
Executive Summary

Nordic Bioeconomy 25 cases for sustainable change

Nordic Council of Ministers, 2017

INTRODUCTION

The bioeconomy

Bioeconomy is about responsible use of renewable biological resources from land and water for the mutual benefit of business, society and nature. It's a major challenge now and in the future.

The bioeconomy consists of the management of renewable biological resources and their conversion into food, livestock, feed, bio-based products and bioenergy via innovative and efficient technologies. It means using every part of the biomass and using it intelligently. It covers all kinds of products: biofuel, heat, construction, bioplastics, smart packaging materials, food, livestock feed, ingredients, textiles, health and pharmaceutical, just to name a few.

The bioeconomy makes up more than 10% of the overall Nordic economy – and in some countries it is steadily moving towards 20% (figures from 2017). A holistic approach to the development of a sustainable bioeconomy is imperative, because in a world with limited resources and a changing climate, resource resilience is a cornerstone of community resilience.

The Nordic countries initiated a collaboration to draw up policies and plan to address those challenges and find lasting solutions to advance all areas of Bioeconomy. The Nordic countries are strongly placed to be global leaders in production and utilization of bio-resources that will enhance both competitiveness and sustainability. Part of this strategy and plan is to collect and categorize a catalogue of the Nordic Bioeconomy. Among other things, this has resulted in a report "Nordic Bioeconomy 25 cases for sustainable change". 25 cases of diverse bioeconomy activities in the Nordic countries for inspiration and enhanced understanding of the bioeconomy, its importance and its potential.

ABOUT THE 25 CASES

The 25 cases are examples of Nordic solutions to global challenges, based on a vision of a smarter, more sustainable and more inclusive society, focusing on the following four pillars: replace, upgrade, circulate and collaborate. The report "showcase" the diversity of the Nordic bioeconomy by including cases from different sectors, actors and areas. Some of the cases are from the largest Nordic companies and clusters to small and medium-size start-ups, from universities to local authorities, and from capital cities to peripheral regions.

Replace

Is about replacing unsustainable, often fossil-based materials with bio-based materials from forest, farmland, marine plants, etc. The Nordic Region has a great potential in terms of replacing fossil-based and artificial resources with bio-based and natural resources, not least due to the vast areas in which biomass is found, e.g. seas and forests.

The opportunities and overall potential are:

- replacing fossil-based materials with bio-based materials
- exploiting waste products from other companies
- replacing fossil-based fuel with renewable energy
- replacing fossil-based fuel with biofuel
- replacing fossil-based fuel with surplus heat from other companies

Following extract of cases is from Scandinavian companies working with bioeconomy initiatives which are good examples of the category of *Replace*.

Trefokus in Norway has increased the use of wood in construction in interaction with the local communities, municipal planning processes, public procurement, interaction with building projects, etc. All of the actors with their different competences play a crucial role. Trefokus utilize wood for construction of small-scale projects - not only in the interiors but also in sheathing and even the load-bearing structures. The wood in the projects comes from certified forests and the ultimate aim is to enable mass-production of building materials and buildings made from wood.

Borregaard in Norway replaces petroleum-based additives in adhesives, coatings, agricultural chemicals, and cosmetics with bio-based materials – namely cellulose from wood in form of Exilva. The production runs on renewable energy, and Exilva thereby not only improves the environmental performance of its products (in shift from petrochemicals to wood), but also the process. Results, verified by independent third party, shows that the environmental and climate footprint has decreased. According to Borregaard, it also provides a better cost-efficiency ratio, good stability, and improved behaviour of the various final products it is being used for.

UPM Biofuels in Finland has developed a process to transform wood-based residues from pulp production into an advanced biofuel that can be used in any diesel engine without modification. The product, BioVerno is a commercial-scale renewable diesel that reduces emissions of greenhouse gas as well as tailpipe emissions significantly compared to conventional fossil diesel. The production of this renewable diesel does not generate additional demand for forest harvest areas or compete with food production as processing residues are used as feedstock. In 2015 UPM Biofuels produced 120 million litres of renewable diesel. Enough for around 1000,000 cars per year.

