NORDREGIO
Nordic Centre for Spatial Development

Developing a greener economy in Nordic regions: interventions to overcome the challenges

Gunnar Lindberg, Ingrid H. G. Johnsen, Iryna Kristensen, Jukka Teräs
With contributions from Edward Hodgson

NORDREGIO WORKING PAPER 2016:4

Developing a greener economy in Nordic regions: interventions to overcome the challenges

Gunnar Lindberg, Ingrid H. G. Johnsen, Iryna Kristensen, Jukka Teräs

With contributions from Edward Hodgson

NORDREGIO
Nordic Centre for Spatial Development

Developing a greener economy
in Nordic regions: interventions
to overcome the challenges

Nordregio Working Paper 2016:4

ISBN 978-91-87295-41-6
ISSN 1403-2503

© Nordregio 2016

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

Analysis and text: Gunnar Lindberg, Ingrid Johnsen,
Iryna Kristensen, Jukka Teräs
Cover photo: Johannes Jansson/norden.org
External consultant: Edward Hodgson,
Hodgson-Green & Associates

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, 2016

Preface

This publication is the third in-depth study on green growth under the Nordic Working Group on Green Growth – Innovation and Entrepreneurship. The work is commissioned by the Nordic Council of Ministers' Committee of Senior Officials for Regional Policy (EK-R) for the period 2013-2016.

The purpose of the project has been to assess the "state of play, practices and needs" related to how Nordic regions work to promote innovation and entrepreneurship for a greener economy.

The Nordic Working Group on Green Growth – Innovation and Entrepreneurship comprises representatives from the Finnish Ministry of Employment and the Economy (chairmanship), The Ministry of Trade and Industry of the Faroe Islands, Innovation Iceland, the Norwegian Ministry of Local Government and Regional Development, the Swedish Ministry of Enterprise, Energy and Communications, and Åland Technology Center.

The aim of the working group has been to contribute to public policy development with a particular focus on innovation and entrepreneurship in the Nordic countries. The working group has focused on the regional policy dimension of potentials for green growth, innovation and entrepreneurship.

Different types of Nordic regions have been involved in the studies carried out within the framework of the working group.

The main tasks of the working group have been:

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

Kjell Nilsson

Director, Nordregio
Stockholm, 30 November 2016

Executive summary

In 2015, the Nordic Working Group for Green Growth – Innovation and Entrepreneurship commissioned Nordregio to conduct a study of the *"state of play, practices and needs"* related to how Nordic regions work to promote innovation and entrepreneurship **for a greener economy.**

Promoting green growth and building greener economies has been at the top of the agenda in Nordic countries. Green growth is about the pursuit of economic growth and social development while preventing environmental degradation, loss of biodiversity and unsustainable resource use. It is a pre-requisite for building a green economy in the context of sustainable development.

This study specifically examines the **main challenges that impede green growth in Nordic countries, and identifies potential ways of overcoming these challenges and driving the green growth agenda forward.** The methodology of the research comprised a survey, sent out to all 74 NUTS 3 (Nomenclature of Territorial Units for Statistics 3) regions in the Nordic countries, and interviews with key national experts, focusing on challenges and government interventions related to the implementation of green growth initiatives. The results highlighted differences between Nordic regions in their work on green growth. In addition, we conducted a policy review of existing Nordic national-level bioeconomy and cleantech strategies, identifying their main focuses, explicit (or implicit) mentions of challenges to developing green growth and government interventions necessary to promote it.

Based on the survey, interviews and our national policy review, we identified several such challenges and government interventions in Nordic regions.

