



NORDREGIO
Nordic Centre for Spatial Development

Nordic working group for green growth – innovation and entrepreneurship 2013-2016 Synthesis report

Kaisu Annala and Jukka Teräs

NORDREGIO REPORT 2017:2



Nordic working group for green growth – innovation and entrepreneurship 2013-2016
Synthesis report

Nordic working group for green growth – innovation and entrepreneurship 2013-2016

Kaisu Annala and Jukka Teräs

Nordic working group for green growth
– innovation and entrepreneurship 2013-2016

Report 2017:2

ISBN 978-91-87295-48-5
ISSN 1403-2503

© Nordregio 2017

Nordregio
P.O. Box 1658
SE-111 86 Stockholm, Sweden
nordregio@nordregio.se
www.nordregio.se
www.norden.org

Analyses and text: Kaisu Annala and Jukka Teräs

Cover photo: Johannes Jansson, Norden.org

The project has been commissioned by the Nordic working group for green growth – innovation and entrepreneurship under the Nordic Council of Ministers' Committee of Senior Officials for Regional Policy.

Nordic co-operation

Nordic co-operation 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 co-operation* 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 co-operation 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

is a forum for co-operation 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 co-operation. Founded in 1952.

The Nordic Council of Ministers

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

Nordregio – Nordic Centre for Spatial Development

conducts strategic research in the fields of planning and regional policy. Nordregio is active in research and dissemination and provides policy relevant knowledge, particularly with a Nordic and European comparative perspective. Nordregio was established in 1997 by the Nordic Council of Ministers, and is built on over 40 years of collaboration.

Stockholm, Sweden, 2017

1. Introduction

The Nordic Working Group for green growth - innovation and entrepreneurship 2013-2016, was established by the Nordic Council of Ministers to focus on the regional policy dimension of Nordic Green Growth and to contribute to public policy development with a particular focus on innovation and entrepreneurship in the Nordic countries. Besides the Nordic Council of Ministers, the primary target group of the Working Group includes the Nordic ministries, regions and stakeholders with an interest in promoting and implementing Nordic green growth and green transition.

The main tasks of the working group included:

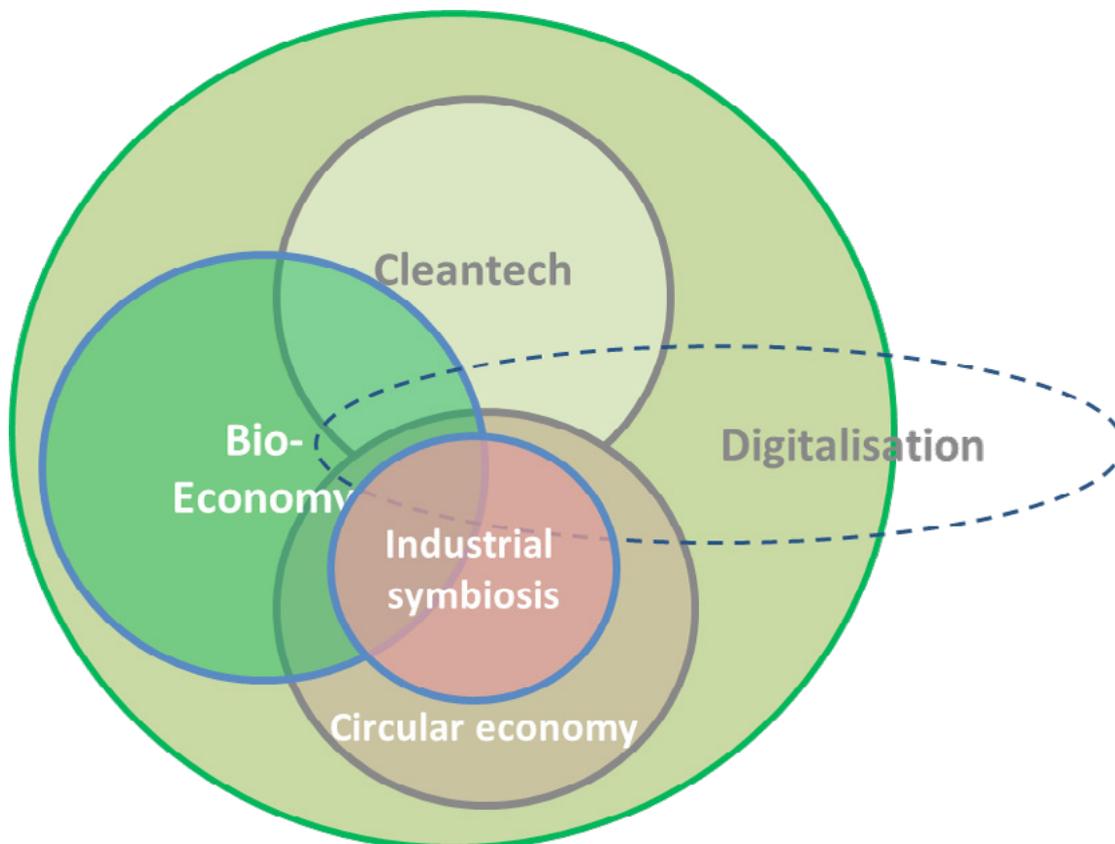
- To present an overview of policy instruments and their importance, and to explore “good practice” case studies of national, regional and local governance to support innovation and entrepreneurship for green

growth and green transition

- To examine factors that hinder or promote green growth
- To disseminate and discuss results with national, regional and local stakeholders in the Nordic countries
- To contribute to policy development in order to support innovation and entrepreneurship for green growth at regional level in the Nordic countries.

As the following figure illustrates, green growth is a broad concept which includes several overlapping areas. Besides the concepts of bioeconomy, cleantech, circular economy and industrial symbiosis, the working group has also included the concept of digitalisation in the figure. Digitalisation is expected to open up new opportunities for green growth in the Nordic context.

Figure: Central areas within green growth. Gaia Consulting Oy 2016.



This report summarises the work and results of the Nordic working group for green growth – Innovation and entrepreneurship in the period 2013-2016 and has been developed in collaboration with Gaia Consulting Oy. A broader, more comprehensive, account of the main results of the work done under the Nordic working group for green growth - Innovation and entrepreneurship can be found in: “Synthesis report on Nordic Green Growth: Innovation and Entrepreneurship” (see Appendix).

Main policy recommendations

Based on the findings of the research conducted under the Nordic working group in 2013–2016, and the feedback collected from the Nordic stakeholders, the following policy recommendations are presented to support further green growth and green transition across the Nordic Region.

- Promote regional green growth, bioeconomy and industrial symbiosis with a focus on actual demand and public/private partnerships.
- Target the “glocal” nature of green growth – by creating local and regional jobs in a global market environment. This often results in establishing local production plants based on local inputs and industrial symbiosis with other nearby industries.
- Increase awareness, visibility and understanding of green growth opportunities in the Nordic regions - across the wide group of relevant actors, including the businesses, research, civil society and public sector. Capacity building is also needed among the regional actors with a focus on intensified public-private collaboration, coordinated use of resources and funding, and strategy work for greener growth.
- Aim to create long-term, predictable public support networks and access to finance, especially in terms of public co-funding.

Joint Nordic efforts are expected and needed, including joint Nordic demonstration plants, international branding efforts, and other Nordic co-development projects. In addition, existing good practice regional examples of green growth across the Nordics deserve to be properly disseminated.

Major research projects

Nordic Bioeconomy (2013-2014)

In 2013-2014, the Nordic working group investigated multiple-case studies on bioeconomy in the Nordic regions as the first in-depth study on Nordic green growth. The in-depth study provided an analysis of the state-of-the-art of bioeconomy in the Nordic regions and outlined recommendations for further development potentials. The analysed Nordic regions were Forssa in Finland, South Iceland, Østfold in Norway, Örnsköldsvik in Sweden, and Lolland in Denmark.

The Nordic bioeconomy in-depth study report “Bioeconomy in the Nordic region: Regional case studies”, Nordregio Working Paper 2014:4, is available at:

<http://www.nordregio.se/Templates/NordRegio/Pages/PublicationPage.aspx?id=3477&epslanguage=en>

Nordic Industrial Symbiosis (2015)

In 2015, the working group implemented a multiple-case study report on industrial symbiosis in the Nordic regions as the second in-depth study on Nordic green growth. The in-depth study provided an analysis of industrial symbiosis in the Nordic region with recommendation for further actions. The in-depth study identified and analysed various forms of resource exchange between companies and other organisations in which the waste of one actor becoming a resource for another actor. The Nordic Industrial Symbiosis case studies were Kalundborg in Denmark, Kemi-Tornio region in Finland, Svartsengi Resource Park in Iceland, Eyde Cluster in Norway, and Händelö in Sweden.

The final report was launched at the COP-21 climate change summit in Paris in 2015. The in-depth study report “The potential of industrial symbiosis as a key driver of green growth in Nordic regions”, Nordregio Working Paper 2015:1, is available at:

<http://www.nordregio.se/en/Publications/Publications-2015/The-potential-of-industrial-symbiosis-as-a-key-driver-of-green-growth-in-Nordic-regions/>



Nordic Road Show in Mariehamn in 2016.

Nordic Green transition (2015-2016)

In 2015-2016, the working group implemented an in-depth study on state of play, practices and needs of Nordic regions working to encourage innovation and entrepreneurship and move towards a greener economy. A survey focused on the green growth practices in Nordic regions, and identified challenges and interventions. The in-depth study report “Developing a greener Nordic economy: interventions to overcome the challenges” Nordregio Working Paper 2016: 4, is available at:

<http://www.nordregio.se/en/Publications/Publications-2016/Developing-a-greener-economy-in-Nordic-regions-interventions-to-overcome-the-challenges>.

Selection of 50 Nordic Good Practice cases on Green Growth

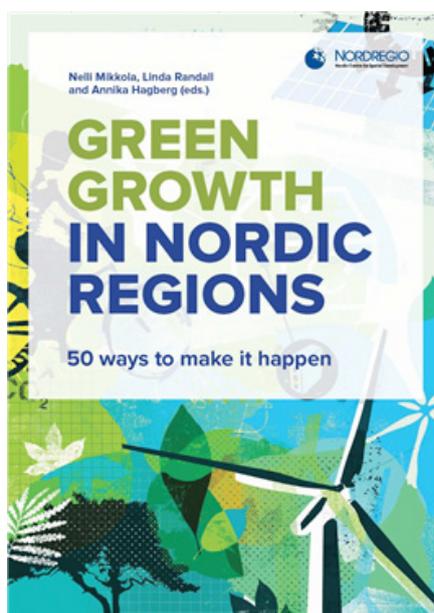
The in-depth studies of Nordic green growth and green transition were complemented by a collection of 50 good practice cases of green growth in the Nordic regions. The collection illustrates the ongoing transition to a greener economy in the Nordic regions in a broad range of contexts, both urban and rural. The 50 examples and their cross analysis highlight the key characteristics of Nordic green growth and are designed to be a source of inspiration for both practitioners and policy-makers. The collection of Nordic cases was presented at the COP-22 climate change summit in Marrakech in 2016 at the Green Zone, hosted by State of Green in Denmark.

The publication: “GREEN GROWTH IN NORDIC REGIONS 50 ways to make it happen”, Nordregio 2016, is available at: <http://www.nordregio.se/en/Publications/Publications-2016/GREEN-GROWTH-IN-NORDIC-REGIONS-50-ways-to-make-it-happen/>

Nordic Road Show on green growth and green transition

The working group facilitated a series of ten national and regional events from April-October, 2016 to present its research findings, and also receive the up-to-date feedback from the regions on Nordic green growth. The Nordic Road Show on Green Growth attracted over 230 participants, representing key actors from both public and private sector, in all five Nordic countries. At each event, the thematic roundtable discussions highlighted the special characteristics and policies of green economy in the respective country and region and how it could be developed further. The Road Show provided Nordic added value and created an excellent network of Nordic regional green growth actors, to be utilised in the implementation of the coming Nordic cooperation programme in 2017–2020.

The Nordic Green Growth Road Show 2016 report is available at: <http://www.nordregio.se/en/Publications/Publications-2016/Nordic-Green-Growth-Road-Show/>



Additional communication & networking activities

Following the completion of the Nordic Road Show events, the Working Group contributed significantly to the Nordregio Forum 2016, entitled “From Fossil to Bio-based and Sustainable Economy – Innovation and Policy for Green Transition in the Nordic Region”. The conference programme built on the key themes covered by the Nordic working group. The Nordregio Forum 2016 in Helsinki attracted more than 150 participants.

The Nordic Working Group has performed significant communication and networking activities in

the period 2013-2016. Along with the dissemination of major research reports, the Green Growth Road Show & Nordregio Forum, the working group has also produced policy briefs and newsletters based on the themes of major in-depth studies. Moreover, the Nordic and Baltic network of the working group has included for example participation at the Nordic Bioeconomy Panel and Baltic Sea Region Bioeconomy Council, and presentations at several Nordic and EU conferences and other relevant events.

