste into biodiesel since 2009. The company uses the fuel for its own operations and also provides biodiesel for the buses of Mariehamn. In 2013, the town became the first town in the entire world to have all of its public transport vehicles running solely on fish biodiesel. All of the town's four buses and three mini-trains operating in the summer used 100% fish biodiesel. In 2016, two of the four buses and the mini-trains still run on fish biodiesel.

If all the buses in Åland were to switch to this source of green energy, CO₂ emissions would be reduced by 1,250 tons per year – which is equivalent to the CO₂ emissions of 600 cars.

The production process of fish biodiesel

Disposing of fish intestines by other means than using them as mink feed is considered problematic. The waste contains approximately 20–30% fish oil. When producing biodiesel from fish waste, the fish oil is first separated from the waste using formic acid. When methanol and lye are added, two layers are formed: the glycerine from the oil will sink to the bottom of the tank and biodiesel is left to float on the surface of the tank. The fish biodiesel has to be washed with water and filtered before it is ready for use. The biodiesel can be used in regular diesel vehicles without needing to modify the engines and the fuel consumption is the same as with regular diesel. It has been said that the bus Torgunn in Mariehamn is now running more efficiently with fish biodiesel than it was with regular diesel.

A promising new industry for Eckerö

Even though the technology for producing biodiesel from fish waste is not new, it is still a promising field for a region like Åland where there are many small fishing villages that produce large amounts of fish waste. Storfjärdens Fisk AB has been a local pioneer in the field. The company has even developed its own esterifying equipment for washing the glycerin off the biodiesel. Its plant produces approximately 400 liters of fish



Source: Röde Orm

biodiesel a day. In a year, the plant can turn 15–20 m³ of fish oil into biodiesel. So far, the company has been using its fish biodiesel for its own operations and for the bus company Röde Orm in Mariehamn. Proper commercial sale has not been implemented yet. One of the reasons for this is the taxation disincentive: biodiesel is still taxed just as heavily as fossil fuels.

Regional dimension

In small fishing towns all over the world, biodiesel production from fish waste is a viable option in the transformation toward more environmentally friendly transport. The volume of transport in these small towns and villag-

es is rather small and there is often an abundant stream of fish waste to utilise. The example of Mariehamn aptly demonstrates that such a system has functioned efficiently in a town with a population of 11,000. For existing fish farms, fish biodiesel production is an ideal way to utilise waste while at the same time cutting operational costs. There is great potential for the growth of biodiesel production in Åland and across the world. Fish biodiesel is carbon neutral and free of fossil fuels and sulfur, which makes it a sustainable source of energy.

Learn more...

- Röde Orm (in Swedish): <http://www.rodeorm.aland.fi/> (in Swedish)



LOCAL BUY-IN FUELS LOW-CARBON ECONOMY IN SAMSO

Samsø is a 114 km² Danish island 15 km off the Jutland Peninsula with a community of approximately 4,000 people. In 1997, Samsø won a government competition to become a model renewable energy community. Today Samsø generates more electricity from renewable energy than it consumes, which results in a CO₂ footprint of -12 tons annually per capita (the average CO₂ footprint in Denmark is 10 tons per capita). The majority of the renewable energy in Samsø is generated from its 21 wind turbines (11 onshore, 10 offshore). Together, these produce 34 megawatts of electricity, which is enough to power 34,000 homes. Samsø's long-term goal is to become completely fossil-fuel free, phasing out oil, gas and coal by 2030.

From global goals to local outcomes

Samsø's journey towards energy independence began in the 1990s, when Denmark's Minister for the Environment—Svend Auken—returned from the Kyoto Climate talks with enthusiasm for reducing carbon emissions in Denmark. In 1997, Auken announced a competition asking local communities or islands to present the most realistic and realisable plan for a complete transition to self-sufficiency using renewable energy. Samsø was announced the winner and received funding from the Danish Energy Authority to formulate the details of their master plan. When the project was initiated, local wind turbines generated only 5% of the island's electricity consumption.

Strong policy support and financial incentives

The initiation of Samsø's renewable energy project in 1998 coincided with the closing of the local slaughterhouse, which employed 100 local residents on the island. Samsø's economy, which was already experiencing challenges due to a low per capita income and an increasing number of people moving away from the island, was expected to be heavily impacted by the closure. Samsø Municipality, in cooperation with Aarhus County's regional development department, saw the energy project as an opportunity to address this challenge and incorporated it into the regional development programme. The development of wind power on Samsø also aligned with the Danish national policy framework, which in the 1990s had a strong focus on the development of renewa-

“If you own a share in a wind turbine it looks better, it sounds better. It sounds like money in the bank.”

— Soren Hermansen, one of the leading proponents of wind power in Samsø

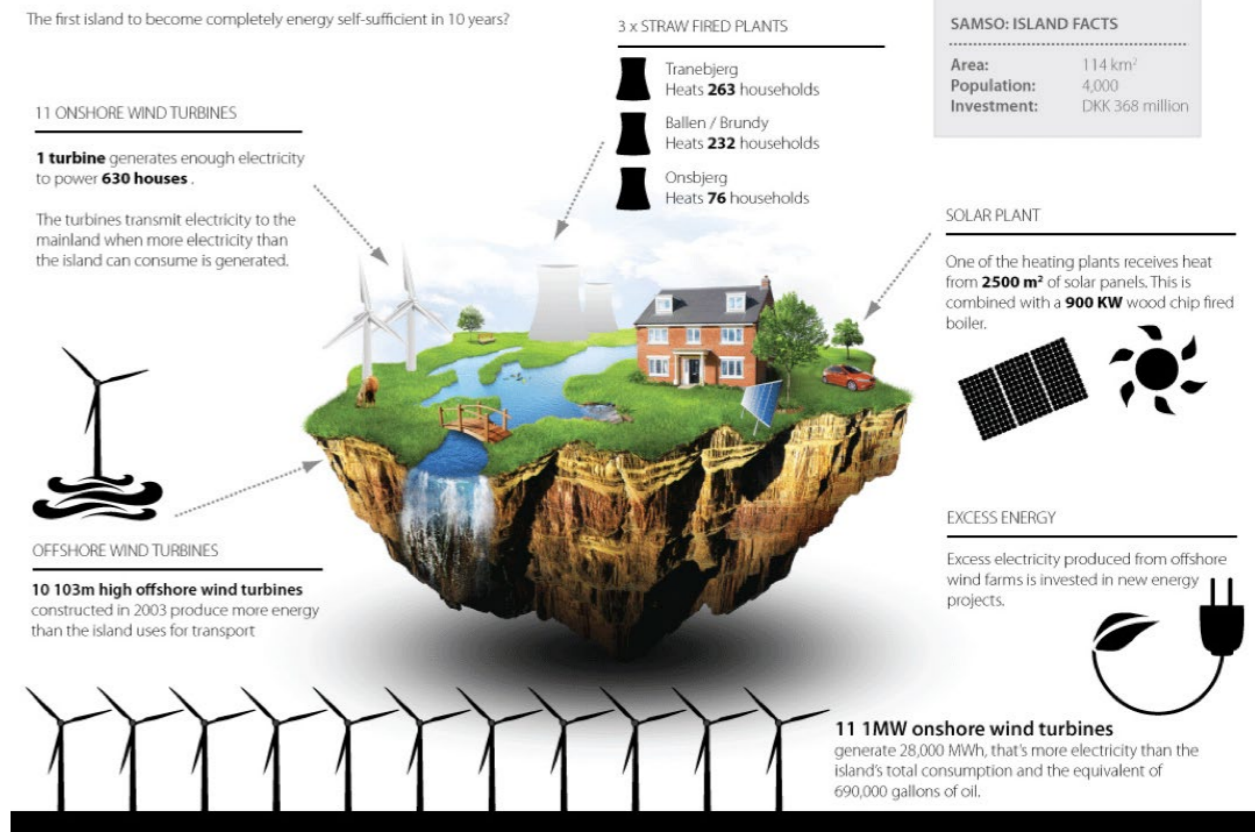
ble energy. The Danish Energy Authority only provided partial financing for single projects. The project was able to draw on national subsidies for energy efficiency and renewable energy; however, the main funding sources were local authorities, private companies and citizens. A feed-in tariff provided to owners of wind turbines provided a solid economic incentive to invest in wind power.

Regional dimension

Alongside the sustainability and self-sufficiency elements, Samsø's energy project has contributed to regional economic development by increasing tourism and creating local jobs and competence. The increase in tourism is largely due to the establishment of Samsø Energy Academy, an independent organisation established in November 2006 to support and promote

SAMSO: THE ENERGY SELF-SUFFICIENT ISLAND

The first island to become completely energy self-sufficient in 10 years?



Samsø's transition to a zero-emissions community. The Energy Academy attracts 5-6,000 professional tourists to the island every year. The centre has also strengthened regional competitiveness by contributing to local competence development. A number of local artisans worked at the slaughterhouse while it was based on Samsø, mainly because of the competitive salary. When the slaughterhouse was shut down, these artisans were able to gain the skills they needed to gain equivalent

employment in the energy project. On an international scale, Samsø has become a global example of how a sustainable community can be created through local ownership and community engagement.

Learn more...