Regarding the challenges impeding green growth in Nordic regions, the following were identified as being encountered most frequently:

- The issue of sustainability often appears to be secondary to basic economic problems in national *"sustainability"* strategies, and **priority is usually given to technological solutions that are easy and cost-effective** (to avoid imposing extra costs on businesses).
- **Localised perspectives are often insufficiently integrated into national policymaking**, thereby imposing a 'one-size-fits-all' approach to the bioeconomy and green growth.
- **Market entry**. Pilot project stages, including technology verification and demonstration, often require large investments, while at the same time being associated with high risk.
- **Lack of industry networks**. Collaboration within and across sectors is important for identifying new projects, value chains, etc.
- **Ineffective public procurement policy**. Public procurement can drive green growth development through active policy that gives priority to green solutions.
- **Uncertain future demand/unstable operating environment**. Instability may lead to lack of investment in new green solutions.
- **The need for streamlining of the licensing process.**
- **Lack of a competence base in green growth industries**. Access to competent staff is a key challenge for companies. There is a need for a stronger focus on educational programmes, research cooperation and participation in international research programmes to ensure skilled workers are available with the right competencies to develop green growth industries.
- **Communication mismatch between the research community and the political system.** Intra- and cross-sectoral cooperation involving research, business and public sector actors is not yet strong enough to sufficiently facilitate the optimisation of synergies between different sectors, which is essential for advancing green growth.
- **The structure and style of the dialogue between national and regional authorities are insufficiently balanced.** Shifting from a competitive to a collaborative relationship between national interests and regional perspectives will increase interaction and communication, even addressing some issues related to skills and capacity.

Regarding the main government interventions for the development of the green economy, the following were identified as most needed to drive the green growth agenda forward in Nordic regions:

- **Green growth should (usually) be achieved at the lowest cost possible** (not imposing extra costs on businesses).

■ **Support for technology verification and demonstration.**

■ **Start-up/new business development.** Entrepreneurship and innovation are key drivers of the green economy. The research results revealed examples of different support mechanisms to foster start-ups and new businesses, such as funding schemes, industry networks, incubators, etc.

■ **Stimulate demand for environmental technologies**. Examples of policies to achieve this include public procurement policies that favour green solutions and taxes that increase the price of fossil-fuel-based solutions.

■ **Creation of a stable and predictable operating environment**. This involves concrete measures to stimulate demand and to increase public support for technology testing and demonstration, such as coherent policies and access to long-term funding schemes.

■ **Cooperation between actors across niches and sectors**. This is encouraged by supporting cluster development and industrial networks.

■ **Ensuring the competence base of green growth industries.**

Summarising the analysis, the following tentative future orientations and possible interventions to address green growth issues at local, regional and national levels in Nordic countries may be identified:

■ **Integrating green growth objectives into broader economic policymaking**. Green growth objectives should be integrated into national development strategies (rather than creating stand-alone strategies) to enhance policy coherence and certainty. This will help create a favourable milieu for private sector investment in long-term green projects.

■ **A coherent framework for green public procurement.** Public procurement is an important instrument for promoting green growth. However, to achieve sustainable development goals, public procurement should not just stipulate and consider environmental criteria when agreements for public goods or services are allocated to private suppliers; it should also consider social and economic impacts. Regarding sustainable development goals, a new rural paradigm should be created based on the principle of "investing instead of recompensing", aiming to leverage local resources and maximise investment in peripheral areas to achieve development (rather than just handing out development grants).

■ **Facilitating inter-sectoral linkages**. Improved communication and interaction between sectors (i.e. between different industrial sectors, the public and private sectors, old industrial sectors and start-ups, etc.) will yield many positive and tangible outputs. For example, the creation of innovation platforms is a good illustration of a small-scale intervention to address challenges related to stakeholder communication.

■ **Place-based marketing**. Regional marketing should be seen as essential to regional green growth agendas, as it applies inside–outside approaches to strategic planning (based on market studies and research).

■ **'Greening' of the school curriculum**. Revising and adapting current school curricula to offer in-depth education on green growth at different educational levels will help raise public awareness of green growth and sustainable development.

■ **Promotion of green business models.** The transition to a green economy requires eco-innovation solutions as well as green and innovative business models (involving more complex value and production chains) that act as catalysts for disseminating these innovations throughout the market. Given the complexity of new business models, government interventions supporting their development must comprise a broad mix of policies (not just a few selected measures) aligned across national, regional and local levels.