Members of the Working Group

The following people have participated in the Nordic working group for green growth- innovation and entrepreneurship during the period 2013-2016.

| | |
|---------------------------------|---|
| Faroe Islands: | Oyvindur av Skarði, Ministry of Trade and Industry |
| Finland: | Kaisu Annala (Chair), Ministry of Employment and the Economy Liisa Saarenmaa, Ministry of Agriculture and Forestry |
| Iceland: | Sigrídur Kristjansdóttir, Innovation Centre Iceland |
| Norway: | Pål Erik Holte, Ministry of Local Government and Regional Development Vincent Fleischer, Ministry of Local Government and Regional Development |
| Sweden: | Örjan Hag, Ministry of Enterprise, Energy and Communications |
| Åland: | Robert Mansén, Åland Technology Centre |
| Nordregio (secretariat): | Jukka Teräs, Lise Smed Olsen |
| Nordregio researchers: | Ingrid HG Johnsen, Gunnar Lindberg, Iryna Kristensen, Anna Berlina, Nelli Mikkola, Alberto Giacometti, Liisa Perjo, Linda Randall |
| Nordregio communication: | Åsa Hildestrand, Pipsa Salolampi, Johanna Feuk |

APPENDIX: *Synthesis report on Nordic Green Growth: Innovation and Entrepreneurship*

Synthesis report on Nordic Green Growth: Innovation and Entrepreneurship

15.11.2016
APPENDIX

Päivi Luoma, Tea Miller, Susanna Sepponen, Elina Heikinheimo, Tiina Pursula, Ida Rönnlund and Paula Tommila

Gaia Consulting Oy

TABLE OF CONTENTS

| | |
|---|-----------|
| Executive Summary | 2 |
| 1. Introduction..... | 3 |
| 1.1. Background and objectives | 3 |
| 1.2. Bioeconomy and industrial symbiosis as part of green growth | 5 |
| 1.3. Green growth in a regional perspective | 7 |
| 2. Global drivers and Nordic strengths | 9 |
| 2.1. Bioeconomy..... | 9 |
| 2.2. Industrial symbiosis..... | 16 |
| 3. Conclusions on strengths and opportunities of Nordic regional green growth | 22 |
| 3.1. SWOT analysis of Nordic regional green growth | 22 |
| 3.2. Added value of Nordic cooperation for regional green growth..... | 25 |
| 4. Looking into the future of green growth in Nordic regions | 26 |
| 4.1. A draft vision for Nordic regional green growth..... | 27 |
| 4.2. Draft strategic targets for Nordic regional green growth..... | 27 |
| 4.3. Draft roadmap 2017-2020: Recommendations for steps to take | 29 |
| References | 32 |
| Appendix 1: Background on Nordic strengths and weaknesses in Bioeconomy and Industrial Symbiosis | 36 |
| Appendix 2: Nordic performance on global green growth related indicators | 39 |

Executive Summary

This synthesis report is a contribution to the work of the Nordic Working Group for green growth – innovation and entrepreneurship, which operated under the Nordic Council of Ministers' Committee of Senior Officials for Regional Policy in 2013-2016 and was facilitated by Nordregio.

The synthesis report summarizes the work done by the Nordic Working Group during their four-year mandate period and puts it in a broader European and international context. The report focuses on the role and relevance of the regional level and regional players in promoting green growth in the Nordic countries and internationally and gives policy recommendations on how the Nordic regions can benefit from enhanced cooperation on green growth activities.

The report focuses on two central areas of green growth: bioeconomy and industrial symbiosis. It analyses the key global drivers for green growth in these areas and positions the Nordic regional green growth - its strengths and weaknesses - against these global drivers.

The **key features of green growth in Nordic regions** are summarised in a SWOT analysis (strengths/weaknesses/opportunities/threats). Key **strengths** recognised were a strong political will and policy framework to support bioeconomy and green growth, vast natural resources and expertise in their management, excellent industrial know-how and infrastructure, pragmatic approaches and proximity to decision makers, the internationally known Nordic brand, and awareness of business and consumers in the Nordics. Main **weaknesses** found were a lack of political leadership for fighting against “business as usual” and enforcing radical change, the mismatch of competence and resources in remote regions, small domestic markets in combination with a lack of capital and investments, and various barriers for creating new business in the regions.

Key **opportunities** for Nordic regions were found in a global urgency and growing demand for clean and green solutions, a need of global forerunners to lead the way to green growth, a shift from traditional industries to new value-creating ecosystems, and opportunities of digitalisation. The most severe **threats** for green growth were recognised in the low oil and raw material prices, international regulatory development, shifting political and media focus, and the ownership and use of natural resources globally.

The report concludes with outlining a **road map** for Nordic regional green growth, based on a vision of *Nordic regions together leading the way to sustainable growth*. The road map outlines three long-term targets: green growth as an integral part of regional strategies and actions; business in the regions based on sustainable solutions; and regional players being active in Nordic and global ecosystems. Finally, the road map provides a range of concrete recommendations on how Nordic regions can engage in cooperation towards these targets in the years to come (2017-2020).

1. Introduction

1.1. Background and objectives

Green growth fosters economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. To do this, green growth must catalyse investment and innovation that will underpin sustained growth and give rise to new economic opportunities. This implies deploying “green objectives” such as resource efficiency in all sectors and industries and in all areas and steps of the value chains from production to recycling and reuse.

Green growth has been a key priority for Nordic cooperation during the last years. In 2011, a task force under the Nordic Prime Ministers defined a joint strategy for “The Nordic region – leading in green growth”¹, which was implemented through a large multi-sectorial programme funded by the majority of Nordic ministries with the ambition to unite the countries’ climate goals with the goals for economic growth. In parallel, the Nordic Ministers for Fisheries and Aquaculture, Agriculture, Food and Forestry put forward a strategy for fostering green growth in primary industries.²

Within this framework, the Nordic Council of Ministers’ Committee of Senior Officials for Regional Policy defined “green growth, innovation and entrepreneurship” as a focus area in their cooperation programme for 2013-2016. The aim was to foster green growth in all Nordic regions by contributing to public policy development and by investigating the potential for environmental innovation and entrepreneurship.³ This task was given to the Working Group for Green Growth: Innovation and Entrepreneurship, which has examined the regional policy dimensions as well as positive and negative factors of green growth in Nordic regions, with a focus on bioeconomy and industrial symbioses. *Bioeconomy* was chosen as a specific theme as one of the most central aspects to Nordic green growth, providing good potential for cooperation, and serving as a rich basis for comparison and inspiration due to the existing country and region specific diverse approaches. Following the same rationale, *industrial symbiosis* was selected as another theme due to its relevance for all Nordic countries as a possible regional and practical approach to realizing circular economy and achiev-

¹ The Nordic Region – leading in green growth: Report by the Nordic prime ministers’ Working Group for Green Growth: <http://norden.diva-portal.org/smash/record.jsf?pid=diva2%3A702359&dswid=4407>

² Based on the Nidaros declaration, <http://www.norden.org/en/nordic-council-of-ministers/council-of-ministers/nordic-council-of-ministers-for-fisheries-and-aquaculture-agriculture-food-and-forestry-mr-fjls/declarations-statements-and-decisions/nidaros-declaration>. The NordBio Programme, led by Iceland, united the ministries for Environment; Fisheries and Aquaculture, Agriculture, Food and Forestry; Trade, Energy and Regional Policies; Education and Research; and Culture, in seeking new ways of improving how we use our resources and minimize our generation of waste. Among other things, the programme led to the establishment of a joint Nordic Bioeconomy Panel, <http://nordbio.org/en>

³ Nordens regioner viser vei: En regional bærekraftig velferdsutvikling, bærekraftig Arktis og grønn vekst. Nordisk samarbeidsprogram for regional utvikling og planlegging 2013-2016

ing green growth.

Two in-depth studies done by the Working Group, one on bioeconomy and one on industrial symbiosis, provide a range of cases and a good ground for knowledge sharing and definitions of the themes in the Nordics. *The third in-depth study* presents the results of surveys and interviews related to how Nordic regions work to endorse innovation and entrepreneurship on green growth and thus provides valuable insight in the incentives, enablers and obstacles connected to implementing green growth initiatives in different Nordic regions. A multitude of case studies have been showcased in a *handbook for Nordic green growth* and extensive consultations held with key stakeholders in diverse Nordic regions through a *road show in 2016* bringing forward practical suggestions and recommendations on how to implement green growth activities in Nordic regions.

This synthesis report combines the main results of the work done under the Nordic Working Group for Green Growth: Innovation and Entrepreneurship, facilitated by Nordregio. It is broadly based on central international reports and publications outlining recent global developments in green growth, publications by Nordregio and by the Nordic Council of Ministers and its institutions, and on interviews.

This synthesis report aims to:

- Frame green growth in the Nordic region into a global context, with a focus on current global trends and drivers
- Highlight Nordic strengths and challenges within bioeconomy and industrial symbiosis, related to the global development, and with a focus on identifying added value of Nordic regional cooperation
- Put forward recommendations for Nordic cooperation that can benefit innovation and entrepreneurship in Nordic regions and support green growth both locally and globally

Chapter 1 of the report describes the framework of this study, central aspects of green growth and the role of regions in fostering green growth, based on desk study, utilizing central international reports and publications and publications by Nordregio and by the Nordic Council of Ministers and its institutions.

Chapter 2 focuses on green growth viewed from the global drivers related to the two main perspectives adopted by the Nordic Working Group, bioeconomy and industrial symbiosis, and analysing key Nordic strengths and weaknesses in response to the global drivers. The description of drivers is based on central international reports and publications and publications by Nordregio and by the Nordic Council of Ministers and its institutions and the latest work of globally relevant organizations for bioeconomy and industrial symbiosis, as well as on interviews with Nordic and international key players within green growth⁴. The analysis of Nordic strengths and weaknesses draws upon the interviews made by Gaia and on the

⁴ Eleven interviews conducted by Gaia Consulting in September 2016, see references (section 5) for list of informants.

findings of Nordregio, as presented in previous reports and case studies, as well as on the road show conducted by Nordregio in this project.

Chapter 3 concludes the analysis of strengths, weaknesses, opportunities and challenges for Nordic regional green growth and points out possibilities for value adding cooperation between Nordic regions. This chapter is based on conducted interviews, Nordregio case studies and road show, and a workshop held at Nordregio 11 October 2016. The results have been further analysed and refined by Gaia.

The concluding Chapter 4 puts forward a set of forward-looking policy recommendations for how Nordic cooperation can support the development of green growth in Nordic regions. The suggestions are largely based on views raised in the interviews, Nordregio road show and the workshop, and further developed by Gaia, in dialogue with the Nordic Working Group.

The conclusions of this report will feed into a roadmap for Nordic green growth to be outlined under the Nordic Council of Ministers' Committee of Senior Officials for Regional Policy for the period 2017-2020.

1.2. Bioeconomy and industrial symbiosis as part of green growth

Green growth fosters economic growth and development, while taking full account of the environmental and social consequences of the growth dynamics of economies. It seeks to catalyse investment and innovation in ways that give rise to new more sustainable sources of economic activity and jobs. The concept of green growth is often used almost interchangeably with other similar concepts such as green economy, but the exact definitions vary between different institutions (Mikkola et al. 2016). While the OECD uses the concept of green growth, the UNEP uses instead the concept of green economy⁵.

On a global scale, a green economy results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy can be thought of as low carbon, resource efficient and socially inclusive. Practically speaking, a green economy is one whose growth in income and employment is driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services.

According to UNEP, these investments need to be catalysed and supported by targeted public expenditure, policy reforms and regulation changes. This development path should maintain, enhance and, where necessary, rebuild natural capital as a critical economic asset and source of public benefits. Building greener societies requires a multitude of approaches and cooper-

⁵ Defining it as an economy where growth in income and employment is driven by investments that reduce carbon emissions and pollution, promote clean energy resources and prevent the degradation of biodiversity or ecosystem functioning. The term green economy is relatively new and originates to the United Nations summit on sustainable development in Rio de Janeiro 2012 where it was one of the formal focus areas.

ation across sectors and governance levels. Green growth is a broad concept including several areas that are partly overlapping and together have the potential to foster greener economic growth in Nordic regions. The central areas of green growth and their overlap is illustrated in the Figure 1.

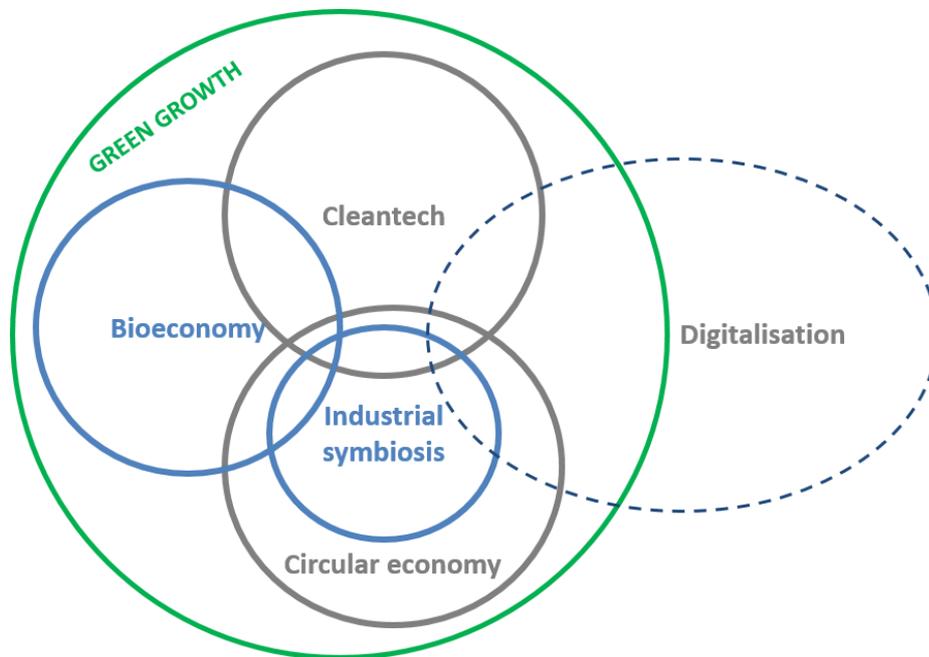


Figure 1: Central areas within green growth

Bioeconomy aims to develop an economy that is based on the sustainable utilization of renewable resources. In its “Communication on Innovation for Sustainable Growth: A Bioeconomy in Europe”, the EU considers the bioeconomy to consist of food, agriculture, paper and pulp, forestry and wood industry, fisheries and aquaculture, bio-based industries, biochemicals and plastics, enzymes and biofuel sectors. The focus in bioeconomy has recently expanded from the more traditional sectors into possibilities of renewable resources in novel applications. In policy-making, a bioeconomy is in many cases also seen as requiring a cross-sectoral approach that calls for a broad range of system-level changes and innovation (Nordregio policy brief 2015:5). Bioeconomy has a key role in reaching a low-carbon and resource-efficient society and is thus an important contributor to green growth in all Nordic countries.