A similar example is Innventia in Sweden who have showcased in collaboration with Brazil how Jet fuel can be produced from wood pulp without competing with food production.

Conclusion

The six cases in the report demonstrate how bio-based products and services have a broad range of applications and can replace environmentally harmful fossil-based products and services. They show the versatility of wood as a material, not only for traditional uses such as construction, but also to be broken down and exploited for its chemical properties. The challenge is to convince stakeholders in the value chain that the new wood-based or sea-based products are competitive and true alternatives to their existing

competitors. Furthermore, a concern is whether an increased wood-based production will take-up land otherwise used for food production. However, in many of the cases residuals in production serve as feedstock, which brings current production facilities closer to a circular model, serving as a source of inspiration for other companies.

Upgrade

It is vital for realising the full potential of the bioeconomy to upgrade and optimise throughout the whole value chain. Focus on increasing the value of currently unused and underutilised living natural resource, as well as on unlocking the full potential of residues, by-products and waste from side-streams, is crucial.

Opportunities and overall potential are:

- utilizing a larger share of raw materials
- using waste products for new products
- improved utilization of energy
- using waste products to produce energy

Following extract of cases from Scandinavian companies working with bioeconomy initiatives are good examples of the category of *Upgrade*.

Codland in Iceland aim at developing valuable new products from parts of the cod that were previously regarded as waste and to increase the utilisation and value of each fish caught from the limited stocks of cod around Iceland. It's an interdisciplinary collaboration between academia, research institutions, and other fisheries, focused on developing facilities capable of refining valuable products (like collagen peptides to replace chemical methods) from underutilised raw materials like fish skin, cod oil from liver, and crude oil and feed from the viscera. The facilities are built alongside existing fish drying plant, enabling almost all fishery by-products to be processed at one location and creating a closed-loop system to eliminate most of the waste-streams and optimise manufacturing.

Polar Seafood in Greenland changed its business model from previously only selling the filets of the halibut to through upgrade in machinery to also process and sell the heads, tails, and bones. Hence, they increased the utilisation rate from 50% to 90% and turned what was formerly regarded as an environmental burden into a profit-making product. Polar Seafood now make a profit from all parts of the fish except for the skin.

Biomega in Norway turned 36,000 tonnes a year of former by-product such as heads, fins, bones, guts and tails into valuable products like salmon oil, meal, and peptide for pet food and human consumption. Biomega now sources these former waste-products from fish slaughterhouses, and hereby reduces waste disposal expenses and provide them with a new source of income. The company uses every part of the salmon except for the fillet, which is sold individually.

Danish Crown in Denmark develops and produces new feed and food ingredients based on side-streams from slaughterhouse operations. The aim is to use the side-streams more efficiently and generate business opportunities from new products and increase overall resource efficiency. From side-stream waste they now produce a series of protein hydrolysates as ingredients in sausages and cured meat products, in sport nutrition products, and in special and senior nutrition products. But also, blood-based products that can help treat iron deficiency and replace supplements from chemicals and fossil-based products, is being produced. Side-stream from meat production generally have very high potentials for being upgraded to products of high value as it only requires minimal extra water and energy.

Royal Greenland in Greenland produces flour fit for human consumption from waste shells at their prawn factory in Ilulissat. Formerly the waste was released into the sea causing environmental problems for the

factory and local society. By upgrading the prawn factory Royal Greenland is now able to double the utilisation rate of the shrimp and create a value-added product from a previous waste-stream.