- Visit Samsø: <https://www.visitsamsøe.dk/en/inspiration/energy-academy/>

A democratic approach and local ownership

A key lesson that can be learned from the Samsø project is that attempts to grow the clean energy economy rapidly are more likely to be successful when everyone in the community has the opportunity to participate and to benefit. Securing buy-in from residents was a core ambition of the project from the outset, with Samsø citizens engaged in the planning process and as investors in the wind turbines. Two organisations were established on the island: Samsø Energy Company, which ensured the technical part of the implementation, and Samsø

Environment and Energy Office, which handled the public participation and awareness raising. Farmers bought nine of the 11 onshore wind turbines and more than 500 people who live on the island or have summer homes there bought shares of the remaining two. Each onshore wind turbine was placed democratically. The island also has four district heating plants using straw and wood chips from local forests and fields. One plant is owned by 240 households, one by a private farmer and two by the energy company NRGi.



AMPERE, THE WORLD'S FIRST ELECTRIC FERRY

The world's first electric car and passenger ferry, Ampere, has been in service since May 2015. Ampere is powered by lithium-ion batteries and is owned and operated by the Norwegian company Norled. Ampere covers the six kilometres across the Sognefjord between Lavik and Oppedal in 20 minutes, 34 times a day, 365 days a year. The stretch of water is part of the European highway E39, about 1.5 hours north of Bergen on the Norwegian midwest coast. The installation of the electric ferry, which is recharged by climate-friendly hydropower, is an important step in the transition to carbon neutral transports.

A winning cooperation

Norway hosts a large number of ferries carrying passengers and vehicles across the country's many grand fjords and lakes. Big, heavy and noisy, they often appear as disturbing misfits in the pristine and grandiose landscapes. The Ministry of Transport and Communications therefore launched a competition in 2010 to develop the most environmentally friendly ferry. The Ministry also announced that the winner would get to operate the Lavik–Oppedal route because the concession license of the then diesel-operated ships would expire in 2015. The electrotechnology company Siemens, with 165 years in the industry and active in more than 200 countries today, teamed up with the Norwegian shipyard Fjellstrand to produce an emissions-free ferry. In an interview, the Siemens Norway engineer Odd Moen explained that

One crossing with the ferry uses 150 kWh – about as much electricity as an average Norwegian household consumes in three days.

The technical details

Ampere is an 80 by 20 metres car ferry that can take 120 vehicles and 360 passengers. The catamaran is quite substantial in size with an 11-ton battery, but it is only half the weight of a conventional ferry because it is made exclusively of aluminium instead of the normally used steel. Aluminium also means that the ship needs less maintenance, as the corrosion-resistant hull is better protected against rust and does not need any special coat of paint. Two electric engines with a combined output of 900 kW power the ferry. The lithium-ion batteries that fuel the engines have a total capacity of 1,000 kWh, which is equivalent to about 1,600 standard car batteries and has enough power to make a few return trips across the fjord. Siemens installed a 260 kWh battery at each dock to recharge the batteries on the ferry without causing temporary blackouts in the local villages where the ferry can recharge for the ten minutes it takes to unload and board passengers. The dock batteries can then slowly recharge from the medium-voltage grid before the ferry returns. Since the region's electricity comes solely from hydropower, the ship runs on fossil-free energy that is cheaper than diesel. In comparison, a conventional ferry on this route would consume about 1 million litres of diesel and emit 2,680 tons of CO₂ and 37 tons of NO_x per year.



Source: Siemens

battery-driven propulsion had been used for submarines for more than a century, so why should it not be possible to “bring such a drive system concept to the surface?” (Siemens 2016).

Public procurement plays a role

Ampere runs between two municipalities: Lavik in Høyanger municipality and Ytre Oppedal in Gulen municipality. Both are part of Sogn og Fjordane County. Installing a new type of transportation affects the local and regional infrastructure, which implies an ongoing dialogue and will to co-operate between the municipalities. The national Ministry of Transport and Communications launched the initiative and set a high environmental ambition. Because of the political will, open-mindedness, and motivation of stakeholders, an innovative, quiet and more sustainable entry won the tender.

Regional dimension

Replacing a conventional fossil-fuelled ferry with a cleantech ferry running on renewable energy brings Norway closer to achieving its national climate targets. Ampere can be the first ferry of many. Odd Moen at Siemens Norway believes that Norway can have battery-powered ferries running profitably on some 50 routes in the near future, especially as batteries become cheaper and more efficient every year. This would be a large step for Norway on its road to running on 100% renewable energy, if the nation decides to keep its oil in the ground (Siemens 2016).

Learn more...

- Setting a course for carbon-free shipping: <http://www.siemens.com/innovation/en/home/pictures-of-the-future/mobility-and-motors/electromobility-electric-ferries.html>



TOWARDS A LOW-CARBON ECONOMY IN AKUREYRI

The municipality of Akureyri with 18 230 inhabitants in northern Iceland has been working strategically in green growth over the past decade. Vistorka is a municipally owned company that was established in 2015 to facilitate the transition towards a zero-carbon future in Akureyri by providing support to start-up companies in the field of clean energy and green solutions. Vistorka's main focus is on promoting the production of renewable fuels, fertilisers and feeds from waste streams.

Natural resources and a pro-active approach

Akureyri municipality has a low-carbon footprint because of its high share of geothermal and hydropower energy in final electricity and heat consumption. Despite this, greening of the transport sector remains a challenge because of its high dependence on fossil fuels. The municipal ambition has been to phase out fossil fuels from the transport sector by producing its own local fuels using different waste streams. In 2006, the municipality shifted to an environmental focus with the decision to make public transport free of charge, which also coincided with the closure of an old landfill site. Collection of organic waste from households was introduced as a new measure, which was intended to test if people were willing to participate in such developments. The results were much better than expected. A more proactive approach has been taken by the municipal actors towards 'greener' development.

Cooperation strong but challenges ahead

A key driver for ambitious green growth work in the municipality has been a strong spirit of cooperation among the stakeholders in the municipality and their shared common vision for a green future. The initiatives have found strong backing and, in a triple helix set-up, key drivers have been private and public sector actors, academic partners from the University of Akureyri and the local community. The municipality is setting the scene for green growth through targeted investments in infrastructure for green vehicles and charging stations, procuring biogas buses, and building bike lanes. It also

The unique culture of cooperation in Iceland is perfectly characterised by the quote “Everybody is aware that we need everybody on board!”.

has an ambitious environmental policy, which will be updated in 2016.

The actors in Akureyri are working together to achieve the goal of becoming carbon neutral and fossil fuel free by 2030. Among the biggest challenges is the lack of an economy of scale in the municipality. Investments in new equipment and technology are quite high, but the market is small and biofuel production is limited by a rather low local substrate availability. To overcome this challenge, Vistorka is working on finding production synergies between small local companies to obtain a better scale for the economy of these initiatives. By co-locating businesses and combining different production processes, and sharing equipment and staff, increased production efficiency and costs reduction are possible. The estimated potential reduction of CO₂ emissions with the current investment is 15 000 tonnes/year. Carbon sequestration through afforestation and carbon capture using landfill gas contributes to further CO₂ emissions reduction by 16 000 tonnes/year. The total in-



Source: Steinþór Traustason.

Carbon neutral Akureyri

In 2009, a composting plant was built in Akureyri. The plant converts biodegradable waste from households and industries in the area into high-nutrient soil for use as fertiliser. In 2011, a biodiesel plant was inaugurated, which produces biodiesel from used cooking oil and animal fat. Its fuel output corresponds to the fuel needs of approximately 300 vehicles. A blend of 1.5% biodiesel is used locally in vessels and vehicles. Since 2014, biogas has been collected from the old landfill and upgraded to a

vehicle fuel. The most recent initiative is the reuse of plastic waste collected from farmers and industries for production of oil that can be used in large engines. The local bus service now runs on biodiesel and biogas. The municipality is continuously working on identifying valuable waste streams to increase efficiency of resource use, eliminate waste and increase biofuel production. Several projects are in the pipeline, including methane production from manure and a fat-rendering plant.

vestment in the projects over the past 6 years was €10 million.

Regional dimension

A strong focus on green growth has opened up new business opportunities and contributed to jobs creation in the area. Local renewable fuel production ensures local value creation, which stays in the region. There is a

high acceptance and support of the initiatives among the local population. Residents are willing to pay more for locally produced renewable fuel and see it as part of their social responsibility. Akureyri municipality is among the leading examples in Iceland in the recycling of organic waste and is a role model for other municipalities.

Learn more...

- Vistorka (in Icelandic): <http://www.vistorka.is/>



ENERGIGÅRDEN, A SMALL FARM FOR BIG CHANGE

The Energy Farm, Energigården, is an educational centre located in the small village of Brandbu, between Oslo and Lillehammer in southern Norway. The Energy Farm consists of newer buildings and actual farm buildings originating from the mid-1700s. Visitors can experience a number of alternatives for small- and medium-scale production and more efficient consumption of renewable energy in, on and around these buildings. Founded in 1991, over 35,000 visitors from 85 countries have been welcomed, educated and trained in decentralized and environmentally friendly energy setups.