Industrial symbiosis⁶ is one way to achieve green growth focusing on resource productivity. In industrial symbiosis resource productivity is increased by enhancing physical exchange of materials, energy, water and by-products between individual firms that are in many cases closely located e.g. in clusters or industrial parks. Definition of industrial symbiosis has recently been extended from including only exchanges of material and energy flows

⁶ There are differences within Nordic regions in the adoption of the term “industrial symbiosis”. Also “green symbiosis” to describe green business models and symbiotic relationships between firms is used.

between firms to cover also personnel and knowledge transfer and sharing of those services that practitioners and other stakeholders regard as important (Johnsen et al. 2015).

Circular economy focuses on keeping the added value in products and materials for as long as possible and at the same time minimizing the generation of waste. Compared to a linear economy, which is characterized by the economic model of ‘take-make-disposal’, circular economy is restorative or regenerative by intention and design and aims to maintain deployed resources in the economy as long as possible. Circular economy offers new growth opportunities in all fields and requires rethinking of value chains, ecosystems and business models. EU’s Circular Economy Strategy was presented at the end of 2015 and it focuses especially on the legislative proposals on waste (EC 2016a).

Cleantech refers to products, services, processes and solutions which improve productive and sustainable use of natural resources while reducing emissions and other negative environmental impacts. Traditionally, the focus of cleantech solutions has been in energy sector and other key sectors being transportation and logistics, water and wastewater, air and environment and industrial manufacturing processes. However, cleantech is not tied to any specific sectors but can be seen more as an asset to promote green growth in any field and in any resource use.

Digitalization opens up totally new opportunities for green growth. It refers to use of digital technologies to redesign and innovate new operating and business models, which offer new revenue and value-producing opportunities. Examples of business models affected by digitalization are such as resource sharing and delivery platforms or networking services. Similarly as circular economy, digitalization challenges the current state of doing business and provide new economic models to be exploited across all sectors.

1.3. Green growth in a regional perspective

In regional development, regions refer primarily to smaller geographic and administrative entities within a country.⁷ However, the regional perspective of green growth is not strictly defined to certain administrative or geographical levels. A fuller realisation of a greener economy with green innovations, entrepreneurship and more sustainable ways of living, requires addressing critical issues and cooperation opportunities on all levels: from the local level, within a defined region (intra-regional), between regions (inter-regional), in regions that cross national boundaries (cross-border) to a (macro-regional) Nordic, Arctic or Baltic Sea level, European and global scale. Regions are also created and perceived as the result of intentional policy actions and cooperation among stakeholders⁸.

Regions – on all different levels - are key players in green growth, as the regions have expertise on their local resources and know their own potential.⁹ⁱ On the other hand, green growth activities contribute to positive regional development, as regions can also make optimal use not only of their natural assets but also retain and strengthen their human capital, skilled

⁷ As classified e.g. in the pan-European “NUTS” and “LAU” systems, see State of the Nordic Region. Nordregio Report 2016: 1

⁸ Such as the cross-border Karlstad-Oslo region’s cooperation on biofuels (source: interviews Sept 2016)

⁹ As pointed out in many of the interviews, Gaia Consulting, Sept 2016

work force, infrastructure and the local and regional innovation potential and entrepreneurship. In addition to environmental sustainability, green growth always has strong economic and social dimensions and support the building of innovative and resilient regions.¹⁰

Green growth strongly connects a global and a local focus, as it depends both on global markets, value chains and networks, and at the same time on local resource flows and ecosystems. Figure 2 outlines some of the critical issues for green growth ranging from the local to the global level, with the regions having an important role for understanding and promoting many of the issues. Regions are key players in implementing Nordic green growth, and green growth activities contribute to positive development of Nordic regions.



Figure 2: Critical issues for green growth ranging from the local to the global level

When talking about regions, it is important to acknowledge that both green growth and Nordic regions are diverse in character – thus talking about “the Nordic Bioeconomy” or “the Nordic regions” as singular entities can be misleading¹¹ and the development of a greener economy needs to be built on an understanding of regional differences and competitive advantages (Mikkola et al. 2016). Regional strategies in all the Nordic countries focus on creating good conditions for development across all parts of the country (Grunfelder (ed) 2016). In the Nordic cooperation for regional development, the focus of green growth is especially on stimulating the development of environmentally oriented business *in all industries and all Nordic regions*.

¹⁰ Innovative and resilient regions is also one of the proposed themes for the forthcoming programme of the ministries for regional policy, building on the results of the working group for green growth, innovation and entrepreneurship.

¹¹ See Nordregio road shows, 2016

2. Global drivers and Nordic strengths

2.1. Bioeconomy

The following section presents five key global drivers in bioeconomy, which have crucial impact on bioeconomy development in the Nordic countries. Each driver is described in the light of the latest international development and used as backdrop for positioning the Nordic countries in a global context. For each driver, the main Nordic strengths and weaknesses are summarized in a table. A more detailed analysis of the strengths and weaknesses is presented in Appendix 1.

- 1. Bioeconomy development is driven by the urgent need to mitigate climate change**
- 2. Decoupling economic growth from resource use**
- 3. Power of consumer choices creates more demand for sustainable products and services**
- 4. Competition between land uses emphasizes the importance of the sustainability of the bioeconomy**
- 5. Need to find new sustainable resources**

1. Bioeconomy development is driven by the urgent need to mitigate climate change

Bioeconomy has great potential to contribute on climate change mitigation providing that in addition to renewability, also sustainability of value chains is guaranteed. In climate change mitigation and global climate targets, the role of bioeconomy has focused on its possibilities to contribute on emission reductions by providing renewables alternatives to fossil ones and on ensuring sustainability of biomass use (BIC 2013, BECOTEPS 2011). An example of bioeconomy-based action to achieve climate targets is the EU biofuels policy and related directives, the aim of which is to reduce emissions while ensuring the sustainability of biomass production in terms of food security, biodiversity and societal aspects (EC 2016c).

Especially in the EU there is a strong political will to foster bioeconomy as it is seen as a way to achieve reduction in GHG emissions and provide growth opportunities and develop rural areas (EC 2012). Also the US has launched the National Bioecono-

my Blueprint¹² which has more emphasis on the growth possibilities of bioeconomy compared to the possibilities of bioeconomy to mitigate climate change. China's new 13th five years plan¹³ also priorities clean production and green and low-carbon industry systems. The main factors hindering the development of bioeconomy are high capital intensity and risk level of new technologies, as well the unpredictability of upcoming regulation is often pointed out by the business. Also the low oil price has weakened the attractiveness of bio-based products and energy compared to present fossil-based alternatives available on the market and thus impeded investment decisions.¹⁴

Table 1 summarises Nordic strengths and weaknesses in relation to the global development.

Table 1. Nordic strengths and weaknesses in bioeconomy development (global driver 1: bioeconomy development is driven by the urgent need to mitigate climate change).

| Nordic strengths | Nordic weaknesses |
|--|--|
| <ul style="list-style-type: none"> - Inclusion of bioeconomy solutions in the climate change policies and strong political will to promote bioeconomy - Public funding and support to promote bioeconomy as a part of climate change mitigation - Development of non-food biomass based solutions | <ul style="list-style-type: none"> - Uncertainties and lack of coherence in policy development - Getting from national level strategies to concrete outcomes - Lack of investment and capital in Nordic regions - Cross-border barriers created by different governance models and regulations |

2. Decoupling economic growth from resource use

A progress towards a more sustainable economy requires an absolute reduction in resource use, while human well-being demands that economic activities should expand and environmental impacts diminish. Also the resources used should add as high value as possible to the society and well-being. Decoupling¹⁵ is not only limited to biomass but also applies for all other renewable and non-renewable materials. Decou-

¹² The Obama administration launched the National Bioeconomy Blueprint in 2012

¹³ China's 13th five year plan for the years 2016-2020

¹⁴ The biobased products and fossil based products still compete on the same market, with costs being the most important factor.

¹⁵ Decoupling means using less resources per unit of economic output and reducing the environmental impact of any resources that are used or economic activities that are undertaken (UNEP 2011).

pling means that resource extraction, use and consumption should always be as efficient as possible leading to utilization of full potential of the raw materials to products with as high overall value addition as possible¹⁶. Lower value products are produced from sidestreams or from recycled materials benefiting from cascading use, and finally the residues are used for energy.

Achieving value cascading and decoupling in bioeconomy requires better upscaling and industrialization of the new biobased value chains. Success depends on technological performance of biotechnology and cost effectiveness of bio-based products compared to present fossil-based products available on the market (CEPI 2012).

Example of high value bioproducts are chemicals and pharmaceuticals. McKinsey & Co. has estimated the share of renewable chemicals in worldwide chemical sales to grow from the current 9 % up to 11 % by 2020 while worldwide sales of chemicals are expected to grow at 4 % annually. The highest growth rates in biochemical sales are expected in new biopolymers and renewable chemicals, biocatalysts for industrial processes and biologic medicines, as well as biofuels (BIO 2016).

According to CEPI (2012), objective for the European biobased industry is that 50 % of high value chemicals and 10 % of bulk commodity chemicals are biobased by 2030. In addition, 25 % of Europe's transport energy needs should be fulfilled by sustainable advanced biofuels. The aim of the CEPI is also to promote use of chemicals and compounds from renewable feedstock in fibre and polymer markets and in industries such as automotive, construction and packaging.

Table 2 summarises Nordic strengths and weaknesses in relation to the global development.

¹⁶ Problems with decoupling if measured only on national level is easily a hidden transfer of the resource intensive parts of the value chain being moved to other countries, and thus not seen in the metrics.

Table 2. Nordic strengths and weaknesses in bioeconomy development (global driver 2: decoupling economic growth from resource use).



| Nordic strengths | Nordic weaknesses |
|---|---|
| <ul style="list-style-type: none"> - Competence to use advanced technologies and digital solutions for resource-efficiency and non-material value-adding services - Existing advanced industry infrastructure, including technological know-how and organized business ecosystems, as a key enabler | <ul style="list-style-type: none"> - Access to skilled work force and education that meets the needs of the business in the regions - Lack of models for shared use of RDI infrastructures - Overshadowed innovation potential of SMEs - Not sufficient focus on higher-value products. |

3. Power of consumer choices creates more demand for sustainable products and services

The growth of the middle class in the emerging markets, particularly in Asia, has a huge potential as an engine of growth. The size of the global middle class is forecasted to increase to 4,9 billion by 2030 from 1,8 billion in 2009 (OECD Observer 2012, OECD 2009a). In addition to the growing number of people with purchasing power, consumer's awareness of sustainability creates more demand for sustainable, biobased products and services of which the Nordic countries can have their share. Due to these market developments investments in bioeconomy are currently growing rapidly in Asia.

Use of renewable feedstock as raw material and demand for green is gaining more attention in consumer behaviour and sustainability is going mainstream. Consumers are increasingly concerned about environmental and social impacts of their consumption and willing to act on those concerns through consumption and lifestyle choices (Innventia 2016). Companies are greatly impacted by the ethical demands of consumers and major consumer companies across all sectors are investing in biobased alternatives to fulfil their sustainability goals (CEPI 2012, Innventia 2016). Bioeconomy has a great potential to fulfil consumers' demand as wood followed by other natural materials are considered to be most reliable and exclusive and least environmental harmful materials which is an important issue in purchasing decisions (Innventia 2016). Consumer's bio-preference can also play a pivotal role in urbanization providing biobased alternatives for smart construction, transportation and other infrastructure solutions (EFI 2015). In addition to demand for green, consumers' are

increasingly expecting to be delivered personalized products and services (WEF 2016).

Also another megatrend, digitalization, has an important role in awareness raising and better communication of the benefits of bio-based products and in delivering personalized experiences and thus serves as an accelerator for the trend. Digitalization is going from being a niche to a norm.¹⁷ In addition to boost the use of different communication channels for awareness raising, digitalization bring new business models for consumer market, similarly than have already happened in sectors like accommodation, transportation and real estate (WEF 2016).

Table 3 summarises Nordic strengths and weaknesses in relation to the global development.

Table 3. Nordic strengths and weaknesses in bioeconomy development (global driver 3: power of consumer choices creates more demand for sustainable products and services)

| <i>Nordic strengths</i> | <i>Nordic weaknesses</i> |
|---|---|
| <ul style="list-style-type: none">- The Green Nordic brand- Consumer awareness- Excellent raw material potential for value added bio products enabling production investments to serve the global markets | <ul style="list-style-type: none">- Small domestic markets- Lack of instruments for market entrance- Communication challenges across scattered and diverse fields |

4. Competition between land uses emphasizes the importance of the sustainability of the bioeconomy

Usage of biomass can create both positive and negative impacts on the environment by contributing to changes in land use. For example, 1st generation biofuels face both social and environmental challenges, largely because they use food crops and thus have impact on food price increases and land use changes (TNI 2015). Ensuring conservation, restoration and sustainable use of terrestrial and freshwater ecosystems including e.g. forest management and food production are also highly prioritized in

¹⁷ Carlos Moedas, Commissioner for Research, Science and Innovation, in: *Bioeconomy Investment Summit Unlocking EU leadership in 21st Century Bioeconomy Final report of the conference held in Brussels, 9-10 November 2015*

UN's Sustainable Development Goals¹⁸. These are highly relevant issues as, for example in EU agriculture is the biggest employer managing 46 % of the territory. The increase in demand for agricultural raw materials for the non-food sector is creating income opportunities and jobs, but also threatening other uses of land. In the Nordic countries this also links to the two-edged purpose of the use of natural resources: forests are supposed to provide biomass to industry and ecosystem services. Forests are also important for nature tourism.