Arla in Denmark successfully converted whey from being a by-product from cheese production into a valuable ingredient in products such as protein powder. The powder is sold for human consumption within medical, infant and sports nutrition. Arla is now importing 50% of the raw material for whey protein as the company need more raw material than its own main production facilities can provide. All components of its primary feedstock, milk, to create and commercialize a whole new value-chain of ingredients and products. Hence, Arla unlock the full potential of the biomass and create new business opportunities to meet new consumer demands. With an annual growth rate of 17% Arla now has a 20% market share of whey by-products (figures from 2017).

Conclusion

The nine cases in the report showcase how companies find new innovative ways to upgrade side-streams and waste from bio-based resource in order to unlock their full potential. Companies in areas such as agriculture, household waste and meat and fish production have all succeeded in creating new, high-value products from previously unexploited raw materials which has helped them to open up new markets and diversify their production. The cases show that upgrading has already had a positive impact not only on the bottom line but also on the environment and local communities, exemplifying the enormous environmental and business opportunities inherent in upgrading waste and side-streams.

Circulate

Is about creating self-sustainable, local and circular bio-solutions. By increasing the value of currently unused and underutilized living natural resources, as well as on unlocking the full potential of residues and waste. For instance, using by-products and waste from aquatic species as input (fertiliser/food) for another species or vegetative cultivation. The circularity of the bioeconomy must be defined more broadly considering the sustainability of the ecosystems and their ability to replace the annual harvest of biological material. All of the Nordic countries have met or exceeded the limits of their ecosystems due to excessively intensive agriculture or fishing, or unsustainable forestry practices. A circular approach to the utilisation of these stocks of natural resources will, therefore, allow for resource renewal through strict compliance with the principles of sustainable harvesting.

Opportunities and overall potential are:

- delivering waste products as raw materials to other companies' production
- delivering waste products to biofuel production
- delivering surplus heat to other companies

Following extract of cases from Scandinavian companies working with bioeconomy initiatives are good examples of the category of *Circulate*.

The Geothermal Resource Park in Iceland is a cluster of different companies built around two geothermal power plants operated by HS Orka. It's an industrial symbiosis where waste-streams from one company are used as valuable raw materials for other companies in the area including fish drying, seafood by-product processing, and warm-water aquaculture. Also is included areas of microalgae cultivation and ingredient production, methanol production from CO₂ biotech greenhouse production. HS Orka's waste stream of geothermal water is benefitting a large number of companies.

Raisogro Ltd in Finland are through the Benella project replacing oil from marine fish with rapeseed oil as the main source of feed for rainbow trout. The project supports the marketing efforts of fish farmers involved, as they can promote their sustainably fed rainbow trout, strengthening their competitiveness.

The project was founded in collaboration between 10 fish farming companies and uses locally sourced marine ingredients, which minimises nutrition load from outside the Baltic Sea. It is a good example of new self-sustainable and local solutions as it helps to conserve diminishing marine resources, as the traditional fish oil is largely replaced with regional rapeseed oil in feed.

Digipolis in Finland is a part of an Arctic industry and circular economy cluster. The ambition is to enhance industrial symbiosis and strengthen the development of a holistic bioeconomy in the Kemi-Tornio region. From by-products and residue streams from companies in the region, value-added products are now being produced by combining and rethinking several by-product and residue streams. The region is compact and provides excellent industrial symbiosis conditions as it generate a total of 1.7 million tonnes of industrial by-products and residue annually from a large ecosystem of mines, metal producers, pulp and paper mills, a cardboard factory, fertiliser and fine chemical producers. The companies in the region is focused on using a cross-sectoral approach to create maximum value of the collective by-products and residues.

Conclusion

The three cases above describe diverse approaches to a form of circular bioeconomy. However, they also represent a more holistic approach, in which regions and universities work together in order to create more symbiotic and self-sustainable solutions with a reduced environmental impact. One case describes a cluster with impressive results and ambitious plans for circulating material and residues between a large ecosystem of companies that include mines, metal producers, and pulp and paper mills. Circulation requires distribution of information and exchanging of knowledge about best and next practise. Also, better communication of the clear financial and environmental benefits of circulating resources between companies and organisations.