Once bitten by the bioenergy bug

In 2013, more than 80% of the world's consumed energy was based on fossil fuels, despite the fact that about 80% of the world's known fossil reserves need to be kept in the ground for a fifty-fifty chance of staying below an increase by 2°C of the global average temperature. Therefore, steering away from fossil fuels and developing and investing in renewable energy is essential for the survival of humankind. Contributing to this transition, Erik Eid Hohle began to develop small-scale energy production from renewable energy on his family farm, Eidsalm. As a student in agriculture, Eid Hohle's interest in renewable energy sparked during the oil crisis in Norway and he became a researcher. He found that many good solutions already existed but were not applied, and decided to do something about it. In 1991, he changed the name of his mother's farm to Energigården and the farm was running on 98% renewables with 80% less greenhouse gas emissions in only a few years. Today, his son, Anders Møyner Hohle, has taken over the operation of the farm and education centre.

Connected challenges

Objectors to bioenergy say that it is wrong to use farmland for energy crops that could otherwise be used to produce food in a starving world. To this, Eid Hohle says in an interview in *Aftenposten*, that only 1–2% of the world's farmland is used to produce bioenergy today, while some 25% is used to produce non-essential foods, such as tea, coffee, wine and narcotics. In addition, an excessive portion of all food produced is lost along the value chain and as food waste from households. Meat

Sowing the seeds for a transition to clean energy

Setting up shop in an oil-exporting country has not been an easy mission, but Eid Hohle's conviction of the essentiality of transitioning to renewable and bioenergy has kept him going. The farm concept has now gone international. Rajendra Pachauri, president of IPCC, found the farm concept to be highly interesting. Pachauri is also leading the Indian–British research and development foundation The Energy and Resources Institute (TERI) and in August 2014, TERI and Energigården set up The Energy Farm International Foundation (EFIF). EFIF will work to establish a global network of competence and education centres for renewable energy, local decentralised energy production and energy efficiency using Energigården as a model. The first centre has already been established on a farm in Kenya, followed by projects in Ukraine, India, Myanmar and Croatia. Examples of solutions being displayed and developed at these centres are: a cooling system fuelled by cow dung; a heating system running on cooking oil; and solar-powered fans for drying grains after harvest. Assisting in mitigating deforestation, climate change and poverty is a strong motivator for Eid Hohle, and his aim is to establish at least 50 energy farms worldwide within a few years.



Source: Energigården

production is also in conflict, where crops that could be consumed directly by humans are instead fed to animals. Of course, food and water security is of highest importance to a growing global population on a finite planet – and so is climate change and moving away from fossil fuels. Therefore, developing and implementing small-scale, decentralised energy-producing systems that support the building of local resilience is important in both Norway and the rest of the world.

Regional dimension

Despite its small size, Energigården can play a large role in regional development of energy resilience and climate mitigation and adaptation. For example, Energigården was part of the EU project BTN (The Bioenergy Technology Transfer Network) in 2000–2006, which was established to develop and highlight good examples of sustainable use of bioenergy to help prepare regional bioenergy strategies and spatial planning processes. Energigården became a national bioenergy demonstration centre, and the EU project led to a three-year project called Bioreg Hadeland, which aimed to turn the Hadeland region into an outstanding national bioenergy region with a focus on bioenergy in practice.

In 2007, Energigården's founder received the Bioenergy Award from the Nordic Council of Ministers for efforts to increase production and use of bioenergy.

Learn more...

- Energigården: <http://www.energigarden.no/english/>
- BTN – The Bioenergy Technology Transfer Network: http://ec.europa.eu/regional_policy/en/projects/estonia/btn-the-bioenergy-technology-transfer-network
- TERI: <http://www.teriin.org/>

GREEN CITIES AND MUNICIPALITIES

Cities account for approximately 50% of the global population but over 75% world's greenhouse gas emissions (IPCC, 2014). The increasing trend towards urbanisation occurring across the globe means that both numbers are likely to rise. In the Nordic countries, over 97% of population growth over the past 20 years has occurred within the 30 largest functional urban areas (Smas & Grunfelder 2016). Given this, it is perhaps no surprise that the urban dimension receives considerable attention in the Nordic green growth agenda. Broadly speaking, the key policy areas that influence green growth in an urban context are: land use planning; transport; buildings; energy; waste; and water (Tepecik Diş 2014). The cases selected for this section are unique in that they combine all of these elements (and in some cases more!) to increase the green profile of the city or town as a whole.

The cases highlighted here range from large Nordic cities (e.g. Case 41. Copenhagen, Europe's latest "green capital"; Case 42: The City of Malmö, the bustling brother down south), to smaller, less well-known municipalities (e.g. Case 40: Eliminating carbon and creating jobs with ProjectZero in Sønderborg; Case 45: Växjö, Europe's greenest city; Case 47: Carbon neutrality in the northern municipality of Ii) and even islands (e.g. Case 44: The "Bright Green Island" of Bornholm). This publication also highlights several examples of collaborations between municipalities that aim to support increased "green activity" (e.g. Case 43: Cities of the future, Norway; Case 46: HINKU Forum, Carbon neutral municipalities of Finland).



ELIMINATING CARBON AND CREATING JOBS WITH PROJECTZERO

Sønderborg, a Danish municipality located between Copenhagen and Hamburg, wants to show the world how CO₂ reductions and economic growth can go hand-in-hand. ProjectZero is working closely with the municipality's 76,000 residents, local business and the public sector and aims to phase out all energy-related carbon emissions by 2029 – 20 years ahead of Denmark as a whole.

From rhetoric to action

The original motivation for ProjectZero was a desire to go beyond political and academic rhetoric and involve the entire community in direct action against climate change. The municipality's carbon neutrality goal was set in 2007. This was followed in 2008 and 2009 by extensive work by over 75 leading Danish energy experts who analysed a range of challenges and opportunities that formed the basis for a master plan and roadmap through which the target could be achieved. A second roadmap was prepared in 2015, and paves the way to 2020. The current road map focuses on three key 'focus segments': Community and Citizens, Business, and The Public Sector. It also encompasses three 'development themes': A Smart Grid, Bio-Economy, and Green Transportation.

Working together creates jobs and growth

When the zero emissions target was set back in 2007, 82 percent of Sønderborg's energy consumption came from fossil fuels. By the time the second road map was prepared in 2015, this number had been reduced by 30 percent – exceeding the 25 percent goal by a comfortable margin. At the same time, an independent analysis concluded that the implementation of the ProjectZero vision created approximately 800 new green jobs between 2007 and 2013. This success appears to be attributable, at least in part, to the 'everyone on board' approach taken in the plan and the strong focus on education and support for the different groups involved. ZEROhome, for example, is a program that uses home

'A green thread in education'

Education is central to the success of ProjectZero. This includes specific programs targeted at particular segments of the community. For example, ZEROcompany, a program that works with companies to reduce CO₂ emissions while at the same time retaining competitiveness, and ZEROshop, a program that works with retailers to lower carbon emissions in both their retail outlets and their supply chains (also ZEROhome and ZEROconstruction – described on next page). The project has also resulted in the introduction of 'a green thread in education' that runs from

kindergarten to Phd. The curriculum is held through Sønderborg's House of Science. It includes a focus on climate, innovation and sustainability and makes sure that even the youngest members of the community are equipped with the knowledge they need to participate in Sønderborg's green transition. At the higher levels, students from the business academy SydVest and the University of Denmark have been working with local craftspeople and companies to solve real world problems and come up with new, practically applicable, energy saving solutions.

Source: ProjectZero



Denmark's first ZERO+ house in Sønderborg produces more energy than the family who live there need

Implementation of ProjectZero's "Roadmap 2020" is expected to create 900 new green jobs every year.

visits to engage residents with the possibility of retrofitting their homes to increase energy efficiency. Alongside this, the ZEROconstruction program has trained approximately 65 percent of the area's craftsmen to equip them to install state of the art energy solution. The total investment in building improvements from private home-owners since 2007 is estimated at approximately 105 million DKK. Similar training and awareness raising programs are operating for the business community and in the public sector.

Moreover, Sønderborg's green transition has greatly benefitted from collaborating with experts and other actors at regional, sub-regional and cross-border levels. ProjectZero has placed strong emphasis on the exchange of experiences and good practices. The project results are disseminated widely and ProjectZero is engaged

in assisting other municipalities and regions in implementing the ProjectZero model globally – e.g. in China and across Europe. This not only conveys to Sønderborg's vision about climate change as a common global issue, but creates additional demand for solutions provided by Sønderborg-based experts and companies.

Regional dimension

Implementing ProjectZero has contributed massively to the course and intensity of regional development in Sønderborg municipality. By turning the challenge of climate change into an opportunity to generate inclusive growth and reduced energy consumption, significant results have been achieved. In addition to the 800 jobs already created, this 'Green Growth Engine' of Sønderborg is projected to create an additional 900 green jobs annually – 80% of which will be created in Sønderborg and South Jutland region (vast majority of them in green building and construction sector). Large capital investments are expected to occur simultaneously. Further growth potential is vested in the export of local Bright Green Business Solutions, international business participation in demonstration projects, study visits to Sønderborg and visitor spending as well as the global branding and marketing of ProjectZero's practices.

Learn more...