In addition, land use sector has important potential to mitigate climate change as carbon stocks. The potential of land use sector in the context of climate and energy targets has lately gained attention in Europe. In 2016 European Commission came up with legislative proposal for the sector land use, land use change and forestry (LU-LUCF) about to incorporate land use and forestry into the EU's emission-reduction efforts¹⁹ (EC 2015). In addition, implementation of the Paris Climate Agreement will have impacts on land use issues. For the world as a whole, carbon stocks in forest biomass decreased by an estimated 0.22 Gt annually during the period 2011–2015, mainly because of a reduction in the global forest area (UNFCCC 2014).

The social and environmental sustainability of biomass production is important factor as the global use of biomass is expected to grow and there is competition between different land uses²⁰.

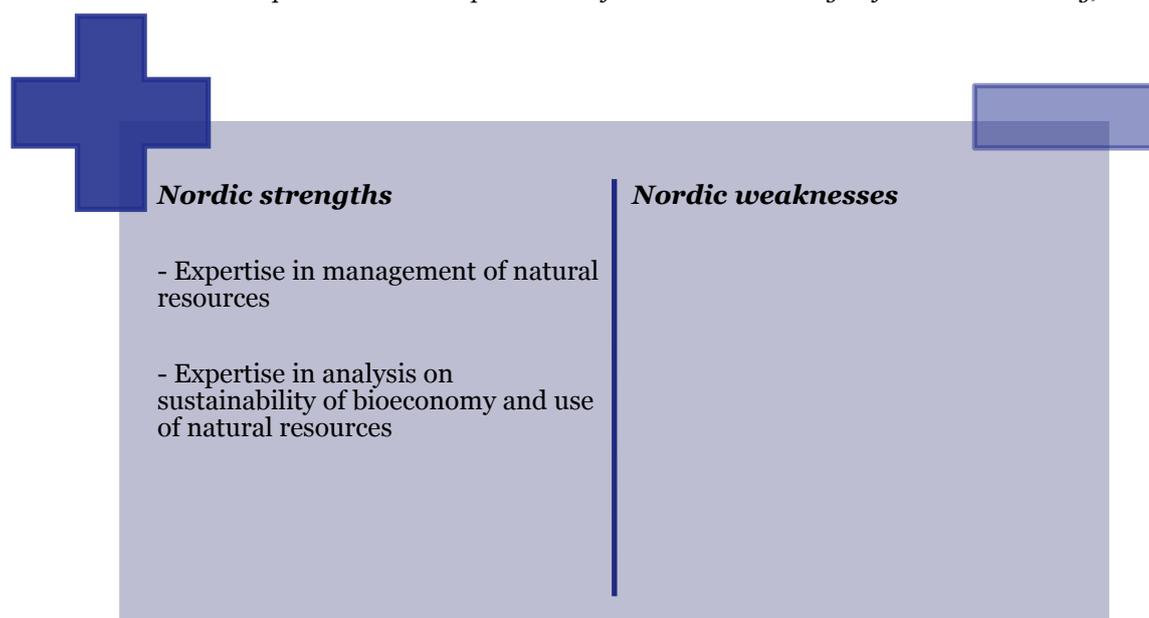
Table 4 summarises Nordic strengths and weaknesses in relation to the global development.

¹⁸ For example Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture, Goal 13: Take urgent action to combat climate change and its impacts and Goal 15: Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss.

¹⁹ The proposal sets out a binding commitment for each EU Member state and the accounting rules to determine compliance and covers CO₂ from forestry and agriculture.

²⁰ The European Commission has non-binding recommendations on sustainability criteria for biomass (EC 2016b). These issues are also dealt on the Fuel Quality Directive and the Renewable Energy Directive both of which also have been criticized to fail to deliver on their promises for low-carbon, sustainable and pro-rural development (TNI 2015).

Table 4. Nordic strengths and weaknesses in bioeconomy development (global driver 4: competition between land uses emphasizes the importance of the sustainability of the bioeconomy)



| Nordic strengths | Nordic weaknesses |
|--|--------------------------|
| <ul style="list-style-type: none"> - Expertise in management of natural resources - Expertise in analysis on sustainability of bioeconomy and use of natural resources | |

5. Need to find new sustainable resources

Focus in the bioeconomy has traditionally been on the use of agricultural and forest biomass together with aquatic resources via fishing. However, the raw material pool for bioeconomy activities is expanding rapidly. Blue growth or blue bioeconomy is a sub-branch of green growth focusing on sustainable growth in the marine and maritime sectors, building on renewable marine biomass (FAO 2014, Mikkola et al. 2016).²¹ In addition to the marine biomass, also agroindustrial sidestreams, sidestreams from process industry, municipal waste) and sludge for example from waste water treatment are in the growing interest (Lange et al. 2015). In addition, new type of biomass such as algae and microbes expand the raw material pool. New raw material pools open opportunities to create new industrial ecosystems and take the leading position in these. In the Nordics, blue bioeconomy offers opportunities especially for the West Nordic countries (Sigrún et al 2014).

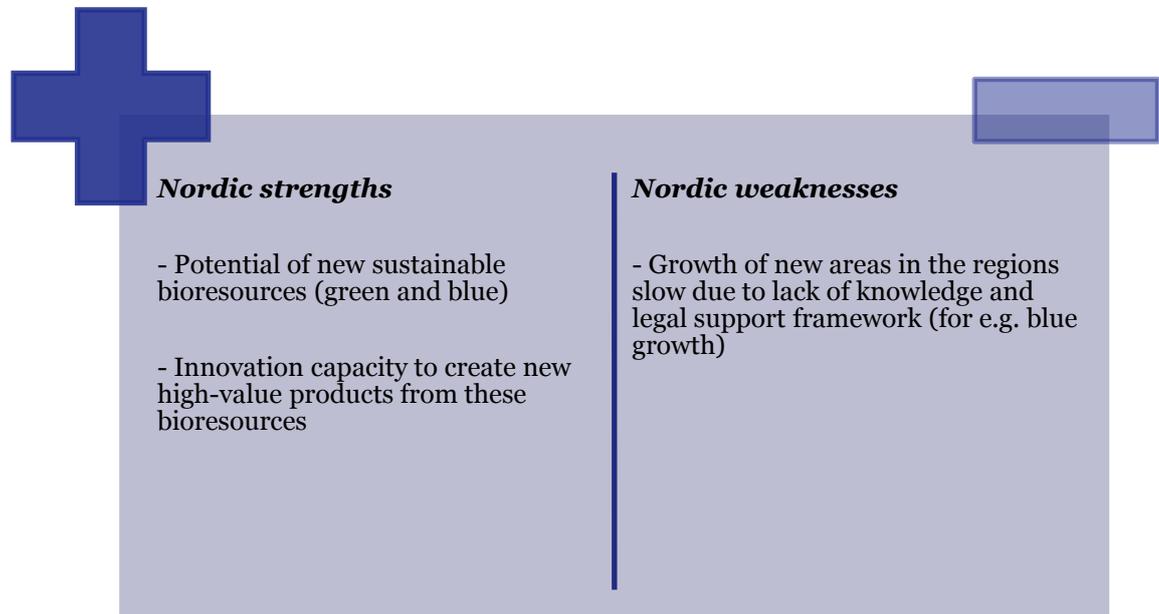
Blue bioeconomy, or blue growth, has rapidly become a global phenomenon. According to WWF (2015), 90 % of the nations of the world that have a coast are involved with some form of Blue Economy declaration, program or formal policy initiative and investments for the sector are increasing. In Europe, a Blue Growth Strategy was launched in 2012 and it highlights opportunities for blue bioeconomy growth especially in aquaculture, coastal tourism, marine biotechnology, ocean energy and seabed mining (EC 2014)²².

²¹ The European Commission has identified aquaculture, coastal tourism, marine biotechnology, ocean energy and seabed mining as key sectors that have a high potential for sustainable growth (EC 2014).

²² Blue growth has also be given a high priority in the Horizon 2020 research programme and received funding of 145 million euros in 2014-2015 together with additional funding opportunities potentially linked to maritime issues across the rest of the research budget (WWF 2015).

Table 5 summarises Nordic strengths and weaknesses in relation to the global development.

Table 5. Nordic strengths and weaknesses in bioeconomy development (global driver 5: Need to find new sustainable resources)



| Nordic strengths | Nordic weaknesses |
|--|---|
| <ul style="list-style-type: none">- Potential of new sustainable bioresources (green and blue)- Innovation capacity to create new high-value products from these bioresources | <ul style="list-style-type: none">- Growth of new areas in the regions slow due to lack of knowledge and legal support framework (for e.g. blue growth) |

2.2. Industrial symbiosis

The following section presents four key global drivers, which have crucial impact on industrial symbiosis development in the Nordic countries. Each driver is described in the light of the latest international development and used as backdrop for positioning the Nordic countries in a global context. For each driver, the main Nordic strengths and weaknesses are summarised in a table. A more detailed analysis of the strengths and weaknesses is presented in Appendix 1.

- 1. Increasing scarcity of natural resources sets pressure on raw material prices**
- 2. Regulation encourages towards more sustainable and resource efficient production**
- 3. Urbanization clusters resource streams**
- 4. Emergence of networked business challenges traditional business sectors and models**

1. Increasing scarcity of natural resources sets pressure on raw material prices

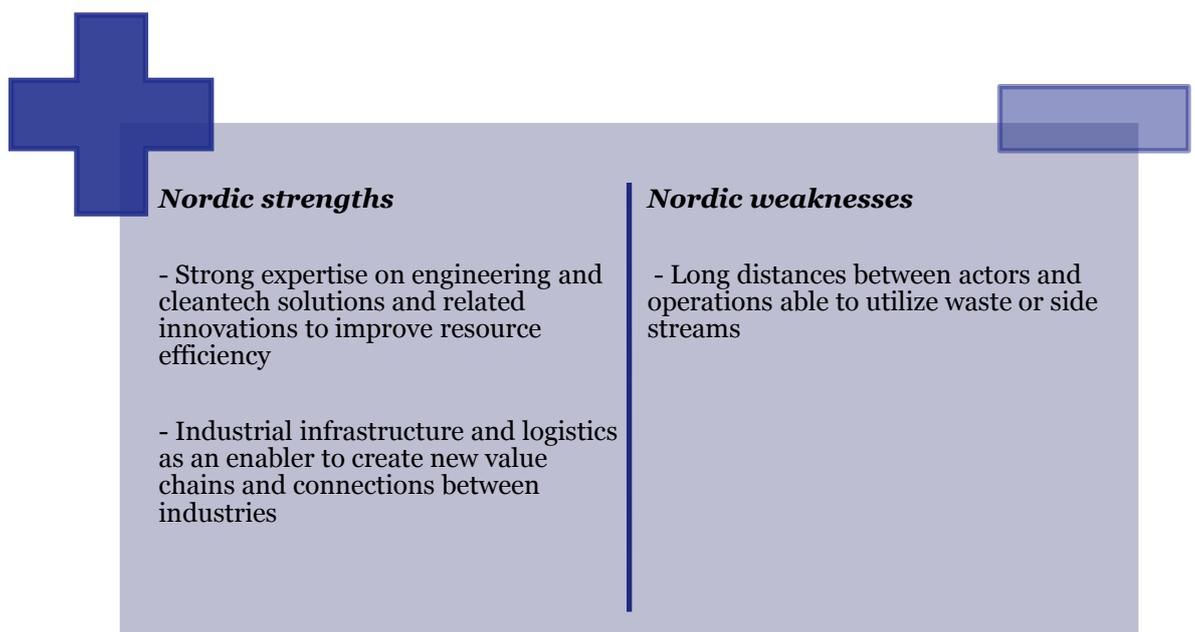
Manufacturing industries account for a significant part of the world's consumption of resources and generation of waste. For example, the industry accounts for more than 50 % of the world's total delivered energy (EIA 2016). Increasing demand for the outputs of the manufacturing industries put pressure on the natural resources, which result in price increase. Rising and volatile commodity prices have potentially significant effects on manufacturing industry and create a strong incentive to improve resource productivity and energy efficiency, develop new alternatives for raw materials and deploy new business models through industrial symbiosis (OECD 2009a).

Raw material scarcity, which leads to higher prices and price volatility, increases manufacturer's costs and risks. Sectors struggling with resource scarcity are for example those relying on minerals and metals such as food production and many manufacturing industries. Global food production is threatened by increasing exploitation of non-renewable phosphate-rock reserved and demand for many metals is expected to grow (Heckens 2015, Neset and Cordell 2012).

Costs and risks can be reduced by systematically focusing on resource productivity throughout the whole value chain and seeking for alternative residue based raw materials. In addition to cost and risk reduction, resource efficient production can benefit companies through increased price premiums of more sustainable products. Industrial symbiosis offers opportunities for companies to rethink their business models across the full supply circle, capture the full potential of valuable resources and thus ensure continuity of the business despite the increasing volatility in resource prices.

Table 6 summarises Nordic strengths and weaknesses in relation to the global development.