■ **Cluster development** can support new business opportunities that arise from green innovation projects through e.g. increased (cross-sectoral) cooperation.

■ **Regions should build on their strengths**. Businesses should drive green growth development by focusing on their core competitive advantage.

■ **Market support**. Policymakers seeking to promote innovation and entrepreneurship within green growth areas should note that there is a greater chance that companies will succeed if they are part of a market that to some extent is created and/or supported by the government, at least initially.

Contents

Preface 4
Executive summary 5

1. Introduction 9
1.1 Background 9
1.2 Aim and scope 9
1.3 Methods 9
1.4 Report outline 10

2. Conceptual framework 11
2.1 Green growth and eco-innovation – concepts and definitions 11
2.2 The bioeconomy and environmental technology – cross-cutting sectors 13
2.2.1 Bioeconomy 13
2.2.2 Environmental technology (cleantech) 14
2.3 Innovation systems approach 15
2.4 Working definition of green growth 18

3. Policy overview 19
3.1 Green growth strategies in the Nordic countries 19
3.1.1 Bioeconomy 21
3.1.2 Cleantech 22
3.2 Challenges and interventions addressed in the strategies 23
3.2.1 Challenges 23
3.2.2 Interventions 24
3.2.3 Policy support 26
3.3 Previous findings about enablers of and challenges to green growth 26
3.3.1 Findings from Nordic regions 26
3.3.2 Findings from European studies 27

4. Methodology 28
4.1 The Biohorizons project – a European perspective 28
4.2 Conceptual survey design 30
4.2.1 Perceptions of barriers and interventions 30

5. Nordic survey of challenges and interventions 34
5.1 What are the Nordic regions working on? 34
5.2 What are the most commonly encountered challenges? 37
5.3 Incentives and enablers for overcoming existing challenges 37

6. Conclusions and policy recommendations 42
6.1 What are Nordic regions currently doing in the field of green growth? 42
6.2 What are the major challenges and government interventions for developing a greener economy in Nordic regions? 43
6.3 Policy recommendations 43

References 45

List of charts 47

List of figures 47

List of maps 47

List of tables 47

National experts consulted, 2016 47

1. Introduction

1.1 Background

The Nordic Working Group on Green Growth – Innovation and Entrepreneurship has commissioned Nordregio to conduct three in-depth studies during the 2013–2016 programming period. The two completed studies have focused on the bioeconomy[1] and industrial symbioses[2].

While previous in-depth studies have been more thematically focused, this third study provides an analysis of the "*state of play, practices and needs*" related to how Nordic regions work to promote innovation and entrepreneurship for a greener economy. The 'mapping' is based on a survey and interviews, focusing on government interventions and challenges related to the implementation of green growth initiatives, and the results specifically highlight differences between Nordic regions in their work on green growth. "Interventions" in this context comprise the incentives (e.g. financial rewards) and enablers (e.g. legislation or regulations) that drive green growth development.

So how do we define green growth? Green growth is usually described as the pursuit of economic growth and social development while preventing environmental degradation, loss of biodiversity and unsustainable resource use. It is a pre-requisite for building a green economy in the context of sustainable development. In a sense, the economy and the production and consumption processes are instrumental to sustainable development, and hence the transformation of such processes is extremely important for sustainable development. It is in this context that we study green growth in Nordic regions. The concept of green growth is further developed in chapter 2.

1.2 Aim and scope

As for the previous studies, the choice of the topic was aligned with earlier and on-going work by the working group and by other Nordic Council of Ministers (NCM) committees. Together with previous in-depth studies in the context of the working group, as well as the Handbook on Nordic Green Growth[3], this third in-depth study supports the broader aim of the working group, which is to contribute to the development of public policy to support innovation and entrepreneurship for green growth at the regional level in the Nordic countries.