- ProjectZero: <http://brightgreenbusiness.com/>



COPENHAGEN, EUROPE'S LATEST "GREEN CAPITAL"

Copenhagen is a world-renowned example of a "green city", and is the latest Nordic city to receive the European Commission's Green Capital Award.¹ The green economy was one of the key factors that caught the attention of the judges. Particularly impressive is the way that the city works in partnership with private sector actors, universities, and citizens to achieve its goals. Given everything that Copenhagen has achieved, the city's continued pursuit of a green economy provides interesting insight into the future of urban green growth.

Measuring local green growth transitions

Greater Copenhagen was the test site for the OECD's local green growth indicator framework, which is designed to "score" a city's progress towards a green economy. The results of the study suggest that Greater Copenhagen is progressing well, and attributes this success to "a unique combination of elements including: the specific institutional, cultural and resource capacities of the city; the installation of the district heating system, the drive for energy security through renewable energy (particularly the wind industry) and the tradition of collaboration and consensus-building within the political system" (Martinez-Fernandez et al. 2013, p. 12-13). Despite this, there remains much work to be done. Ten key actions were identified that would support continued green growth:

1. Investing in capacity for green jobs, skills, and entrepreneurship
2. Accelerating the transfer and diffusion of new knowledge and technology
3. Fostering "disruptive" innovation
4. Enhancing funding for innovation and attracting foreign direct investment
5. Strengthening cross-sector linkages to connect global and local firms
6. Developing a bottom-up, next generation governance architecture
7. Developing a people-driven investment agenda
8. Facilitating knowledge-intensive green activities for the Cleantech Cluster
9. Stimulating education, research, and exchange programmes, and
10. Investing in indicator data collection at the local level while coordinating with national agendas (Martinez-Fernandez et al. 2013, p. 13-16).

The green sector employs 25,000 people across Greater Copenhagen and is anticipated to generate €3.64 billion between now and 2025.

Such an extensive "to-do" list may appear daunting at first, particularly to cities just setting out on their green growth journey; however, two points are worth bearing in mind. First, the indicator framework is designed to be implemented in collaboration with local stakeholders, and as a result, the outcome will reflect the starting point. Second, with respect to the green growth agenda in general, considering what comes next for a city already quite advanced in terms of green growth indicators is useful in providing insight into the future of urban green growth.

Regional dimension

As the capital, Copenhagen's green growth agenda has implications for not only the development of the region, but also Denmark as a whole. Denmark is a small country with limited natural resources, so it relies heavily on human resources as a driver of its national economy. Innovation is a large part of this, and Denmark fares well in measures of innovation both at a European and a global level. The 6,000 companies that make up Copenhagen's green sector are an integral part of this

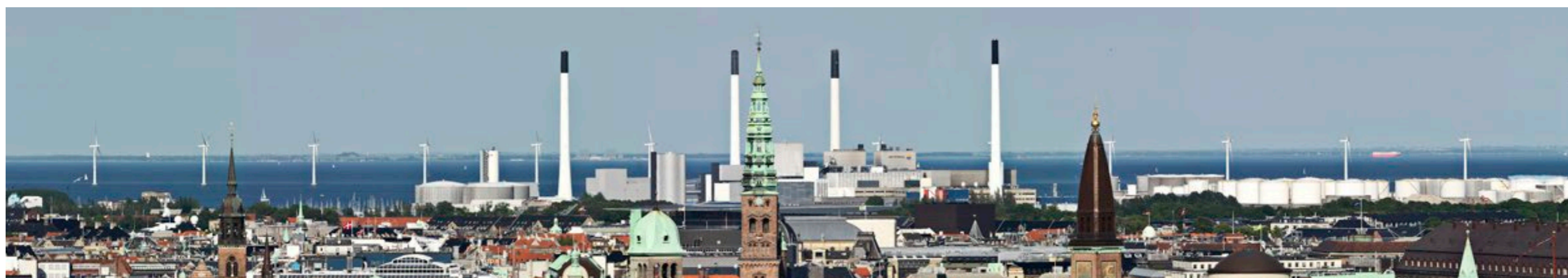
Copenhagen's green profile in numbers

- 55% of Copenhageners cycle to work or school/college
- 31% of its electricity needs are met by wind energy
- 24% cut in carbon emissions between 2005 and 2012
- 90% of building waste is reused (58% recycled, 40% used to fuel the cities district heating network)
- <2% of total waste goes to landfills
- 96% of Copenhageners live within 15 minutes of a large green or blue area
- 17% of food consumed is organic (75% in municipal organisations)
- 98% of households are served by district heating
- 25,000 people in Greater Copenhagen are employed in green industries
- €3.64 billion will be generated by the green sector by 2025
- Zero carbon emissions goal for 2025

success. The green sector also appears to fare better in unfavourable economic conditions compared with other industries. During the financial crisis, the green sector maintained a growth rate of 8% per year, while the Danish economy as a whole only grew by 1.1%.

Learn more...

- State of Green: <http://stateofgreen.com/en/profiles/city-of-copenhagen>



¹Stockholm received the inaugural award in 2010.



THE CITY OF MALMÖ, A BUSTLING BROTHER DOWN SOUTH

Sweden's third largest city is located in the lively Öresund region. Malmö has more than 300,000 inhabitants, and the region, including Copenhagen, is home to some 3.6 million people, making it the most densely populated area in Scandinavia. Formerly an industrial city of factory workers, Malmö today hosts less manufacturing and more research and development, retail and private services. With a political leadership that has been focusing ambitiously on sustainable development for some decades now, the City of Malmö is internationally renowned for its green profile. The city knows the benefits of first-mover advantage on, for example, green technology and holistic urban development.

A bumpy childhood

With a history dominated for centuries by manufacturing and heavy industry, Malmö went through a number of major crises during the economic rollercoaster ride of the 20th century. However, the many sharp turns may have endowed the city with a flexible mindset and a certain fearlessness for trying new innovations. Malmö's green development took off strongly with the construction of the new environmentally smart city district Western Harbour, initiated for the European Housing Expo Bo01 in 2001. Malmö thereby stepped onto the Swedish sustainability stage with determination – and it has remained on the frontline since. The city has invested in several large sustainability projects such as the solar park in Sege Park and the transitioning of the neighbourhood Augustenborg. However, there are also countless smaller initiatives that add up to a large total. Much of the success can be attributed to ambitious and bold politicians, and to the continuous dialogue with and inclusion of the residents in the various neighbourhoods.

The City of Malmö has set the goal of becoming a climate-neutral organisation by 2020, and for the entire city to run on 100% renewable energy by 2030.

Leading by diversity

In support of its extensive and varied efforts for sustainable urban development, the City of Malmö has taken part

Circular clouds and growing mussels

Two interesting initiatives can be noted as examples of the City of Malmö's bold, curious and open-minded attitude. One is the city's public-private cooperation with the company off2off, which offers a cloud-based communication tool to identify unused furniture and inventories at different public workplaces, matching them with demands from other workplaces, and redistributing the items for continued use. Over the course of one year of this circular business project, the City of Malmö saved the annual equivalent of 15 teachers' salaries, the CO₂ emissions from 60 cars and the electricity consumption of 57 electrically heated villas. The project is now scaling up and can be easily replicated in other municipalities, regions and countries. The other initiative concerns reducing eutrophication in the Öresund strait, for which the City of Malmö is growing mussels to support the ecosystem services the mussels provide. The mussels live off nutrients in the water, and when harvested they can be used as feed for livestock or to produce biogas in Sweden's only biogas plant specially designed for marine biomass, located in Trelleborg.

in or led the development of several management tools and policies. For example, Malmö co-operated with WWF Sweden in 2010–2012, which resulted in an improved cleantech strategy to develop the city as a trial location for globally interesting environmental innovations. The city also collaborated in the improvement of the tool REAP, developed by the Stockholm Environment Institute to retrieve data on ecological and carbon footprints at local level. The City of Malmö has also established the Institute for Sustainable Urban Development in collab-

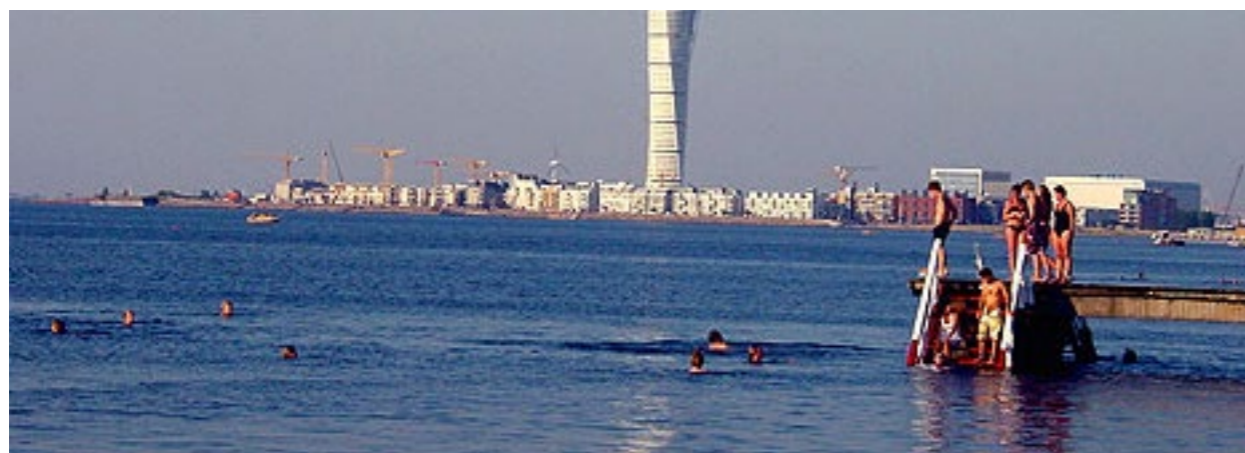
oration with Malmö University as a hub for knowledge and experience exchange on urban redevelopment processes. Significant for the city's sustainability work is also the strong emphasis on social sustainability to stem its increasing social gaps and health inequality. The city appointed a commission to investigate how to address these issues, resulting in two overarching recommendations that the City Executive Board has endorsed: establishing a social investment policy that can reduce inequities, and changing processes by creating knowledge alliances and democratised governance.