Table 6. Nordic strengths and weaknesses in industrial symbiosis development (global driver 1: increasing scarcity of natural resources sets pressure on raw material prices)



| <i>Nordic strengths</i> | <i>Nordic weaknesses</i> |
|--|--|
| <ul style="list-style-type: none">- Strong expertise on engineering and cleantech solutions and related innovations to improve resource efficiency- Industrial infrastructure and logistics as an enabler to create new value chains and connections between industries | <ul style="list-style-type: none">- Long distances between actors and operations able to utilize waste or side streams |

2. Regulation encourages towards more sustainable and resource efficient production

In addition to the market driver (increasing commodity prices), development for resource efficient production and industrial symbiosis is driven by regulation and the role of regulation can be expected to even strengthen in the future²³ (EC 2016a). At European level, the EU encourages Member States to increase the use of a combination of regulatory and economic instruments to encourage industrial symbiosis activities (Watkins 2014). Regulation is used as a policy instrument to enhance industrial symbiosis for example by creating market pull or by promoting regulation related to the utilization of waste materials.

Despite that the role of regulation is recognized to be important, there are no binding targets or regulation directly related to industrial symbiosis on a country level in Nordic region or on a European or global level. Despite the lack of binding targets, voluntary-based tools and supporting instruments for companies and public sector are available²⁴. On European level industrial symbiosis is however strongly linked to the revised EU Circular Economy Package and its legislative proposal on waste, which aims to clarify rules on by-products and set nationally binding waste recycling targets in order to facilitate industrial symbiosis. Many of the EU research and implementation programs (such as H2020, SPIRE 6, BBI-JU, COST, Life+) also support industrial symbiosis and the development of related business networks.

On a global level, the United Nations Environment Programme (UNEP) has promoted both industrial symbiosis and ecoindustrial parks as voluntary instruments to encourage sustainable production systems. Also United Nations Industrial Development Organization (UNIDO) promote adaptation and adoption of resource efficient and cleaner production focusing especially on developing countries. Industrial symbiosis is also indirectly included in the UN's Sustainable Development Goals²⁵.

Table 7 summarises Nordic strengths and weaknesses in relation to the global development.

²³ E.g. EU's Circular Economy Package includes revised legislative proposals on waste to stimulate Europe's transition towards a circular economy.

²⁴ Such as FISS (Finnish Industrial Symbiosis) in Finland, the Green Symbiosis Programme in Denmark, and the recent mission of the Swedish Government to Vinnova to support the development of circular business models and industrial symbiosis, <http://www.vinnova.se/sv/Om-Vinnova/Regeringsuppdrag/Aktuella-regeringsuppdrag/Uppdag-att-stodja-utvecklingen-av-cirkulara-affarsmodeller-och-industriell-symbios/>

²⁵ Industrial symbiosis contributes to delivering Sustainable Development Goals (SDG), especially SDG 12 ("Ensure sustainable consumption and production patterns").

Table 7. Nordic strengths and weaknesses in industrial symbiosis development (global driver 2: regulation encourages towards more sustainable and resource efficient production)



| Nordic strengths | Nordic weaknesses |
|---|--|
| - Partly clear strategic national policy objectives | - Partly lacking strategic policy objectives |
| - Proactive approach to environmental regulation | - Over-implementation of EU environmental regulations |
| - Public support for industrial symbiosis | - Opposition and lack of knowledge at the local level |
| - Forerunners in resource efficiency | - Difficulty of bringing cross-border cooperation into concrete action |

3. Urbanization clusters resource streams

The remarkable wave of urban growth²⁶ has effects on the location of resource and material flows. Material flows will be more concentrated to urban centres which decreases possibilities for local symbiosis due to geographical differentiation of raw material production (rural areas) and consumption (urban centres) (Aho et al. 2013, OECD 2009a). This is especially the case in the agriculture and food production. On the other hand, increasing scarcity of natural resources sets more pressure on the recycling and reuse of waste materials, largest and the most easily collected volumes generated in urban centres. Recycling and reuse of waste materials offers a huge business opportunity for the concept of industrial symbiosis. As it is estimated that in Asia two-thirds of infrastructure demand over the next ten years will be for new construction, rather than maintenance and upgrading, urbanization offers an opportunity to design and build industrial system from the start (OECD 2014).

The world's fastest urbanizing areas have recognized the challenges arising from the polarization of people and raw materials and started to act. Asian Development Bank has sharpened the focus of its urban sector strategy on livable and sustainable cities and provides funding for low-carbon urban solutions (ADB 2013). The Chinese government released in 2014 a National Plan on New Type of Urbanization (2014-2020) for which many cities have responded by announcing their green development vision and goals and by carrying out pilot projects. In addition, the China Urban Sustainable

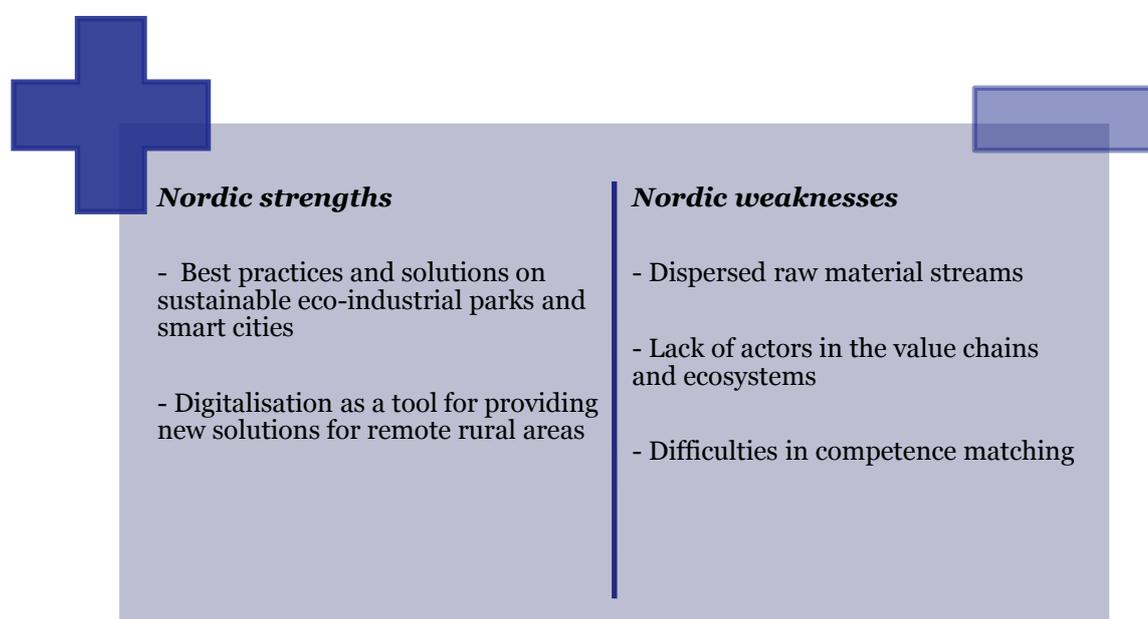
²⁶ More than half of the world's population now lives in towns and cities, and by 2030 this number is expected to grow to about 5 billion. Much of this urbanization will unfold in Africa and Asia (UNFPA 2016).

Coalition including nearly 20 non-profit organizations have declared their recommendations for low-carbon urbanization (EDF et al. 2015).

Although urbanization is not expected to cause significant social, economic or environmental transformation in the Nordic countries, it brings business opportunities to import knowledge and technology to global rapidly developing areas. Impacts of urbanization are also seen in the Nordic countries but in smaller scale. Urbanization creates demand to develop different kinds of industrial symbiosis solutions for urban centres and rural areas.

Table 8 summarises Nordic strengths and weaknesses in relation to the global development.

Table 8. Nordic strengths and weaknesses in industrial symbiosis development (global driver 3: urbanization clusters resource streams)



| Nordic strengths | Nordic weaknesses |
|---|--|
| <ul style="list-style-type: none">- Best practices and solutions on sustainable eco-industrial parks and smart cities- Digitalisation as a tool for providing new solutions for remote rural areas | <ul style="list-style-type: none">- Dispersed raw material streams- Lack of actors in the value chains and ecosystems- Difficulties in competence matching |

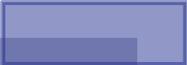
4. Emergence of networked business challenges traditional business sectors and models

The focus of innovations in manufacturing industry is expanding from technological advances also into opportunities of networking. Businesses are moving beyond traditional industry silos and cooperating globally and locally in networked ecosystems. This creates new opportunities to restructure value chains and invent new business models and innovative products and services. Advantages of networked business ecosystems are thus more resource and cost efficient value chains and reduced dependence on changing raw material and waste management costs (Luoma et al. 2015, Aho et al. 2013). Some advanced players have started adopting new ways of doing but the big revolution in manufacturing industry is still expected to come (OECD 2009b).

UK's NISP (National Industrial Symbiosis Programme) is an example of a business opportunity program connecting industry to share knowledge and ideas and identifying opportunities to reuse underused or undervalued resources whilst generating economic and environmental benefits. NISP bases on the facilitated industrial symbiosis and the concept has been replicated in 30 countries across five continents, also in Finland.

Table 9 summarises Nordic strengths and weaknesses in relation to the global development.

Table 9. Nordic strengths and weaknesses in industrial symbiosis development (global driver 4. emergence of networked business challenges traditional business sectors and models)



| <i>Nordic strengths</i> | <i>Nordic weaknesses</i> |
|--|--|
| <ul style="list-style-type: none">- High level of trust- Long track record of successful symbiosis- Positive change in mindset- Good experience of Nordic cooperation | <ul style="list-style-type: none">- Lack of time and resources for creative thinking- Adaptation of new roles of players in complex circular systems and business models- Too little experience of open innovation and cooperation |

3. Conclusions on strengths and opportunities of Nordic regional green growth

3.1. SWOT analysis of Nordic regional green growth

The global development described in the previous chapter creates a framework for future Nordic green growth development. The main Nordic strengths and weaknesses defined form the basis to build on to meet the challenges and opportunities arising from the global development. A summarised SWOT analysis of strengths, weaknesses, challenges and opportunities of Nordic regional green growth is presented below. The SWOT is a product of independent expert analysis, based on both the synthesis study and the Nordregio workshop in Stockholm in October 2016 and with the main sources of information given in brackets for each point. The SWOT is divided over two pages, presenting first the strengths and weaknesses and then the opportunities and threats of Nordic regional green growth.

STRENGTHS

Strong political will and policy framework to support bioeconomy and green growth. In addition to national strategies, bioeconomy has been a priority in the Nordic cooperation over the last five to ten years, and political support also includes regional authorities. (sources: desk study, workshop)

Vast natural resources and expertise in their management and related green growth innovations. The Nordic countries have vast natural resources, compared to population that can be utilised in green growth. Also a strong R&D and innovation background and expertise coupled with high density of knowledge institutions and growing industry-academia partnerships has ensured globally well-known expertise on green growth. (sources: desk study, interviews, workshop)

Industrial know-how and infrastructure. There is strong technological know-how and organized business ecosystems in many relevant business sectors enabling green growth, which could be also applied to new sectors. The Nordic countries are global forerunners and ranked internationally high on several green growth related indicators e.g. on cleantech solutions, resource efficiency and green economy ²⁷. (sources: desk study, interviews, workshop)

Pragmatic approaches and proximity to decision makers. Green growth requires cooperation between national, regional and local policy makers and market players across the multiple sectors. This is possible in the Nordic countries, which are internationally known for their pragmatic approaches and proximity to decision makers. The tradition for Nordic cooperation. (sources: desk study, interviews, workshop)

Internationally known Nordic brand and awareness of business and consumers in the Nordics. The Nordic green and high-quality brand is an international trademark, which can be utilised when entering new markets and providing “Nordic” solutions, or attracting investments to Nordic regions. Awareness of both business and consumers on sustainability is high in the Nordic countries. (sources: desk study, interviews, workshop)

WEAKNESSES

Lack of political leadership for fighting against “business as usual” and enforcing radical change. Also lack of coherence of policies and dialogue between sectors e.g. contradictions in subsidising policies, overlapping strategies and action plans prohibit development and radical moves. (sources: workshop)

Mismatch of competence and resources in remote regions. There are difficulties in competence matching and a mismatch between the availability of natural resources and skilled workforce and competence in rural regions. Policies and incentives, including education, are needed to match the assets and business needs better. (sources: workshop, interviews)

Small domestic markets in combination with a lack of capital and investments, lack of visibility and knowledge of regional players to take knowledge to markets, lack of domestic references needed for entering international markets (and underutilisation of the possibilities for Nordic cooperation), with many small players, makes it difficult to commercialise ideas. (sources: desk study, interview, workshop)

Creating of new business in the regions. When aiming for green growth and regional growth overshadowed innovation potential of SMEs, lack of instruments for market entrance, lack of time and resources for creative thinking, over-implementation of EU environmental regulation, and lack of legal framework to support growth in new areas might be critical weaknesses (sources: desk study, interviews, workshop)

²⁷ See appendix 2 presenting the Nordic countries’ ranking on the following indicators: The Global Cleantech Innovation Index 2014, The Global Green Economy Index 2016, Environmental performance Index 2016, The Climate Change Performance Index 2016, EY Renewable energy country attractiveness index 2016

OPPORTUNITIES

Global urgency and growing demand for clean and green solutions due to environmental challenges, regulatory development and growing awareness opens up new business opportunities for Nordic entrepreneurs. (sources: desk study, workshop)

Regional forerunners are in need globally to lead the way to green growth. Smart cities and eco-industrial parks are some of the areas where Nordic countries have a lot of best practice to share. Innovations are in need in a variety of different countries. (sources: desk study, interviews)