The specific objective of this in-depth study is to provide an analysis of the state of play, practices and needs of Nordic regions in promoting innovation and entrepreneurship related to a greener economy. This study examines the **main challenges that impede green growth in Nordic regions, and identifies potential ways to overcome these challenges and drive the green growth agenda forward.**

The unit of analysis is the region, and we focus exclusively on public actors. The regional level in this case is NUTS 3[4], which corresponds to county level, i.e. the 74 administrative units at this level in the Nordic countries.

1.3 Methods

The methodology of the research combines a survey and interviews, focusing on challenges and government interventions related to the implementation of green growth initiatives and highlighting differences between regions in their work on green growth.

The main empirical data gathered is based on a survey developed from previous European studies focusing on incentives for and barriers to green growth. In particular, the Biohorizons survey was used as an inspiration when developing our questionnaire[5]. Our survey was developed to serve a twofold purpose:

- to achieve a general overview of the different types of challenges and interventions related to the development of a greener economy in Nordic regions; and

1) Teräs et al. (2014)

2) Johnsen (Ed.) et al. (2015)

3) Mikkola, Randall and Hagberg (Eds.) (2016)

4) The NUTS classification (Nomenclature of Territorial Units for Statistics) is a hierarchical system for dividing up the economic territory of the EU for the purposes of: (1) the collection, development and harmonisation of European regional statistics; (2) socio-economic analyses of the regions; and (3) the framing of EU regional policies. Three levels of NUTS are defined. NUTS 3 is the most detailed level and corresponds to landsdele in Denmark, maakunta in Finland, fylke in Norway and län in Sweden. Iceland is divided into two NUTS 3 units: the capital region and the rest of the country.

5) Biohorizons (2015)

■ to obtain a broad perspective on green economy activities in Nordic regions from a wide range of regional stakeholders.

A combination of survey modes – internet plus telephone – was used to approach the 74 NUTS 3 regions. Internet and telephone questionnaires were completed during the same period. The first part of the questionnaire dealt with the different types of challenges obstructing green growth in Nordic regions; the second part was concerned with government interventions that may help to address some of the identified challenges. In total, the questionnaire yielded a 34% response rate (corresponding to 25 complete answers). The relatively low response rate can be attributed to several reasons:

■ Although the intention was to address the questionnaire to dedicated experts on green growth topics, the actual responses showed that several survey recipients had no direct connection to the topic.
■ The survey terminology may not have been fully comprehensible or familiar to all respondents.
■ Some respondents may not have felt confident enough to answer the questionnaire in English.

Taking into account the relatively low response rate, the results should be interpreted as qualitative evidence from regions inside Nordic countries that have a clear focus on "green growth" initiatives, rather than being representative of all Nordic countries. Although the respondent sample is rather small and was drawn from a wide variety of contexts, the results are still useful as suggestive indicators that support the findings of other analyses undertaken. Furthermore, by combining these survey results with findings from previous studies[6], a broader picture may be established of which "green topics" should be considered as part of national green growth or bioeconomy strategies.

1.4 Report outline

This report is structured in six chapters. Chapter 2 provides a conceptual framework for this study. We define the concepts of green growth and eco-innovation and develop a conceptual framework for studying challenges and interventions related to green growth. Chapter 3 provides insight into the national strategies for green growth in the Nordic countries, and how they explicitly or implicitly deal with challenges and interventions. In chapter 4, we present the research methodology (the survey and interviews) used to gather the empirical data used in the study. Chapter 5 presents the results of the Nordic survey and interviews with national experts. Finally, in chapter 6 we present the conclusions and policy recommendations based on our study.

6) Star-COLIBRI (2011); Teräs et al. (2014); Johnsen (Ed.) et al. (2015); Lindberg et al. (2015)

2. Conceptual framework

This chapter introduces the concepts of green growth and eco-innovation in the context of this report. We explain why eco-innovation is one key to promoting green growth, and how the bioeconomy and cleantech are two important cross-sectoral activities in the transition towards a greener economy.