Regional dimension

The case of Malmö demonstrates the benefits of a fresh perspective when considering the environmental sustainability and liveability challenges faced by cities today. Instead of viewing the environmentally sustainable city as an overwhelming endeavour accompanied by large investment needs, the City of Malmö's leadership saw an opportunity to create a better place to live. Malmö's green transition started with the rejuvenation of the old industrial city and, as a consequence, sustainable urban development has advanced in Malmö during the last two decades. This is largely due to the long-term strategic work undertaken by the City of Malmö, which began in the 1990s as a response to the economic restructuring process necessitated by the decline of industrial production and engineering in Malmö. Today, Malmö has long-term strategies and policies in place to create a greener city with a particularly strong hub of cleantech companies. It is a solid example of a city that fruitfully combined efforts to reduce carbon emissions with a focus on improving the liveability for their citizens.

Learn more...

- Malmö Cleantech City: <http://www.malmocleantechcity.se/in-english/>
- off2off case study: <http://www.off2off.se/referenser/case/>



Source: Malmö City



Source: Malmö City



CITIES OF THE FUTURE, NORWAY

Perhaps one of the most comprehensive cases in this collection, the governmental project “Framtidens Byer” (“Cities of the Future”), involved Norway’s 13 biggest cities in an urban development project to reduce greenhouse gas emissions and make the cities nicer to live in. The project ran for seven years, 2008–2014, and had five main themes: improved urban environment; urban planning and transport; energy in buildings; consumption and waste; and climate adaptation. The most important effect appears to be the establishment of several successful networks in and between the five themes, and between not only the 13 cities but also essential actors such as industry, NGOs, and academia.

Improving the cities to improve the nation

While about half of the world’s population lives in cities today, cities account for 80% of the world’s greenhouse gas emissions. In Norway, 80% of the population lives in urban areas, so if the cities can reduce their emissions it would make a large difference. To ensure that Norwegian cities pollute less, be better prepared for the forecasted climatic changes, and be healthier places to live in, the Norwegian government launched the project Framtidens Byer together with the nation’s 13 biggest cities. The cities involved in the project were Oslo, Sarpsborg, Fredrikstad, Bærum, Drammen, Skien, Porsgrunn, Kristiansand, Sandnes, Stavanger, Bergen, Trondheim, and Tromsø. Beginning in 2008, the participating cities are described to have been “blank sheets” in many respects, but they have all improved swiftly with local initiatives and adjusted public policy. The success of the project can be largely attributed to the dialogues and platforms for knowledge-sharing that many of the people involved took part in, and that are celebrated as the main take-away message from the national venture.

Taking the time to talk

Throughout the report summarising the seven-year project are examples of networks and the important role they have played for the success of various initiatives within the themes. Many of the networks have interacted via platforms for exchange of knowledge and experience, and it seems providing venues for these in-

Through their own greenhouse gas calculation project, the city of Trondheim found that 80% of its emissions come from municipal procurements of goods and services.

teractions has been of high priority. It also appears that this project has been perceived as a joint venture for the common good, which encourages mutual support and the sharing of resources. If launched as a competition, it could instead have supported self-centred and protectionist behaviour and had the opposite effects. Many good lessons on constructive communication and cooperation can be learned here. For example, something many of the municipal employees have come to realise is the impact potential for improved sustainability by the city through public procurement processes.



Source: stateofgreen.com

Many small initiatives making a big national difference

The improvements of the cities’ greenhouse gas emissions – and liveability – have been reached through various local initiatives and 25 pilot projects. For example, within the theme of urban planning and transport, much focus has been put on cyclists and public transport, creating meeting spaces, and improving the cities’ capacity to handle increased amounts of rain. Urban areas have been made denser and greener, not only to improve the cities physically, but also to help the inhabitants live healthier lives. As one initiative, Finans Norge cooperated with the climate adaptation network of Framtidens Byer to assess data from insurance compa-

nies with the aim of averting future water damage in the municipalities. Money has been granted to improve public parking policies; water runoff is now used to support urban biodiversity; all the cities have district heating and plans to extend it; tools to calculate and create greenhouse gas budgets for buildings have been revised; efforts have been made to have as many public and private actors as possible acquire environmental certifications; etc. The list of ideas and initiatives is long, the number of actors involved is even longer, and the compilation of good results and valuable lessons learned is ever growing.

Regional dimension

Apart from the obvious, positive, and physical effects of climate mitigation, climate adaptation, and more sustainable behaviour, an important outcome of this project has been improved communication between cities, regions, and the state. The established networks and connections, as well as the practical cooperation between various actors – vertically as well as horizontally – can be used continuously to improve regional development.

Documenting the development of the fruitful frameworks and processes of communication and making the information freely available and easily replicable is therefore of high importance in sharing the format with other regions and nations.

Learn more...

- Framtidens Byer: <http://forbildeprosjekter.no/framtidens-byer1>



THE “BRIGHT GREEN ISLAND” OF BORNHOLM

Bright Green Island is a partnership between Bornholm Regional Municipality, local industry and other authorities that aims to make Bornholm Island sustainable, renewable and environmentally responsible by 2025. The actors behind the Bright Green Island strategy want to show the world that technology, design and creativity are not just for big cities. The strategy takes a holistic approach by including sustainable business, good living, smart island (i.e. energy technology) and green destination elements (i.e. tourism) in its vision (see figure: Bright Green Island: Strategic focus areas).

A strengths-based approach

The conception of what was to eventually become the Bright Green Island strategy began in 2007 in response to an economic downturn resulting from the decline of traditional industries in Bornholm, such as fisheries, farming and heavy industry (Worldwatch Institute Europe, nd.). Local actors came together with a common goal: to go beyond simply addressing the challenges associated with being a small island community and instead turn these challenges into a competitive advantage. The result was a bold strategy that turned Bornholm into a testing ground for renewable energy, green business ideas, behaviour change programs and sustainable tourism strategies.

One strategy, many innovations

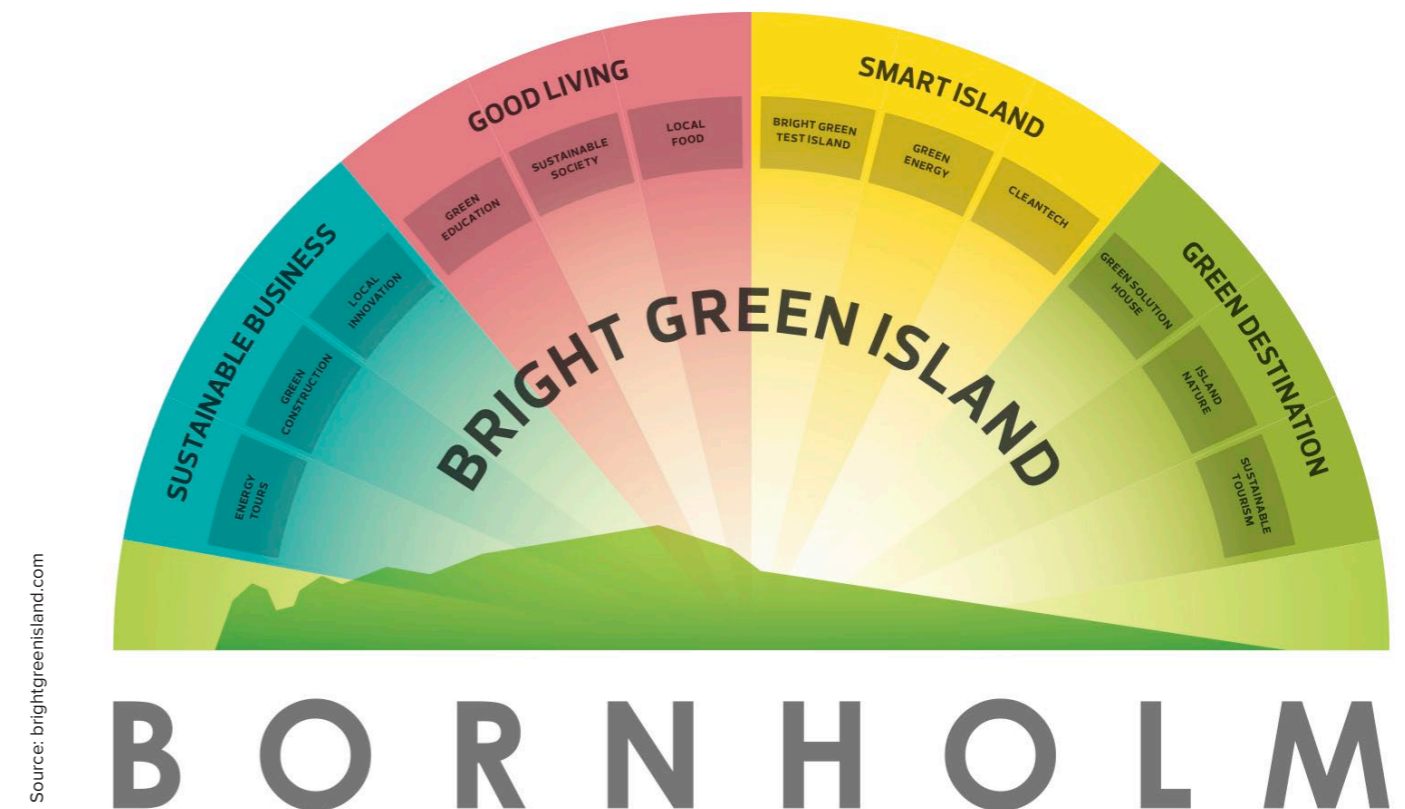
Bright Green Island is underpinned by a clear strategy that was developed through a transparent and collaborative process. The Regional Municipality of Bornholm and the Bornholm Growth Forum have been key actors driving the implementation of the strategy; however, the collective commitment of public and private sector actors across the island have also been vital to its success. The holistic approach, incorporating the four dimensions, ensures that responsibility is shared across a range of sectors. The strategy has a strong focus on innovation; examples include the construction of a “green solution house”, a conference and knowledge centre built almost entirely of biodegradable material, and