A shift from traditional industries to new value-creating ecosystems. Traditional value chains are changed, new actors and new links between actors emerge. Nordic businesses in the regions can be key actors in the emerging global value chains and ecosystems. (sources: desk study, interviews)

Opportunities of digitalisation can provide new solutions for remote rural areas and the Nordic countries are in the forefront in digital development and have experience of digital platforms to facilitate resource exchange, which can provide best practice examples for regional work on green growth. (sources: interviews, workshop)

Financial incentives with regional focus (e.g. access to EU structural funds and H2020) The European Structural and Investment Funds has played an important role in the Finnish and Danish case study regions for promoting industrial symbiosis projects, and could do that also in the future. (sources: desk study, workshop)

THREATS

Low oil and fossil-based raw material prices may slow the development and market entrance of green solutions. It has a direct impact on the attractiveness of clean and green alternatives and profitability of the investments. (sources: desk study, workshop)

EU and global regulatory development. EU and global regulatory framework may stamper the development in the regions, if regulations are seen too difficult, complex, or lacking coherence and predictability. The market for green solutions also still strongly depends on how different solutions are subsidized and market pull created by the regulation. Especially on a regional perspective the creation of demand is crucial and a good balance between pull, push and regulation is needed. (sources: desk study, interviews, workshop)

Shift of political and media focus. Many of the green growth drivers have had a relatively strong focus in politics and media in the recent years. There is a threat that main political and media focus in EU and internationally might shift to other challenges. Also consumer awareness internationally may shift focus to global challenges which are not directly related to environmental issues. (sources: workshop)

Ownership and use of natural resources creates conflicts in increasing amounts. In the era of diminishing natural resources the ownership and use of the natural resources can cause conflicts globally, nationally and regionally. (sources: desk study)

3.2. Added value of Nordic cooperation for regional green growth

The mapping of Nordic strengths and challenges provides a good basis for identifying future possibilities for cooperation adding value to green growth development in Nordic regions. The identified strengths form a Nordic competitive edge, and some of the identified weaknesses, on the other hand, can be diminished through common efforts. The studies and interviews made and especially the regional case studies show that Nordic regions can achieve growth when cooperating on the strengths they have identified and jointly battling their challenges.

As the SWOT analysis points out, the development of internationally strong and innovative Nordic regions requires cooperation between all societal levels and sectors, also across the national borders.

- National authorities and actors provide the big picture and vision of the future opportunities of the regions and how green growth can contribute to it, providing strategies and regulations that support the development. The role of cluster organizations and networks as well as communication and coordination initiatives at the national level can also play an important role in creating awareness about the potential of green growth (as many of the cases show)²⁸. (Johnsen et al. 2015, interviews, Nordregio road show 2016)
- Regional and municipal authorities and development organisations provide the knowledge on regional and local characteristics using structural funds and other tools in a way that promotes green growth, helping SMEs to take an active role in green growth through funding and support, mediating change and offering a platform to meet and facilitate new green growth activities. Regional authorities also have a crucial role in facilitating the creation of company clusters and networks, where companies are brought together. (interviews)
- Companies and their employees are the most important players and provide together with other companies and actors the solutions for green growth. Companies together with the academia and authorities create a common ecosystem where everybody has an important role. (Nordregio road show, interviews)
- Academia provides the knowledge base and expertise for new solutions and development platforms in partnership with industry. The Nordic region has a high density of academic environments and research organisations can act as facilitators of knowledge building and infrastructure. (desk study, Nordregio road show 2016)
- The people of the regions provide both the work force needed for innovative entrepreneurship, and as consumers the market pull for new greener solutions. In order for regions to prosper they must attract skilled work force and have not only the business infrastructure but also the needed

²⁸ E.g. Finland has had success with clusters (such as the Vaasa energy cluster and the Lahti cleantech cluster) where private company forerunners and the management of municipalities have committed to cluster development.

societal infrastructure in place (including health care, education, attractive leisure environment etc). (interviews)

The Nordic governmental cooperation realized through the Nordic Council of Ministers and its institutions supports cooperation on all levels and across sectorial, regional and national borders. Existing structures and instruments cover both **policy development, financial incentives and structures for facilitating networking on all levels across regional, national, and sectorial borders.**

4. Looking into the future of green growth in Nordic regions

The SWOT analysis of the Nordic regional green growth as well as the consultations made in the regions by Nordregio (Nordregio road show) point out possibilities for Nordic regions to develop into strong sustainable biobased and circular economies, as well as contributing to solving some of the most relevant/currently present sustainability issues globally. However, this transformation requires not only incremental steps but also radical renewal of the socio-economic structures including not only the material streams and business concepts but legislation, policies and education, cutting through all parts of the society and economy.

As a starting point, an optimisation of existing frameworks and instruments can be a good tool for sharing knowledge, raising awareness and enabling incremental improvement in existing industrial ecosystems and public private partnerships, cultivating the ground for more radical long-term change. However, in the longer run unlocking the potential for Nordic regional green growth requires measures that support and drive radical societal change.

The draft road map for green growth presented below was outlined as part of the work with the synthesis report. It is based on essential views raised during Nordregio's work with green growth, innovation and entrepreneurship 2013-2016, supplemented by views from the international interviews made by Gaia as well as on the outcomes of the workshop held at Nordregio on 11 October 2016.

The draft roadmap for Nordic regional green growth outlines a possible vision for Nordic regional green growth, and tries to combine long-term (year 2030) and short-term (year 2020) targets with recommendations for concrete actions towards more sustainable, innovative and resilient Nordic regions. It provides a point of departure (as of October 2016) for the next four years, to be further developed.

4.1. A draft vision for Nordic regional green growth

**Vision for Nordic regional green growth:
Nordic regions jointly lead the way to sustainable growth
in the short and long term**

The key elements of the vision are:

- **Nordic regions** and regional diversity and inclusiveness, the vision concerns all regions, urban and rural, from the Arctic to southern Denmark
- **Together** although different, regional diversity creates strengths and added value of cross-border Nordic collaboration, promoting a diverse but unified and clear Nordic voice
- **Lead the way** as an active forerunner to solve most actual global challenges not afraid of tackling difficult issues as well
- **Sustainable**, as in green, innovative, and resilient regions with well-being people, considering all three dimensions - economic, environmental and social - of sustainable development
- **Growth** as an ongoing transition, based on the strengths that *each Nordic region* has identified
- **In the short and long term** means that not only incremental but also radical moves are possible

4.2. Draft strategic targets for Nordic regional green growth

Strategic targets (for the year 2030) that support the vision are²⁹:

Green growth is an integral part of regional strategies and actions

Business in the regions is based on sustainable solutions

Regional actors are active in Nordic and global ecosystems

²⁹ The targets were outlined based on group discussions of the workshop at Nordregio on 11 October 2016 and further refined by Gaia and commented by the Nordic working group on green growth, innovation and entrepreneurship.

Some first steps towards reaching these targets were identified:

**Vision: Nordic regions together lead the way
to sustainable growth in the short and long term**

Strategic target 2030

Targets by 2020

**Green growth is an integral part
of regional strategies and actions**

1. Regions are making full use of their strengths and discuss with each other to fill the gaps and taking steps towards smart Nordic regional specialization.
2. Nordic, national and regional authorities offer incentives for the adoption of green growth/circular economy principles in all regions.
3. National and regional authorities favour green public procurement

**Business in the regions is based
on sustainable solutions**

1. Companies create new business models and partnerships, increasing the resource-efficiency and profitability within green growth.
2. Business support organisations and advisory business services offer active coaching for entrepreneurs in all regions.
3. There are tools and indicators in use that show green growth on regional level.

**Regional actors are active in Nordic
and global ecosystems**

1. Nordic, national and regional authorities offer incentives and platforms for knowledge exchange and sharing of best practice regionally, nationally and globally.
2. Nordic regions engage actively in knowledge sharing and mutual learning with other regions in the world and push for development in European and global networks.
3. Digital solutions provide possibilities for peripheral regions to move into the centre of Nordic and global networks.

4.3. Draft roadmap 2017-2020: Recommendations for steps to take

Specific recommendations are to be further developed and prioritised in the work to come. Below, some recommendations are exemplified for each target.

Green growth is an integral part of regional strategies and actions

1. Regions are making full use of their strengths and discuss with each other to fill the gaps and taking steps towards smart Nordic regional specialization.

- Actively use the regional strengths already identified for creating action plans for green growth and for capitalizing on the existing strengths and assets of the regions to create smart specialization, e.g. strategic positioning of regions as part of larger regional, national and global ecosystems (regions) (Nordregio road show, interviews, workshop)
- Drive the creation of ecosystems of business, academia and authorities based on the regional strengths and use spatial presentation of strategies and strengths for raising the awareness of the regional perspectives, as a networking tool for the regions and as a help to identify industrial symbiosis opportunities (regions, Nordic Council of Ministers, Nordregio) (Nordregio road show, interviews, workshop)
- Share insight and knowledge on the best Nordic practices in developing sustainable and smart cities and regions as well as effective programmes and instruments on regional, Nordic and global level (regions, Nordic Council of Ministers, Nordregio) (Nordregio road show, workshop)

2. Nordic, national and regional authorities offer incentives for the adoption of green growth/circular economy principles in all regions.

- Harness Nordic cooperation to support the cross-border flow of material and joint use of infrastructure, share business development services and infrastructures and encourage companies to locate close to each other (regions, Nordic Council of Ministers, national policies) (desk study, interviews, workshop)
- Help the creation of eco-industrial parks through town planning and land-use regulation³⁰ and promote the planning and designing of new areas in a way that enables circular economy and industrial symbiosis already into master plan phase (regions) (Nordregio road show)
- Use local utility stations as key driving forces for circular economy and industrial symbiosis development³¹ and support waste management companies in building new business models (regions) (Nordregio road show, workshop)

³⁰ Lehtoranta et al. 2011

³¹ A utility station in Sweden created a matrix that clarified what different companies in the municipality could contribute to the renewable energy and energy efficiency projects initiated by the utility station

- Build bridges between local sharing and collaborative communities and traditional business and in that way support the transition to sharing and collaborative economy (regions, Nordic Council of Ministers, national policies) (Nordregio road show, interviews)

3. National and regional authorities favour green public procurement

- Use green public procurement to encourage green growth, taking example from e.g. Norway's greenmarking of public tenders as an example how government can create market for green solutions (regions, Nordic Council of Ministers) (interviews)
- Organize competence building and means for lowering barriers for public procurement (as not all barriers are legally founded) (regions, Nordic Council of Ministers) (workshop)
- Use public procurement as a support mechanisms for giving companies necessary references for entering international markets (regions) (desk study)

Business in the regions is based on sustainable solutions

1. Companies create new business models and partnerships, increasing the resource-efficiency and profitability within green growth.

- Support the creation of new business ecosystems and knowledge exchange by getting business together with academia and by possibly employing financial incentives (e.g. regional innovation vouchers for green growth) (Nordic Council of Ministers, national policies, EU) (desk study, workshop)
- Support Nordic companies in internationalizing their business together, through joint ambitious actions or e.g. Nordic representations and Innovation Houses (Nordic Council of Ministers) (desk study, interviews)
- Promote the upscaling of regional innovations by piloting and demonstration through intensified co-operation between Nordic regions and by encouraging cities and municipalities to invest more in piloting and demonstration to stimulate innovation in their region (regions, national policies) (desk study, Nordregio road show, interviews)
- Cooperate on green growth service concepts, using best practice form the different countries (regions) (desk study, Nordregio road show, interviews, workshop)

2. Business support organisations and advisory business services offer active coaching for entrepreneurs in all regions.

- Use existing incubators to work with the establishment of new companies, engaging a wider set of players, incl. students, incubators and expert advisors, launch innovator scale-up programs (regions) (Nordregio road show, interviews, workshop)
- Pilot the use of digital tools to develop the functionality and outreach of regional business support systems (regions) (workshop)
- Facilitate accelerated innovation and business cooperation such as regional and cross-border business matchmaking events (regions, Nordic Council of Ministers) (Nordregio road show, workshop)

3. There are tools and indicators in use that show green growth on regional level.

- Develop measures and indicators to show the green growth on the regional level to encourage actors to work towards green growth (Nordregio) (workshop)

- Significantly increase the visibility of Nordic green growth, by communicating the results regionally, nationally and globally to strengthen the position of the Nordic countries on the green growth development (regions, Nordregio, Nordic countries) (workshop)

Regional actors are active in Nordic and global ecosystems

1. Nordic, national and regional authorities offer incentives and platforms for knowledge exchange and sharing of best practice regionally, nationally and globally.

- Use Nordic cooperation as a tool for promoting dialogue between different actors for example facilitating fora for enhanced policy coordination between regional players and state-level policy makers across Nordic borders to support industrial symbiosis (regions, Nordic Council of ministers) (Nordregio road show, workshop)
- Facilitate contacts and encourage multi-disciplinary and inter-sectoral knowledge sharing on methodologies for industrial symbiosis development, also between different industrial clusters (Nordic Council of Ministers and Nordic institutions, regions, companies, Nordic symbiosis networks) (Nordregio road show)
- Involve research organisations as facilitators of development and for sharing of infrastructure and innovation platforms (companies, research organisations, regions, national policies, Nordic Council of Ministers) (Nordregio road show)

2. Nordic regions engage actively in knowledge sharing and mutual learning with other regions in the world and push for development in global and European networks.