Collaborate

Is about building the collaborative structures needed to develop the new bioeconomy further. The “new” bioeconomy aspires to be circular and place-based, rather than sector-specific. Fully utilising side-streams and upgrading by-products to replace fossil-based materials, requires extensive collaboration between various partners on multiple levels. Companies in different sectors must align their processes closely together with R&D institutions and regional authorities to ensure the right solutions and infrastructure. Collaboration is crucial for successful development of Bioeconomy’s other three pillars: replace, upgrade and circulate.

Opportunities and overall potential are:

- building partnerships and supply chains that enable minimisation of waste and CO₂ emissions and allow recycling of materials and energy

Following extract of cases from Scandinavian companies working with bioeconomy initiatives are good examples of the category of *Collaborate*.

SP Processum in Sweden launched in 2003 as a technology park but has since evolved into a cluster host for development, upscaling, and commercialisation of biorefinery processes. RISE Research Institute of Sweden and 22 companies, cooperates with other biorefinery initiatives, industry partners, and academic institutions to develop new products, process, and energy solutions from wood raw material and residual streams from other industry processes. SP Processum connect individuals and companies with good ideas to the relevant partners, helping them to test their ideas, commercialise, and scale it up.

Paper Province in Sweden is a non-profit cluster organisation working to advance the forest-based bioeconomy and showcase how a bio-based society could look like if we minimise our use of fossil-based

products and fuels. Through collaboration between industry, academia, and public stakeholders, member companies improve their products, services and competitiveness, contribution to overall growth in the region. Member companies represents the entire value chain and Paper Province is able to support participating companies and inventors with knowledge and capital in the process from concept to commercial deployment.

Sodankylä Municipality in Finland is reinventing the food value chain to support locally produced and processed food and minimise food waste. The aim of the project is to increase demand for local produce and create growth opportunities for small- and medium-size enterprises to stimulate the local economy and reduce food waste. Food waste have already been reduced by 20% and import of food reduced by 30% (figures from 2017).

Conclusion

The above cases presented show that collaboration is crucial for realising the full benefits of the bioeconomy. Often, it's characterised by public-private partnerships, in which various actors – regions, cities, research institutions, companies and other public and private entities work together on ambitious policies, plans and clusters. The different actors also benefit from each other's resources, either by exchanging knowledge or actual physical resources. Companies form symbiotic clusters in which they utilise each other's side-streams as feedstock for new products. These cases are good examples of how stakeholders across sectors show will to collaborate in order to accelerate the transition towards a bioeconomy. Collaboration is not only crucial at local, regional and national level, but across all levels too.

BREAKING OUT OF THE SHELL

The replace cases demonstrate the many ways in which bio-based resources can replace fossil-based or unsustainable resources. Replace is an important pillar in which biomass is not only used to produce energy, heat and fuel but replace a wide range of unsustainable products.

The cases regarding Upgrade show how companies find new and innovative ways to upgrade side-streams and waste from bio-based resources in areas such as agriculture, household waste, and meat and fish production. All succeeded in creating new and valuable products from previously unexploited materials, showing a positive impact - not only on the bottom line but also the environment.

Circulate overlap with several aspects the replace and upgrade approaches and must be defined broadly. The cases show how exploring place-based production synergies and utilising and growing more local resources are central to realising a circular bioeconomy.

The collaborate cases are good examples of how stakeholders collaborate across sectors to accelerate transition towards a sustainable bioeconomy with benefits in terms of new products, revenues streams, job creation and better resource utilisation.

The Nordic bioeconomy is driven by a wide range of stakeholders with the focus on bringing about a green transition through the replacement of unsustainable and fossil-based resources. Creating circular and self-sustainable local solutions to take advantages of side-stream and waste. We hope this report will inspire others to break out of the shell, innovate and devise their own solutions and forms of collaboration that will lead to a green transition.