2.1 Green growth and eco-innovation – concepts and definitions

As argued in the introductory chapter, green growth is about the pursuit of economic growth and social development while preventing environmental degradation, loss of biodiversity and unsustainable resource use. When the concept is discussed at the Nordic level, reference is often made to the OECD definition of green growth, which has also been applied by the NCM. The OECD has worked extensively on the issue of green growth and has come to define it in the following way:

"Green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. To do this it must catalyse investment and innovation which will underpin sustained growth and give rise to new economic opportunities"[7].

According to the OECD, the concept of green growth has the same main objectives as the concept of sustainable development. It does not replace sustainable development but directs more attention to innovation and the tools that are needed to facilitate the greening of the economy. The concept is often used almost interchangeably with other similar concepts such as the green economy[8], but the exact definitions vary between different institutions. While the OECD uses the concept of green growth, the UNEP uses instead the concept of the green economy, defined 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. Moreover, the UNEP is clear about the green economy not replacing sustainable development but instead focusing attention on *"getting the economy right"* as a precondition for sustainability[9].

The OECD has also studied the implications of green growth at the regional and local levels. In its study of cities and climate change (among other places), the OECD emphasises that *"each stage of the local policy-making process presents an opportunity to incorporate climate change priorities, agenda setting, policy design, implementation and policy evaluation"*[10].

The issue of green growth has also been of growing importance in the EU framework. The EU has not published any specific policy documents on green growth as such, and it has followed the OECD recommendation of not creating new strategies for green growth but instead integrating the principles of green growth into existing strategies[11]. However, sustainable growth is an integral part of the *Europe 2020 Strategy*, which aims to achieve growth that is sustainable, smart and inclusive. For the EU, sustainable growth means promoting a more resource-efficient, green and competitive economy. From this point of view, environmental technologies, efficient smart grids and an improved business environment are seen as some of the main priority areas. The *Europe 2020 Strategy* also includes two flagship initiatives that are used to promote sustainable growth, focusing on a resource-efficient Europe and industrial policy that can support businesses to respond to environmental challenges. The EU cohesion policy and its structural funds are considered the key tools for achieving smart, sustainable and inclusive growth for member states and at the regional level[12].

At the Nordic level, the NCM has adopted the concept of green growth into its policy framework and uses the OECD definition of the term. The NCM is positive about the opportunities for the Nordic region in the green economy, and states that the global market for green solutions provides the Nordic region with op-

7) OECD (2011a)

8) OECD (2011a)

9) UNEP (2011)

10) OECD (2010)

11) Olsen and Weber (Eds.) (2012)

12) Olsen and Weber (Eds.) (2012)

portunities to improve its market position. The NCM also considers Nordic cooperation and collaboration on green growth essential for increasing the market share of the Nordic region, among other things. The prioritised areas in the NCM's vision, *The Nordic Region – Leading in Green Growth*, are energy efficiency, sustainable energy, environmental awareness, investment in innovation and research and ambitious international targets for energy and the climate[13)].

It is usually argued that existing technology is insufficient to drive development. This implies that innovation is one of the most important sources of green growth, and that suitable policies and frameworks are needed to allow the emergence of new ways to address environmental problems and to facilitate and promote innovation[14)]. Innovation can involve new products and methods of production, new sources of supply, new ways to organise industry and the opening of new markets, which will underpin sustained growth and give rise to new economic opportunities.

In line with the working programme adopted by the working group, this report applies a broad definition of entrepreneurship and innovation, which, in relation to green growth, is closely associated with the concept of eco-innovation: *"Eco-innovation is the introduction of any new or significantly improved product (good or service), process, organisational change or marketing solution that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole life-cycle"*[15)]. Key to this definition is the focus on environmental benefits, which is one of the main factors that distinguishes eco-innovations from other types of innovations.