1. Provide common input to national policymakers and the EU Commission and use Nordic instruments for joint access to new networks (regions, Nordregio, Nordic Council of Ministers, Nordic symbiosis network) (desk study, Nordregio road show, workshop)
2. Strengthen the Nordic brand as a forerunner in green growth (e.g. by feeding into the branding work currently done under the Nordic Council of Ministers) and use the work done and existing material for making Nordic solutions visible in international fora, where relevant, e.g. Nordic countries joining forces like in COP22 Marrakech (Nordregio, Nordic Council of Ministers, Nordic institutions) (desk study, interviews)

3. Digital solutions provide possibilities for peripheral regions to move into the centre of Nordic and global networks.

- Actively explore the opportunities of digitalization for new business models and networking, cooperating on digital solutions enhancing cross-border collaboration (regions, companies, national policies, Nordic Council of Ministers) (interviews, workshop)

References

ADB. 2013. Financing Low-Carbon Urban Development in South Asia. <https://www.adb.org/sites/default/files/publication/30422/low-carbon-urban-development-south-asia.pdf>

Aho, M., Hakala, L., Karttunen, V., Pursula, T., Saario, M., Tommila, P., Vanhanen, J. 2013. Arvoa ainekierroista – teollisten symbioosien globaali markkinakatsaus. Sitran selvityksiä 70.

BECOTEPS. 2011. The European Bioeconomy in 2030 - Delivering Sustainable Growth by addressing the Grand Societal Challenges. White Paper.

Biotechnology Innovation Organization (BIO). 2016. Advancing the Biobased Economy: Renewable Chemical Biorefinery Commercialization, Progress, and Market Opportunities, 2016 and Beyond.

CEPI. 2012. Biobased for Growth - a public-private partnership on biobased industries.

EIA. 2016. The International Energy Outlook 2016.

EFI 2015. The European Forest Industry Strategy.

Environmental Defense Fund (EDF), Energy Foundation China (EFC), Institute for Sustainable Communities (ISC), Natural Resources Defense Council (NRDC), World Resources Institute (WRI), and World Wide Fund for Nature (WWF). 2015. Ten Key Principles of Low Carbon Urbanization. <https://www.nrdc.org/sites/default/files/10-key-principles-of-low-carbon-urbanization-1126.pdf>

Erkman, S. & Massard, G. 2015. 12th Industrial Symbiosis Research Symposium. Activity Report. Organized by Université de Lausanne. http://is4ie.org/resources/Documents/IS-Section/12thISRS_SymposiumReport_comp.pdf

European Commission. 2012. Innovating for Sustainable Growth: A Bioeconomy for Europe. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.

European Commission. 2016a. Circular Economy Strategy. http://ec.europa.eu/environment/circular-economy/index_en.htm

European Commission. 2016b. Renewable Energy. Biomass. <https://ec.europa.eu/energy/en/topics/renewable-energy/biomass>

European Commission. 2016c. Renewable Energy. Biofuels. <https://ec.europa.eu/energy/en/topics/renewable-energy/biofuels>

European Commission. 2015. LULUCF. <http://forest.jrc.ec.europa.eu/activities/lulucf/>

European Commission. 2014. Maritime Affairs. Blue growth. http://ec.europa.eu/maritimeaffairs/policy/blue_growth/index_en.htm

EU 2030. <http://www.epsoweb.org/file/560>

Food and Agriculture Organization of the United Nations FAO. 2014. The State of World Fisheries and Aquaculture: Opportunities and Challenges. <http://www.fao.org/3/a-i3720e.pdf>

Innventia. 2016. Innventia Global Outlook 2016: A Cellulose-Based Society. Press Report. http://www.innventia.com/Documents/Aktuella%20projekt/Pressrapport_eng.pdf

Heckens, M. L. C. M., van Ierland, E. C., Driessen, P. P. J., Worrel, E. 2016. Mineral resources: Geological scarcity, market price trends, and future generations. Resource Policy. Volume 49, p. 102-111.

Johnsen, I. H. G. (Ed.), Berlina, A., Lindberg, G., Mikkola, N., Smed Olsen, L. & Teräs, J. 2015. The potential of industrial symbiosis as a key driver of green growth in Nordic regions. Nordregio Report 2015:1

KPMG. 2011. Energy and Natural Resources: Taxes and Incentives for Renewable Energy. <https://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Documents/Taxes-Incentives-Renewable-Energy-2011.pdf>

Lange, L., Björnsdóttir, B., Brandt, A., Hildén, K., Hreggviðsson, G. O., Jacobsen, B., Jessen, A., Nordberg Karlsson, E, Lindedam, J., Mäkelä, M., Smáradóttir, S. E., Vang, J. and Wentzel, A. 2015. Development of the Nordic Bioeconomy NCM reporting: Test centers for green energy solutions – Biorefineries and business needs. TemaNord 2015:582.

Lehtoranta, S., Nissinen, A., Mattila, T. & Melanen, M. (2011) Industrial symbiosis and the policy instruments of sustainable consumption and production. Journal of Cleaner Production. 19(16):1865-1875.

Lindberg, G., Johnsen I., Kristensen I., Teräs J. + Hodgson E. (2016): Incentives, enablers and obstacles for developing a greener economy in the Nordic regions (forthcoming)

Lombardi, D. R. & Laybourn, P. 2012. Redefining Industrial Symbiosis. Crossing Academic–Practitioner Boundaries. Journal of Industrial Ecology. Volume 16, Issue 1, pages 28-37.

Luoma, P., Harder, S., Hjelt, M., Larvus, L., Pursula, T., Raivio, T. & Vanhanen, J. 2015. Innovation in Natural Resources: Evaluation of Tekes' Programmes on Natural Resources. Evaluation Report.

Mikkola, N., Randall, L., Hagberg, A. (eds.). 2016. Green Growth in Nordic Regions – 50 ways to make it happen. Nordregio 2016

Neset, T. S. and Cordell, D. 2012. Global phosphorus scarcity: identifying synergies for a sustainable future. Journal of the Science of Food and Agriculture.

Nordregio 2016. State of the Nordic Region. Nordregio Report 2016: 1

Nordregio policy brief 2015:5: Bioeconomy – the Growth Engine of Nordic Regions?

Nordregio roadshow 2016: Interim report on Nordregio Nordic Green Growth Road Show 2016 (unpublished)

OECD Observer. 2012. An emerging middle class. http://oecdobserver.org/news/fullstory.php/aid/3681/An_emerging_middle_class.html

- OECD. 2009a. The Bioeconomy to 2030: designing a policy agenda. International Futures Programme.
- OECD. 2009b. Sustainable manufacturing and eco-innovation: Framework, Practices and Measurement. Synthesis Report.
- OECD. 2014. Urban Green Growth in Dynamic Asia. A conceptual framework. <https://www.oecd.org/regional/regional-policy/Urban-GG-Dynamic-Asia-report.pdf>
- Teräs, J., Lindberg, G., Johnsen, I. H. G., Perjo, L., Giacometti, A. Bioeconomy in the Nordic region: Regional case studies. Nordregio Working paper 2014:4.
- Sigrún Elsa Smáradóttir, Lilja Magnúsdóttir, Birgir Örn Smáráson, Gunnar Þórðarson, Birgit Johannessen, Elísabet Kemp Stefánsdóttir, Birgitte Jacobsen, Unn Laksá, Hrönn Ólína Jörundsdóttir, Svein Ø. Solberg, Rólvur Djurhuus, Sofie Erbs-Maibing, Bryndís Björnsdóttir, Ragnhildur Gunnarsdóttir, Kjartan Hoydal, Guðmundur Óli Hreggviðsson, Guðmundur Bjarki Ingvarsson, Amalie Jessen, Hörður G. Kristinsson, Daði Már Kristófersson, Nette Levermann, Nuka Møller Lund, Josephine Nymand, Ólafur Reykdal, Janus Vang, Helge Paulsen, Sveinn Margeirsson. 2014. Future Opportunities for Bioeconomy in the West Nordic Countries. Matis Report.
- BIC Bio-based Industries Consortium. 2013. Strategic Innovation and Research Agenda (SIRA). Bio-based and Renewable Industries for Development and Growth in Europe
- Rönnlund, I., Pursula, T., Bröckl, M., Hakala, L., Luoma, P., Aho, M. & Pathan, A. 2014. Creating value from bioresources. Innovation in Nordic Bioeconomy. Nordic Innovation Publication 2014:01.
- Salmi, O. 2013. Industrial Symbiosis - competitive edge from material efficiency: Global trends. VTT Webinar 1.1.2013. <http://www.vtt.fi/medialle/tapahtumat/industrial-symbiosis-competitive-edge-from-material-efficiency>
- Tennant, M. 2013. Sustainability and manufacturing: Future of Manufacturing Project: Evidence Paper 35. Foresight, UK's Government Office for Science.
- Tomic, S. & Delic, D. Effects of Industrial Symbiosis on Company's Energy Efficiency and Renewable Energy Use
- TNI. 2015. The Transational Institute. The Bioeconomy – a primer
- UNFCCC. 2014. Land Use, Land-Use Change and Forestry (LULUCF). [http://unfccc.int/land use and climate change/lulucf/items/1084.php](http://unfccc.int/land_use_and_climate_change/lulucf/items/1084.php)
- UNEP. 2011. Decoupling natural resource use and environmental impacts from economic growth, A Report of the Working Group on Decoupling to the International Resource Panel. Fischer-Kowalski, M., Swilling, M., von Weizsäcker, E.U., Ren, Y., Moriguchi, Y., Crane, W., Krausmann, F., Eisenmenger, N., Giljum, S., Hennicke, P., Romero Lankao, P., Siriban Manalang, A., Sewerin, S.
- UNFPA. 2016. Urbanization. <http://www.unfpa.org/urbanization>
- Watkins, G. 2014. Opportunities and Barriers in the Beneficial Utilisation of Process Industry Residues. Aalto University publication series. Doctoral Dissertations 56/2014.
- WWF. 2015. All hands on deck. Setting course towards a sustainable blue economy.

World Economic Forum. 2016. World Economic Forum White Paper Digital Transformation of Industries: Digital Consumption. <http://reports.weforum.org/digital-transformation-of-industries/wp-content/blogs.dir/94/mp/files/pages/files/wef-dti-digital-consumption-narrative-final-january-2016.pdf>

Interviews conducted by Gaia Consulting for this study:

Bleriot, Jocelyn, Executive Officer, Ellen MacArthur Foundation, United Kingdom. Interview 15 September 2016.

Hallberg, Magnus, Chief Executive Officer, Processum, Sweden. Interview 26 September 2016.

Herlevi, Kari, Senior Lead, Circular Economy, Sitra, Finland. Interview 30 September 2016.

Homanen, Ilkka, Director, Cleantech, Energy, Environment and Forest Industries, Finpro, Finland. Interview 28 September 2016.

Lange, Lene, Professor, PhD and Dr.scient, Technical University of Denmark, Department of Chemical and Biochemical Engineering, Denmark. Interview 20 September 2016.

Migliorini, Paola, Team Leader Circular Economy, the European Commission, Directorate General Environment, Belgium. Interview 23 September 2016.

Saddler, Jack, Professor, Forest Products Biotechnology/ Bioenergy, The University of British Columbia, Canada. Interview 21 October 2016.

Schwager, Petra, Industrial Development Officer, Cleaner and Sustainable Production Unit, UNIDO, Austria. Interview 19 September 2016.

Siitonen, Sari, Director, Sustainable Business, Confederation of Finnish Industries (EK), Finland. Interview 26 September 2016.

Thormodsdottir, Sigrídur, Senior Innovation Adviser; and Dahl, Bergny Irene, Senior Adviser; Innovasjon Norge, Norway. Interview 23 September 2016.

Werner, Marit, Programme Manager, Vinnova, Sweden. Interview 19 September 2016.

Appendix 1: Background on Nordic strengths and weaknesses in Bioeconomy and Industrial Symbiosis