EcoGrid

A central element of the Bright Green Island strategy is the 2025 target for an island run entirely on renewable energy. Bornholm’s power grid has only a single point of connection to the rest of the world and thus can be easily isolated. This, along with its geographically favourable position, small population (40,000 people) and already high share of renewables, make it an ideal testing ground for new energy technologies. One such project is EcoGrid, an EU Consortium initiated by Energinet, a non-profit enterprise owned by the Danish Climate and Ener-

gy Ministry. EcoGrid uses real-time price information to encourage regulation of electricity use based on peak and off-peak rates of supply. The pilot project involved 2,000 (approximately 10%) of Bornholm’s households who were encouraged to adjust their energy consumption based on a real-time energy price provided by “smart” meters installed in their homes. The first phase of the EcoGrid project is now complete and a second phase, EcoGrid 2.0, commenced on January 1, 2016 (EcoGrid, nd.).

Bright Green Island: Strategic focus areas



creation of a consolidated food brand that allows many local producers to sell their goods on the international market under a single brand. Initiatives under the strategy have attracted considerable funding from a range of EU programmes.

Regional dimension

Bornholm’s strategic decision to turn its regional challenges into a competitive advantage appears to be a winning one. Since conception of the strategy, Bornholm has become the site of many pilot activities across a range of sectors and is attracting considerable international attention. Overall, activities in green technology and construction are increasing on the island and an assessment by the regional development authority

Bornholm aims to become a 100% sustainable and carbon-free community by 2025.

found that there is great potential for further growth in this area (Hestbæk 2012).

Learn more...

- Bright Green Island: <http://brightgreenisland.com/>



VÄXJÖ, “EUROPE’S GREENEST CITY”

Växjö has a population of 85,000 and is often referred to as Europe’s greenest city. Characterised by considerable environmental degradation prior to the 1960s, the city has since undergone a major transformation. It is now predicted to become the first city in the world to achieve total fossil fuel freedom (C40 Network 2011). This shift has been achieved through a multifaceted policy approach, large-scale investments in renewable fuel technologies and housing infrastructure and a collaborative approach that includes partnerships between the city council, industries, transport companies and citizens.

The road to sustainability

Växjö’s pursuit of sustainability dates back to the 1960s. Around this time, the city launched a broad effort to clean up its surrounding lakes, which were heavily polluted and considered unsafe for swimming. The next major milestone came in 1980, when Växjö achieved positive results using biomass for district heating. The 1990s saw the release of United Nations Agenda 21 (1992), a voluntary large-scale action plan involving pollution control and atmospheric protection among its social and economic themes. A number of Växjö’s city leaders were inspired by this document and in 1996 Växjö became the first city in the world to set the goal of becoming fossil-fuel free by 2030. A new Environmental Programme was introduced in 2006, with key themes in transportation and energy, water and conservation as well as consumption and waste.

Clean energy production and resource efficiency

CO₂ emissions per capita in Växjö in 2014 (2.4m tonnes) were less than one-third of the EU average (7.3m tonnes), suggesting that the environmental measures taken by the city have had a positive impact. More than 90% of the energy used for heating and about half of all electricity used in the city is derived from wood waste from the local forest industry. Sandvik (Växjö Energi AB), a large, woodchip-fuelled, combined heat and power plant, provides electricity for 29,000 customers and heat for 6,500 customers. Centralised district heating and cooling systems form a 350km network, and households outside it are also offered renewable energy solutions for heat production. Some energy is imported from outside the city, with hydropower as the main source.

Växjö has also implemented ecoBUDGET, an Environ-

Before they were cleaned up in the 1960s, the pollution levels of Växjö’s surrounding lakes caused the fish to be inedible and the water unsafe for swimming.

mental Management System for planning, monitoring and reporting the consumption of natural resources within the municipal area. Various efficiency standards have been imposed on new buildings, such as smart metering of energy consumption, energy efficiency training for local builders and special requirements for ventilation and insulation. It is estimated that new buildings will be carbon neutral by 2030 and the whole city by 2050.

Despite Växjö having an average car occupancy rate of almost three, transportation will be the most difficult obstacle to reaching the goals of 2030. In addition to biogas, the potential for ethanol and biodiesel technologies and electric cars is being studied. Moreover, large investments in projects with long payback periods, such as passive housing systems and district heating expansions, are still problematic because of the short-term time frames of the market, and can make the debt load of city-owned companies unattractive to the private sector.



Source: www.vaxjo.se, photograph Mats Samuelsson

Biogas from sewage fuels public transport

the Sundet sewage water treatment plant in Växjö produces biogas from organic waste collected throughout the municipality. This biogas is used to fuel public transport and other municipal vehicles. The plant is the first in Sweden to adopt a thermal hydrolysis system, which allows for an increase in specific methane production efficiency of at least 15% by increasing the degradability of biowaste. The whole process (including the hygienisation phase) runs on renewable energy (e.g., wood pellets) and resulting biosolids are used as REVAQ-certified fertiliser in agriculture.

Regional dimension

The steps taken to actualise Växjö’s environmental goals have resulted in extensive collaboration between the city administration and a range of stakeholders, including industry, not-for-profit organisations and, of course, local residents. This has led to a culture of sustainability that permeates the city at every level and has the power to withstand changes in political leadership. Environmental education is integrated into schooling early on and the city council offers environmental information sessions and programmes to businesses.

Learn more...

- Växjö Municipality: <http://www.vaxjo.se/>



HINKU FORUM – CARBON NEUTRAL MUNICIPALITIES OF FINLAND

HINKU Forum, or “Carbon Neutral Municipalities Forum” in English, brings together municipalities, businesses, citizens, and experts with the aim of reducing greenhouse gas emissions and creating carbon-neutral municipalities. Participating municipalities are committed to resource efficiency and plan to reduce CO₂ emissions more rapidly than at European Union-mandated rates. HINKU Forum started as a project of the Finnish Environment Institute in 2008. The project, which started with five municipalities, now includes 32 municipalities with a combined population over half a million people.

Local climate work

Becoming a HINKU-municipality involves fulfilling certain criteria such as committing to lower emissions at all levels – from citizens to businesses and other stakeholders. A HINKU municipality must, for example, commit to lowering greenhouse gas emissions by 80% by 2030. HINKU municipalities must also form a HINKU-committee, sign an energy efficiency contract with the Ministry of Employment and Economy, and take into account the climate and environmental aspects in all aspects of decision making. The HINKU Forum is coordinated by the Finnish Environment Institute and has several partners, such as the Association of Finnish Local and Regional Authorities, Finnish Funding Agency for Innovation, the Ministry of Employment and the Economy, as well as many private companies.