The concept of eco-innovation is used broadly to refer to innovations that support green growth by the OECD and the EU, among others. According to the OECD, an eco-innovation can concern goods, services, manufacturing processes or business models and can be technological or non-technological[16)]. The OECD has specifically focused on systemic innovation in green growth. Systemic innovations *"are concerned with technological systems, disruptive technologies, as well as all types of system changes"*[17)]. Furthermore, they are more likely to take place beyond the boundaries of one company or organisation, as they often require complementary infrastructure[18)]. One example of systemic innovations is industrial symbioses, which require new business models as well as collaboration across organisations and shared provision of infrastructure.

The OECD emphasises three ways in which eco-innovation can be distinguished from general innovation[19)], as follows.

- Eco-innovation emphasises the reduction of environmental impacts, whether intended or not. Eco-innovation lowers specific negative externalities while generating positive spillovers from innovation.
- Eco-innovation often includes innovation in social and institutional structures, and changes in norms and cultural values.
- The transition to green growth requires more radical and disruptive innovation, in which eco-innovation has a key role.

The Eco-Innovation Observatory (EIO), which was established by the EU to promote eco-innovation, emphasises the life-cycle perspective on eco-innovation leading to the overall better use of resources. In line with the OECD approach, the EIO includes both technological and non-technological innovations in its definition of eco-innovation, and argues that eco-innovation can involve organisational change, a new marketing method in a company or a wider change with systemic implications for the economy or society. It is furthermore emphasised by the EIO that while incremental eco-innovations concerning e.g. improved products and services are needed, disruptive eco-innovations that lead to a paradigm shift or change in an entire system are of key importance for green growth[20)].

However, the NCM has not adapted the concept of eco-innovation to the specific Nordic context. Nordic Innovation[21)] uses the OECD definition of eco-innovation and emphasises the role of different types of eco-innovations, including disruptive and radical innovations that change entire systems. Nordic Innovation has also intensively studied green business model innovation from a Nordic perspective[22)].

13) European Commission (2010)

14) OECD (2011b)

15) Eco-Innovation Observatory (2012)

16) OECD (2011b)

17) OECD (2011b), p. 41

18) Beltramello et al. (2013), p. 14

19) Beltramello et al. (2013)

20) Eco-Innovation Observatory (2012)

21) Nordic Innovation is a Nordic institution under the NCM working to promote cross-border trade and innovation

22) Nordic Innovation (2012)

2.2 The bioeconomy and environmental technology – cross-cutting sectors

2.2.1 Bioeconomy

The bioeconomy in the broad sense of the term is understood as an important contributor to reducing climate change, by reducing the use of fossil-fuel-based materials. The bioeconomy requires a cross-sectoral approach involving sectors such as forestry, agriculture, fishery, food and feed, biotechnology, bioenergy and biofuels.

A shift towards a green economy is about transforming economic processes, societal structures and consumption patterns. The bioeconomy should be seen as an operational (and instrumental) part of this, i.e. a means to develop better alternatives and more sustainable products and processes. Often the bioeconomy is perceived as one activity/sector/part of the green economy, at least when the green economy is studied from a sectoral perspective. To this end, sectors such as agriculture, forestry and fishery are defined as the bioeconomy, and the links to other sectors such as energy, construction, biochemicals, etc. are part of bioeconomic development. This part of the green economy seems to be extremely important in the Nordic countries, which are strong performers in all the sectors and resources that together comprise the bioeconomy, and well advanced when it comes to innovation and the development of resources linked to these sectors.

To make the contribution of the bioeconomy more explicit, it should be recognised that it can itself support many dimensions and sectors in the greening of the economy and society, by substitutions in energy, materials and eco-innovation. Development of the bioeconomy is one building block in the development of a greener economy because it contributes to reducing the use of fossil fuels and greenhouse gas (GHG) emissions, increases the utilisation of waste and residues and uses biotechnology to reduce environmental pressure and resource use in sectors such as agriculture. At the same time, it could be said that the concept of green growth also applies to the different sectors of the bioeconomy, in the sense that its production processes, waste, emissions, etc. can be made greener and so contribute to the greening of the economy.