Appendix 1. Background on Nordic strengths and weaknesses in Bioeconomy

| Global driver | Nordic Strengths | Nordic Weaknesses |
|--|--|--|
| Bioeconomy development is driven by the urgent need to mitigate climate change | <p>Inclusion of bioeconomy solutions in the climate change policies and strong political will to promote bioeconomy. In Denmark, Finland, Sweden and Island, bioeconomy is directly or indirectly covered in national strategies. Bioeconomy has been a priority in the parliamentary and governmental cooperation between the Nordic countries over the last five to ten year. The strong political support includes also regional authorities. (sources Teräs et al. 2014, Lange et al. 2015, Lindberg 2016)</p> <p>Public funding and support to promote bioeconomy as a part of climate change mitigation is relatively strong in the Nordic countries. All public funding agencies in the Nordic countries have established major programmes dedicated to developing knowledge, knowhow and technologies of relevance to the bioeconomy. (interviews, Lange et al 2015)</p> <p>Development of non-food biomass based solutions, e.g. residue-based biofuels, where Nordic countries have the necessary framework and knowhow. However, the availability of residues is limited. (desk study, interviews)</p> | <p>Uncertainties and lack of coherence in policy development. Policy development is partly contradictory (e.g. with regard to regulations and subsidies), and changing political priorities hinder the implementation of long-term strategies. A more holistic approach is needed. (Lindberg 2016, Nordregio road show 2016)</p> <p>Getting from national level strategies to concrete outcomes. The Nordic countries have ambitious targets for the development of bioeconomy but instruments and actions to reach the targets are seen insufficient (Teräs et al. 2014). (interviews, Nordregio road show 2016)</p> <p>Lack of investment and capital in Nordic regions slow down the development of business. Building new industries (such as technological solutions in bioeconomy) requires a lot of capital, and thus the development of the regulation needs to be predictable to encourage innovations. (Lindberg 2016, interviews)</p> <p>Cross-border barriers created by different governance models and regulations between the Nordic countries. Mental barriers concern e.g. how to mediate between collaboration and competition and the movement of material and people across borders. (interviews, Nordregio road show 2016)</p> |
| Decoupling economic growth from resource use | <p>Competence to use advanced technologies and digital solutions for resource-efficiency and non-material value-adding services are major enablers of future bioeconomy. The Nordic countries have a competitive edge and can be in the forefront on these type of solutions and change management. (interviews)</p> <p>Existing industry infrastructure, including technological knowhow and organised business ecosystems as a key enabler: This knowhow of traditional business sectors can also be transferred and applied to new sectors. Existing biorefinery initiatives within the Nordic region also provide a good basis for opportunities. (interviews, Lange et al. 2015)</p> | <p>Access to skilled work force and education that meets the needs of the business in the regions is a challenge in sparsely populated regions. Local education is partly lagging behind when compared to the demand for technology expertise in bioeconomy-related fields. The low population density of the Nordic region is also a challenge. (interviews, Nordregio road show 2016, Lindberg 2016)</p> <p>Lack of models for shared use of RDI infrastructures e.g. for upscaling biorefinery technologies and processes, especially needed are facilities for upscaling technologies and solutions. The Nordic countries could do much more in sharing best practices and joint use of development platforms. (Lange et al. 2015)</p> <p>Overshadowed innovation potential of SMEs. Big industries and traditional fields of bioeconomy easily overshadow the potential of small enterprises to develop cleantech solutions. In addition, many SMEs do not fully acknowledge the need for cooperating with other companies, especially across borders. (interviews)</p> <p>Not sufficient focus on higher-value products. The Nordic countries would need to focus more on upgraded use of bioresources for high value products, such as food and feed ingredients, chemicals and functional materials. (Sigrún et al. 2014, Lange et al. 2015, interviews)</p> |
| Power of consumer choices creates more demand for sustainable products and services | <p>The green Nordic brand is internationally known and can be used for creating market opportunities and for promoting Nordic success stories. (interviews)</p> <p>Consumer awareness is high in the Nordic countries, in comparison with international markets. The same applies to the business awareness. (desk study, workshop)</p> <p>Excellent raw material potential for value added bio products enabling production investments to serve the global markets. Taking advantage of these opportunities based on the specific characteristics of the Nordics would enable further production investments to serve the global markets. (desk study)</p> | <p>Small domestic markets in the Nordics require companies to enter international markets in order to grow and be competitive. However, the Nordic countries fail to provide companies with sufficient support instruments for internationalization and many SME's are not familiar with international funding opportunities. (interviews)</p> <p>Lack of instruments for market entrance. R&D funding in the Nordics is strong, but mainly focused on basic R&D with too little support for upscaling and realising scale-up solutions (as compared to e.g. China and the US), market entrance requires capital. (Lindberg 2016, interviews)</p> <p>Communication challenges across scattered and diverse fields. Conservative perceptions about traditional industries still exist, although the public awareness of the value of green growth activities is generally high in the Nordics. Insufficient communication between the different areas of green growth creates barriers, where strengths could be built. (Nordregio road show 2016, interviews)</p> |
| Competition between land uses emphasizes the importance of the sustainability of the bioeconomy | <p>Expertise in the management of natural resources: The Nordic countries have extensive technological knowhow and expertise (skilled work force) in the management, use and refinement of biomasses. A strong R&D background coupled with high density of knowledge institutions and growing industry-academia partnerships enables the valorisation of side streams from primary production and from the bio-industrial sector as a base for developing high-value industries. (Lange et al. 2015, Teräs et al 2014, interviews)</p> <p>Expertise in analysis on sustainability of bioeconomy and use of natural resources (Desk study, interviews)</p> | |
| Need to find new sustainable resources | <p>Potential of new sustainable bioresources (green and blue). Marine bioresources especially in the West Nordic countries provide opportunities for "agriculture of the oceans". Cultivation of algae can benefit from experiences from land-based agriculture (e.g. property rights), where the Nordics have strong experience. Blue biorefineries can also be smaller and more local. (Sigrún et al. 2014, Lange et al. 2015)</p> <p>Innovation capacity to create new high-value products from these bioresources: The Nordic countries have the necessary technology and know-how to be able to utilise bioresources efficiently and make high value products from green and blue biomass (e.g., in Iceland, 80 % of the cod in food products, when normally only 40 % of fish ends up in products). (interviews, Nordregio road show 2016)</p> | <p>Growth of new areas in the regions slow due to lack of knowledge and legal support framework (for e.g. blue growth). Currently legislation and regulation, or the lack of knowledge to adapt these, make obstacles for recycling and upgrading resources that are waste or sidestreams from production (as an example, there are restrictions for using fish waste for making new products). (Interviews, Nordregio road show 2016)</p> |

Appendix 1. Background on Nordic strengths and weaknesses in Industrial Symbiosis

| Global drivers | Nordic strengths | Nordic weaknesses |
|--|--|---|
| Increasing scarcity of natural resources sets pressure on raw material prices | <p>Strong expertise on engineering and cleantech solutions and related innovations to improve resource efficiency in the Nordic countries, showcased e.g. in multiple IS best practice cases (Mikkola 2016, Nordregio road show 2016, interviews)</p> <p>Industrial infrastructure and logistics as an enabler to create new value chains and connections between industries to harness possibilities of industrial symbiosis (Johnsen 2015, Mikkola 2016, interviews)</p> | <p>Long distances between actors and operations able to utilize waste or side streams (desk study, workshop)</p> |
| Regulation encourages more sustainable and resource efficient production | <p>Partly clear strategic national policy objectives: In Denmark, Finland and Sweden, strategies for circular economy/industrial symbiosis have been defined, accompanied by policies, networks, activities, information, network platforms, etc. (Johnsen et al. 2015; http://www.regeringen.se/contentassets/869c75f458fc4585ab4ec8c13b250a07/informationsmaterial-smart-industri--en-nyindustrialiseringsstrategi-for-sverige)</p> <p>Proactive approach to environmental regulation. The Nordic countries have utilized the opportunity to promote resource efficiency and industrial symbiosis through environmental regulation (as an example, landfill tax regulations in Sweden contribute by making waste available for energy recovery, and energy and CO2 taxation policies have supported increased updating and uptake of more energy-efficient solution). There is a consensus at the political level of what changes in industry are required in order to be competitive in the future. (Teräs et al. 2014, interviews)</p> <p>Public support for industrial symbiosis: The concept of industrial symbiosis has gained attention and funding is available. In Sweden, VINNOVA is a strong partner because of the promotion of long-term funding for projects e.g., through the Vinnväxt programme. The European Structural and Investment Funds has played an important role in the Finnish and Danish case study regions for promoting industrial symbiosis projects. (Johnsen et al. 2015, interviews)</p> <p>Forerunners in resource efficiency: Resource efficiency is still a challenge on the EU level (although it has improved, see EEA report 2015), providing the Nordic countries with a competitive edge. (interviews)</p> | <p>Partly lacking strategic policy objectives: There is a clear difference in how far the different Nordic countries have progressed with regard to developing strategies for circular economy/industrial symbiosis, with Denmark and Finland as clear forerunners in this context. (Johnsen et al. 2015)</p> <p>Over-implementation of EU environmental regulations, for example waste regulations, environmental permitting and complaint procedures, which prohibit a fast implementation of green innovations (Nordregio road show 2016, interviews).</p> <p>Opposition and lack of knowledge at the local level are among the greatest barriers to industrial symbiosis development and reflects on the granting of permits to industry (Nordregio road show 2016).</p> <p>Difficulty of bringing cross-border cooperation into concrete action: Industrial symbiosis in the Nordic countries needs to go cross-border, which leads to regulatory challenges due to different national regulations (interviews). Concepts and terminology are partly overlapping and used in different ways in each Nordic country, which further make information change and cooperation efforts difficult. (Johnsen et al. 2015)</p> |
| Urbanization clusters resource streams | <p>Best practice on sustainable eco-industrial parks and smart cities in response to global demand (interviews)</p> <p>Digitalisation as a tool for providing new solutions for remote rural areas: The Nordic countries are in the international forefront in digital development. (interviews)</p> | <p>Dispersed raw material streams create a challenge especially for urban areas, where industrial symbiosis is dependent on the concentration of streams for creating local solutions as well as international competitive edges. (desk study, interviews)</p> <p>Lack of actors in the value chains and ecosystems. In some locations, the lack of key actors in the emerging chains and ecosystems are an obstacle for the development of the ecosystems. (Rönnlund et al. 2014)</p> <p>Difficulties in competence matching in remote and sparsely populated areas is a challenge, as well as (funding for) infrastructure development, which is strongly interconnected with the possibilities to develop industrial symbioses. (Nordregio road show 2016)</p> |
| Emergence of networked business challenges traditional business sectors and models | <p>High level of trust between companies is a valuable feature with good examples from the Nordics. For example, the Svartsengi Resource Park in Iceland has developed due to the enthusiastic and committed private sector and the possibility to manage the network in a flexible and informal way, based on trust. (Johnsen et al. 2015)</p> <p>Long track record of successful symbiosis in the Nordic countries including industry park operators, cluster organizations etc. For example the Kalundborg industrial park in Denmark has been developed approx. 40 years. (Johnsen et al. 2015)</p> <p>Positive change in mindset. The public funding organizations in the Nordic countries have recognized the phenomena and provide tools for networking and new business development. (Luoma et al. 2015)</p> <p>Good experience of Nordic cooperation makes it easier for Nordic companies to engage in cross-border cooperation, where other Nordic companies are both competitors and partners. (interviews)</p> | <p>Lack of time and resources for creative thinking. Among the main hindrances to industrial symbiosis development identified in regions are the companies' lack of time and resources to implement new business models. This is particularly true in the case of SMEs. (Johnsen et al. 2015, Nordregio road show 2016)</p> <p>Adaptation of new roles of players in complex circular systems and business models. As the technology shifts, some players will diversify, and some will narrow, changing the whole system, which needs to be sufficiently agile to adapt to the changes. (Nordregio road show 2016, interviews)</p> <p>Too little experience of open innovation and cooperation prohibit companies to benefit from industrial symbiosis for innovation and growth. Many companies see other companies in the value chains and business ecosystems only as competitors rather than valuable partners. (Rönnlund et al. 2014, Johnsen et al. 2015, interviews)</p> |

Appendix 2: Nordic performance on global green growth related indicators

| Index | The Global Cleantech Innovation Index 2014 | The Global Green Economy Index 2016 | Environmental performance Index 2016 | The Climate Change Performance Index 2016 | EY Renewable energy country attractiveness index 2016 |
|-------------------|---|--|--|--|--|
| Index provider | Global Cleantech Group in partnership with WWF (bi-annually) | Dual Citizen LLC (annually) | Yale University (annually) | Germanwatch & Climate Action Network Europe (annually) | EY (3-4 issues/year) |
| Index description | Explores which countries currently have the greatest potential to produce entrepreneurial cleantech startups that will commercialize clean technology innovations over the next 10 years. | Measures the green economic performance of 80 countries and how experts assess that performance. Here the performance rank is given. | Ranks countries' performance on high-priority environmental issues in two areas: protection of human health and protection of ecosystems. | Assessment of countries' climate policy and success in tackling climate issues. | Assessment of the attractiveness of countries' renewable energy investment and deployment opportunities. |
| Nordic ranking | Finland 2/40 Sweden 4/40 Denmark 5/40 Norway 14/40 Iceland n/a | Sweden 1/80 Norway 2/80 Finland 3/80 Iceland 7/80 Denmark 9/80 | Finland 1/180 Iceland 2/180 Sweden 3/180 Denmark 4/180 Norway 17/180 | Denmark 4/61 Sweden 6/61 Finland 23/61 Norway 36/61 Iceland n/a | Denmark 15/40 Sweden 20/40 Norway 32/40 Finland 35/40 Iceland n/a |
| Top 3 countries | 1. Israel 2. Finland 3. USA | 1. Sweden 2. Norway 3. Finland | 4. Finland 5. Iceland 6. Sweden | Positions 1-3 not awarded | 1. USA 2. China 3. India |
| Source | 2nd edition 2014: http://www.cleantech.com/wp-content/uploads/2014/08/Global_Cleantech_Innov_Index_2014.pdf | 5 th edition 2016: http://dualcitizeninc.com/GGEI-2016.pdf | 15 th edition 2016: http://epi.yale.edu/sites/default/files/2016EPI_Full_Report_opt.pdf | 11 th edition 2016: https://germanwatch.org/en/download/13626.pdf | 48 th issue 2016: http://www.ey.com/Publication/vwLUAssets/EY-RECAI-48-October-2016/\$FILE/EY-RECAI-48-October-2016.pdf |



The report shall be provided based on the facts and instructions in the specific assignment considering the circumstances at the time of the assignment in accordance with the respective scope of work. We assume that all the information provided to us is accurate and complete and that you have verified the correctness of the disclosed information.

We assume no responsibility and make no representations with respect to the accuracy or completeness of the information in this report unless otherwise stated. The report should not be regarded, or be relied upon, as a recommendation in decision making concerning any matter referred to in it.

It should be understood that we do not assert that we have identified all matters included in these documents that may be relevant if these documents are included as disclosures against the warranties of the future agreements. Our review of the documents has only been what we consider appropriate in the context of the scope of our work as set out in our offer.

Further, we accept no responsibility to update the report in light of subsequent events (after the date of this report).

Gaia Group Oy

Bulevardi 6 A,

FI-00120

HELSINKI, Finland

Tel +358 9686 6620

Fax +358 9686 66210

ADDIS ABEBA | BEIJING |
BUENOS AIRES | HELSINKI |
SAN FRANCISCO | TURKU |
ZÜRICH

You will find the presentation
of our staff, and their contact
information, at www.gaia.fi