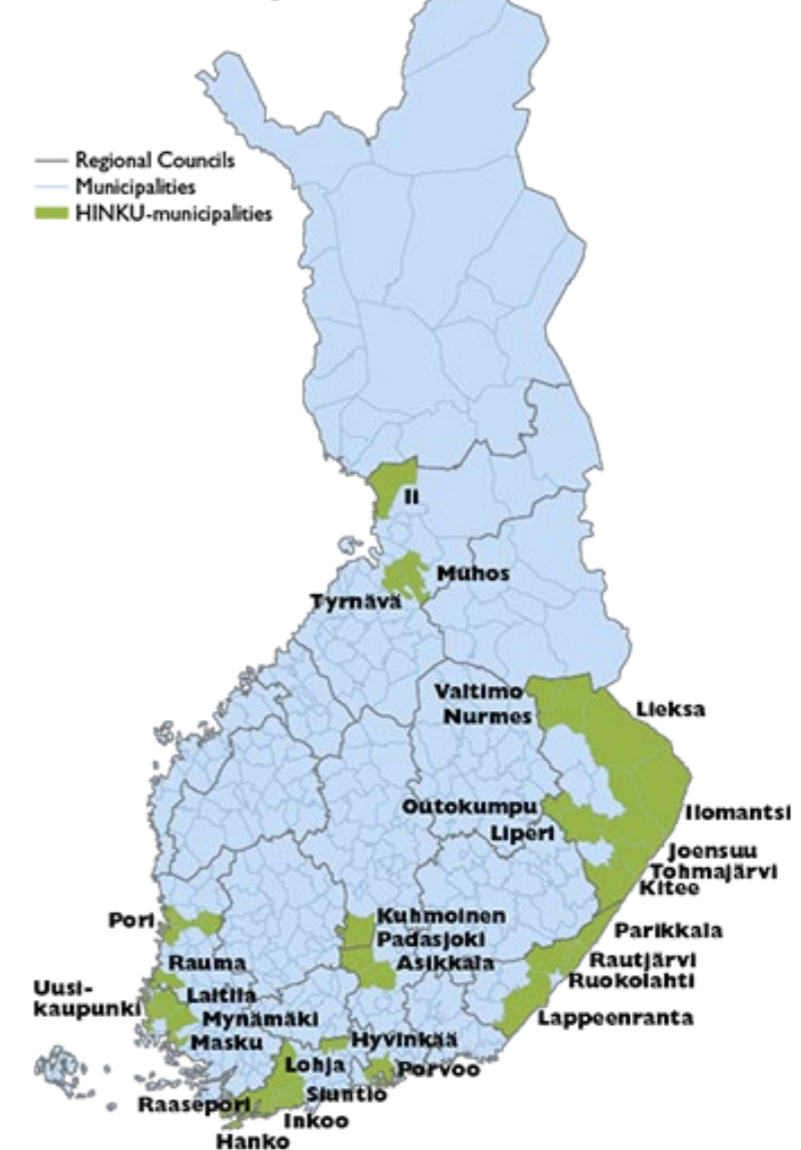
Sustainable solutions

HINKU Forum activities have had some significant results. In the years 2007–2013, HINKU municipalities’ emissions were lowered by 21%. The municipality of Ii fared the best, lowering emissions by almost 70% (see Case 47). In addition to the benefits of climate change mitigation, HINKU Forum activities have also provided financial benefits for the municipalities. The municipalities of Ii and Padasjoki, for example, have saved hundreds of thousands of euros through reduced oil consumption after adopting renewable energy solutions. When reducing greenhouse gas emissions becomes a primary goal

The largest solar panel order ever in Finland was made through the cooperative efforts of four municipalities and 20 private persons in the HINKU framework.

for municipalities, it also increases interest in green business. This creates a positive cycle whereby municipal operators, residents, and businesses work together to reduce greenhouse gas emissions. In fact, this type of cooperation between stakeholders is a cornerstone of the HINKU Forum. The HINKU model provides a fine example of concrete actions to mitigate climate change at the local level in Europe.

HINKU-municipalities



Source: The HINKU Forum

Regional dimension

The HINKU Forum is unique in that it encourages municipalities to work together to achieve individualised goals around carbon neutrality. Collaboration between municipalities opens the door to networking opportunities and allows good practice to be shared nationally and internationally. The forum has developed tools such as “HINKUMappi”, where partners can share best practices and “Hankintamappi”, a public procurement database focused on clean energy solutions. Actions realised in municipalities are diverse, ranging from better bicycle lanes to town halls heated with renewable energy.

At the local level, the purpose of the HINKU Forum is to strengthen local cooperation and improve wellbeing

through energy efficiency and new business opportunities. As the local authority, municipalities play an important role in promoting renewable energy use. At the same time, municipalities can save money through energy efficiency. Municipalities can also support local cooperation within the business community based on its own experiences of the benefits of emission-saving activities. When local businesses see energy efficiency as an everyday matter, emission cuts and new solutions become naturally sustainable.

Learn more...

- HINKU Forum: <http://www.hinku-foorumi.fi/en-US>



CARBON NEUTRALITY FROM THE NORTHERN MUNICIPALITY OF II

Ii is a municipality of approximately 10,000 inhabitants just north of Oulu in Northern Ostrobothnia. Ii has been a member of the HINKU Forum since 2011 and has had some interesting experiences in its journey to becoming a carbon neutral municipality. Ii's mission is to increase the use of renewable energy and to improve energy efficiency in its municipal operations, businesses and households. These goals have three key components: activating investment in renewable energy sources, decreasing dependence on oil and economic improvement through decreased CO₂ emissions.

A positive circle

Ii's journey to carbon neutrality began with inquiries from the business community about the feasibility of installing wind turbines in the area. Ii is an ideal spot for wind-power production due to its favourable location near major infrastructure and the sea and its abundance of uninhabited areas. The municipality then got behind the initiative, considering renewable energy an ideal way to create jobs, cut costs and increase investment in the area.

Just start doing it!

Energy efficiency and local energy production are key to Ii achieving carbon neutrality. Concerning specific initiatives, Ii's approach is to first pilot and measure, then to upscale and implement. Starting on a smaller scale encourages people to just start doing things and learn in the process, says Ii's Mayor Ari Alatossava.

In the beginning, attracting investment to support renewable energy and energy efficiency was somewhat challenging. However, now that the return on these investments has been firmly established, they have become part of everyday life in Ii.

Innovative ways of improving energy efficiency have also been found. For example, devices that measure heat and lighting have been installed in schools. Students themselves can think of and implement ways of saving energy. When the school saves energy through these actions, half of the saved amount is given back to the school and can be used for things like class trips. This creates a positive incentive for further saving measures.

Kuivaniemi heating centre and woodchip terminal

The aim of the Kuivaniemi heating centre and woodchip terminal is to increase wood usage in energy production. A project is under way to replace four district heating boilers with a bioenergy plant, which will be finalised during 2016. It is estimated that the terminal will create 30 new jobs in the logistics chain. Moreover, it is calculated that this initiative will reduce CO₂ emissions by 1,926,900 kg per year and reduce the consumption of oil by over 10,000 MWh.

Regional dimension

Ii's decision makers believe that concentrating on these tasks will not only cut the cost of municipal operations but will also create more jobs and therefore make Ii a more attractive municipality for new inhabitants and businesses. Focusing on energy efficiency in Ii has produced significant results. For example, it has been estimated that the local economy gains €300,000 per year just by replacing imported oil with local renewable energy.



© Jorma Kauppi



© Ii Municipality

Ii has six fully electric vehicles that are used for municipal operations such as delivering the post and the home care service.

The municipality has also promoted a participatory approach as an important component in generating local green growth. Some wind turbine projects in Finland have failed as a result of public resistance. In Ii, wind turbine companies must first contact landowners and discuss the potential environmental, noise and landscape effects with them. Only if the landowners and the municipality come to an agreement is the planning process started. Cooperation is the key here – the municipality will not make decisions without consulting the residents first.

Learn more...

- Municipality of Ii: <http://www.ii.fi>





SKJUTSGRUPPEN RIDE SHARING MOVEMENT

Skjutsgruppen is an organically grown movement that has gone from naught to international recognition in just a few years, solely through the activities of its participants. Skjutsgruppen has as its main focus to spare the environment while helping participants to save money and grow new social connections through increased trust between strangers. As a non-profit entity, it stands out in the collection and has many lessons to share, for example, on values-based operations and communication, as well as successful regional network management and transparency. Fostering a vivid participatory culture with high-tech digital platforms, it stands as an inspirational role model for sustainable business networks and collaborative economics.

Rolling forward together

Interested in both environmental and social issues, Mattias Jägerskog managed to combine these when deciding to start the small social experiment Skjutsgruppen in 2007. Friends invited friends to share rides, motivated by their unchanged motto “to come closer to each other” – both mentally and physically. Today, the non-profit ridesharing movement has more than 60,000 participants in Sweden and forms a growing community internationally, although the digital platform is still in Swedish. Skjutsgruppen also welcomes buses, trains, and sailing boats, and anyone can join the movement to ask for or offer a shared ride for commuting, long distance trips, going to events, or for road trips abroad. At Skjutsgruppen’s heart is the movement’s participatory culture, meaning everyone involved is neither a user nor member nor consumer, but rather participant and cocreator of everything Skjutsgruppen does – from crowd funding the platform to organizing the movement as a non-profit group.

Collaborating for a greener economy

Working with the development of Skjutsgruppen, Jägerskog developed his own understanding of collaborative economy and its potential as a foundation for a more sustainable society. Applicable to most things, a collaborative economy encourages the use of “idle capacity” – in this case, mainly empty car seats. Since the movement has grown so large, it affects not only individuals’ use of seats, but the societal service of transportation. Instead

International Ridesharing Day (Samåkningsdagen) was celebrated in 17 countries in October 2014.

of seeing Skjutsgruppen as a competitor in a conventional market, the way of the future could be to see it as an important actor for mobility management cooperation. Open-minded players, such as municipalities, villages, festivals, and local public transport companies, have already had constructive cooperation with the participant-driven movement. Recently, Skjutsgruppen also launched Europe’s first search engine combining offers from public, nonprofit, and private actors, as they started collaborating with the global car rental firm Hertz.