It is important to distinguish between two aspects of green growth: improving what is already there, and developing new products, processes and structures. As an example, one objective is to reduce energy consumption, and another is to substitute renewable forms of energy. Similarly, an objective of the agricultural sector is to become greener, e.g. through more organic agricultural production, and at the same time to develop new crops that can be used for energy production. All these aspects are part of green growth and in this case also the development of the bioeconomy.

As a starting point to formulating a standalone definition of the bioeconomy, we can use the EU and OECD definitions. According to the EU, the bioeconomy *"encompasses the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, and bio-based products"*[23]. The OECD definition states that *"A bioeconomy can be thought of as a world where biotechnology contributes to a significant share of economic output. The emerging bioeconomy is likely to involve three elements: the use of advanced knowledge of genes and complex cell processes to develop new processes and products, the use of renewable biomass and efficient bioprocesses to support sustainable production, and the integration of biotechnology knowledge and applications across sectors"*[24].

Both the EU and the OECD focus on an economy where a significant share of economic output is directed towards the "production of renewable biological resources" and their conversion into food, feed, bio-based products and bioenergy. This implies a transition from a brown economy based on fossil fuels to a greener economy driven by sustainable production. This transition is based on the use of biomass rather than fossil fuels and, to this end, the definition of biomass and its usefulness should be as wide and inclusive as possible. That is, it is about biomass not only for energy production, but also for food, feed, materials, chemicals, etc.

As is evident from the OECD definition, a key driver in the transition towards a bio-based economy is *"innovation"*. The Bioeconomy Observatory proposes three pillars of bioeconomic strategy: i) investments in research, innovation and skills, ii) stronger policy coordination and engagement with stakeholders, and iii) enhancement of markets and competitiveness in the bioeconomy. These could be thought of as tools to develop the bioeconomy[25].

From previous studies conducted by Nordregio[26], we know that there is often a regionally dominant field in the bioeconomy. In Finland, Sweden and Norway, the forestry-related bioeconomy plays a dominant role. In Denmark, the focus is on agricultural biomass and by-products for bioenergy production, while in Iceland, the marine-based bioeconomy dominates. In

23) Nordic Innovation (2012)

24) OECD (2009), p. 8

25) European Commission (2016)

26) Teräs et al. (2014); Lindberg et al. (2015)

many regions, there is a flagship bioeconomy project that acts as a locomotive for development. One example is the next-generation bio-product mill in Central Finland, backed by an investment of EUR 1.1 billion. The bioeconomy initiatives in most of the Nordic case study regions enjoy abundant local raw material – but there still seem to be struggles when it comes to enabling conditions and barriers to further developing the regional bioeconomy.

2.2.2 Environmental technology (cleantech)

The terms environmental technology and environmental innovation (eco-innovation) are often used interchangeably. Environmental technology generally refers to all technologies that directly or indirectly improve the environment. The term encompasses technologies that limit contamination of the environment through purification, greener products and production processes, more efficient resource management and systems that lower environmental impact. In this context, the term *"technology"* can be understood as knowledge, services and physical facilities that contribute to the improvement of the environment[27)].

The Copenhagen Cleantech Cluster, which is a leading cluster in Denmark, refers to cleantech as activities that develop, produce or implement new or improved processes or products[28)]. These activities (including consultancy and research) contribute to one or several of the following goals: producing renewable energy or sustainable materials; reducing the use of natural resources by exploiting resources or energy more efficiently; reducing the harm caused by fossil fuels; or reducing pollution problems through products or processes.

Investment in environmental technology is an important driver for solving major environmental challenges and in the transition towards green growth. Environmental technology creates significant value creation opportunities because it constitutes the world's most promising technology market[29)]. This implies that green energy production and environmental technology are a new growth industry in the Nordic countries.