The initiative has been criticised for having more people travel by car rather than by bicycle, waiting for the bus, or not going at all. However, these attitudes are put into perspective when considering the total emissions reductions that result from increased ridesharing along with the invaluable positive social effects.



Source: www.facebook.com/skjutsgruppen

Driving development of trust

On the theme of trust and social sustainability, the fun stories from ride sharers of new encounters and unexpected friends seem endless. Simultaneously, the effects of increased wellbeing from improved social contact and sense of belonging have a high value for society, but are difficult to measure. One example was when a couple who had been active in Skjutsgruppen for three years were inspired by their good experiences and started a dinner group for unaccompanied refugees. Trust between citizens is vital to a healthy society, and Jägerskog believes much of Skjutsgruppen’s suc-

cess is in its transparency. For example, when you look into a potential ride on the homepage, your social connection to the driver or rider is shown by how your friends are connected on Facebook. By knowing that my friend is friends with your friend, I feel more trust in you than by reading endorsements by people who are unknown to me. According to a theory, all people on Earth are connected by at most six degrees of separation – Jägerskog says in Sweden it is rarely more than four degrees, which is why the road to a society with strong mutual trust should be shorter for us.

Regional dimension

In some regions, Skjutsgruppen is definitely an apparent actor in transport and a good source of increased social values. For example, it has cooperated with over 30 municipalities in Sweden, such as Umeå. However, its geographic activity is completely dependent on the number and activity of its participants. The core team, driving the management and development of the movement, is a group of professionals who could provide impor-

tant input for regional social and mobility development. Additionally, being transparent, strong in its values, and believing in open source knowledge, Skjutsgruppen is at the forefront of driving societal development for the common good using new ways of financing and models for cooperation.

Learn more...

- Skjutsgruppen: <http://skjutsgruppen.nu> (in Swedish)



AARHUS, THE SECOND CITY IN THE LEAD

Aarhus is Denmark's second largest city, located on the east coast of the Jutland peninsula at the same distance from Copenhagen as from Hamburg. As a green city, Aarhus is not only striving for successful climate mitigation, but has also made great progress on climate adaptation. For example, Aarhus University has researched how to turn the potential risk of increased rainfall into an opportunity to develop new recreational areas. One of the best cities for bicycling in the world, Aarhus is also a strong player on the global wind energy market and intends to be carbon neutral by 2030.

With the wind at our back

Founded by Vikings in the 8th century, Aarhus is today a city with an interesting history and plans for the future. The fast-growing city is home to 320,000 inhabitants, of whom more than 50,000 are students – Denmark's highest percentage of students in relation to the total population. Surrounded by a high percentage of agricultural land, cleantech companies and research institutes, Aarhus City Council was visionary enough to decide on making Aarhus a carbon neutral city by 2030. The City realised that the diversity of participants and solutions is key; therefore, part of the plan is to get citizens, academia and enterprises to join the agenda. Important

measures are to reduce energy consumption and increase the share of renewable energy sources. This is where the city's love for wind comes in. Aarhus already hosts several wind power industries and there are plans to erect more wind turbines. The City aspires to be "a solid testing ground for wind technologies" and supports the establishment of smart electricity infrastructure that can utilise wind power as the main energy source.

Clusters, culture and change

One of the successes of Aarhus as a green city is the active participation and cooperation by so many different

Studstrup Power Station, which provides Aarhus' residents with 80% of their district heating, is being converted from coal to biomass because of a new bill passed by the Danish Parliament.



actors in the area. Two examples are the wind energy cluster covering the entire value chain regionally and the new school, Navitas, where 2,000 engineering students, teaching staff and researchers will share space with 400–600 employees connected to the INCUBA Science Park. For example, if the municipality or a company pushed for society's transition to sustainable resources on its own, not much would change. However, the outcomes will be different when people come together, make resources available and see the good use in constructive communication based on sustainable values. Another angle for pushing a social transition is to see the sustainability potential in every case. For example, Aarhus has been elected the European Capital of Culture for 2017, and will take the opportunity to show the necessity of connecting culture, art and sustainability for a thriving future urban society.

Regional dimension

As banks, companies, universities and municipalities divest from fossil fuels one after the other, and the world's political leaders subsequently raise climate ambitions and sharpen sustainability legislation, Aarhus has its aim set true. Already a focal point for wind turbine production and renewable energy research, Aarhus also has many lessons to share on sustainable urban mobility and cross-sector cooperation. Laying the foundation for improved health and life quality, achieved climate goals and future jobs in several sectors is just the beginning of what Aarhus can mean for the region and for Denmark as a nation.

Go at your own pace

As a fairly concentrated city in a relatively flat country, Aarhus had something of a head start in becoming one of the world's best cities for cyclists and was also an early adopter of creative methods to encourage more inhabitants to choose the bike instead of the car. The City has gone from building Denmark's first bicycle lanes to creating a sustainable mobility plan: offering e-bikes and commuter bikes for rent; free air stations for pumping bike tires; a city map app for cyclists; and, since 2013, city bikes. The 450 city bikes are available from April to October and can be found at 56 locations throughout the city. Usage is free but a 20 DKK (€2.70) coin is needed as deposit. However, late-night cyclists need to bring their own bike lights. This type of municipal bike-sharing system is found in several cities all over Europe today, but Aarhus began investigating the possibilities in 1999, which shows the city's affinity for being a first-mover.

Learn more...

- City of Aarhus: <https://www.aarhus.dk/da/omkommunen/English.aspx>
- Smart Mobilitet Aarhus: <http://www.smartmobilitet.dk/>

Source: <http://www.smartmobilitet.dk>





BRIGHT GREEN FORSSA REGION

The Forssa region is a lively Finnish sub-region consisting of five municipalities. It has around 35 000 inhabitants and is located almost in the centre of a triangle defined by the three largest major cities in Finland (Helsinki, Turku and Tampere) in the province of Southern Finland. The Forssa region is known for its regional Bright Green approach, in which the focal areas are self-sufficient environment and energy, well-being, technology and green logistics. The Forssa region also facilitates one of the most advanced industrial symbiosis in Finland.

From grains to symbiosis

The Forssa region constitutes a significant grain-production area. Building on this local resource, municipalities and regional actors have consistently aimed at creating a competitive regional pool of expertise and companies – both local, national and multinational – with environmental sustainability as their guiding principle. The regional industrial symbiosis is based on the production and utilisation of grain, and the circle involves everything from industrial biotechnology, bioethanol and biogas production to pig feed, fertilisers and the production of glass wool and construction material. Most of the energy required in the process is produced locally from renewable resources such as peat and wood chips.

The regional actors believe in the power of symbiotic practices and cooperation and invest in the future with the goal of creating an efficient, practical Bright Green operating environment. There are currently numerous long-term projects underway in the area with goals such as promoting greener logistics and bioindustries.

Facilitating a greener region

The Bright Green strategy of the Forssa Region is based on the view that a green approach should be considered in all business operations. Besides green businesses, the regional strategic programme emphasises bioeconomy and sustainable use of natural resources.

This regional approach calls for significant investments from all operators. The Forssa region's preparedness for environmental business is realised in the sufficient availability of business premises, business subsidies, supply of education and training, skilled labour, know-how, a strong expert network and an ideological commitment to green solutions. The Envitech area is also

The recent wind-power park project in the Forssa region can create employment worth 200–400 man-years during the construction phase and employ 10–20 people once the park is operational.

known for active public–private cooperation and intensive networking.

The Bright Green approach is supported by specialised environmental, agricultural and food industry education and research in the Forssa region. Educational and research institutions, such as the Natural Resources Institute Finland and Forssa Vocational School work in close collaboration with local companies and contribute to supporting their operations.

Regional dimension

The joint strategic work and a shared green vision of the municipalities in the Forssa region have created an ideal setting for green companies. Close cooperation



Source: Brightgreen.fi

Green business environment

The business development strategy of the Forssa region is based on the Bright Green approach, which focuses on business activities that are environmentally friendly and support sustainable development. A concrete example of this thinking is the Forssa Envitech area, which has become a major centre of eco-industry over the last 20 years, facilitated by local land use planning and active company networking. Following their birth in recycling strategies, the innovative companies of the area have made the Forssa region today an important production area of renewable energy

and a significant centre of material flows in northern Europe.

A comprehensive concentration of environmental expertise is found in Envitech, which is a community of environmental companies and public entities in the Forssa region. The Forssa region is home to many companies in the environmental and energy sectors with industry-leading expertise in environmental technology, research, consulting and services. The Envitech community protects the interests of environmental business and promotes development and cooperation in the region.

between regional businesses offers companies the opportunity to share costs and make use of each other's materials, data, technologies, know-how, research results and energy. This, in turn, has increased the attractiveness of the Forssa region both from company and investment perspectives. Simultaneously, a dynamic business environment has contributed to job creation and regional prosperity and resilience. Regional industrial symbiosis, alongside conscious emphasis of envi-

ronmental values and business stimulation, has contributed to a sustainable and greener Forssa region.

Learn more...

- Read more about Kiimassuo wind park at: www.voimavapriikki.fi
- Webpage and additional information: www.brightgreen.fi

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