At the European level, the European Commission has launched the Environmental Technologies Action Plan (ETAP), which is intended to make eco-innovation an everyday reality throughout Europe[30)]. The plan was adopted by the European Commission in 2004 and covers a wide range of activities promoting eco-innovation and the use of environmental technologies. The main objective of the ETAP is to improve European competitiveness in this area, and enable the EU to become the recognised world leader[31)]. The ETAP refers to environmental technologies as any technologies whose use is less environmentally harmful than relevant alternatives. Examples include the following:

- Renewable energy generation – such as photovoltaic or wind power
- Cleaner cars
- Passive houses or environmentally friendly construction materials
- Treatment of waste for re-use or recycling

Based on an overview of cleantech in the Nordic countries, published as an internal Nordregio paper (2014) and as a supplement to the selected in-depth studies in relation to the Nordic Working Group on Green Growth – Innovation and Entrepreneurship, it is evident that two sectors are predominant: energy and the environment. In that paper, it is further argued that defining cleantech as involving issues related to energy on the one hand, and the environment on the other, is a potentially useful approach to understanding the concept.

Within the energy field, the key strengths of most Nordic countries are in green energy production and energy efficiency. While energy infrastructure and energy storage have not been highlighted as key strengths, there are companies active in these fields across the Nordic region. The Nordic countries are represented as being active within all areas of environmental cleantech, particularly with regard to waste and recycling, and water and wastewater management.

In Denmark and Finland, renewable energy and energy efficiency make up the largest green business areas[32)]. In the environment area, waste management is the largest green business area in Denmark[33)]. Other strengths and potential growth areas underlined in the Danish Plan for Growth for Water, Bio and Environmental Solutions are water and wastewater management. The production of advanced bio-based products has large business potential for the biotech industry directly; for the agriculture, forestry and waste sectors as suppliers of biomass; and for resource use efficiency

27) Norwegian Ministry of Trade and Industry/Ministry of Climate and Environment (2011)

28) CLEAN (2016)

29) Norwegian Ministry of Trade and Industry/Ministry of Climate and Environment (2011)

30) European Commission (2006)

31) European Commission (2006)

32) Cleantech Finland (2013), Danish Energy Agency/Ministry of Climate, Energy and Building, Danish Business Authority/Ministry of Business and Growth, Danish EPA/Ministry of the Environment (2012)

33) Danish Energy Agency/Ministry of Climate, Energy and Building, Danish Business Authority/Ministry of Business and Growth, Danish EPA/Ministry of the Environment (2012)

and a reduction in air pollution[34]. Finland has also emphasised clean processes, materials and products; consulting and advisory services; water management and water processing; green buildings; and air quality protection[35].

Most of the Norwegian cleantech companies are active in waste handling, recycling and hydropower, as well as power distribution and trading, as these are already mature businesses[36]. Environmental services and consultants and energy and resource reuse/efficiency in buildings and processes are the largest business segments of cleantech in Sweden, followed by water, energy and waste management. On a more detailed level, Swedish cleantech companies are found to be strong in waste technology, collection and recycling, water purification, biogas, air quality (energy-efficient ventilation and filtration), bioenergy, heating technology (district heating and heat pumps), electricity transmission and the automation of buildings (i.e. to reduce energy consumption)[37].

The Icelandic cleantech refers to cleantech as products or services that improve operational performance, productivity, or efficiency while reducing costs, inputs, energy consumption, waste, or pollution. The member companies of the Clean Tech Iceland cluster focus on clean energy, recycling, ICT and energy efficiency in transport, buildings and manufacturing[38].

As is evident from the different activities in the Nordic countries, cleantech can be characterised as cross-cutting and cross-sectoral, and it involves developing new products, processes and services that can contribute to more efficient and sustainable use of natural resources and reduce pollution. This implies that investment in environmental technology is dependent on both a significant mobilisation of the private sector's innovative capacity, problem solving and efficiency, and governments' capacity to create framework conditions that makes it profitable to offer and ask for good environmental solutions.

2.3 Innovation systems approach

As already argued in section 2.1, innovation arises from a complex web of interactions between different actors and is crucial for the development of green economies. The OECD often gives special attention to systemic innovation in eco-innovation[39]. The main argument is that the innovations needed for the transition to a greener economy are more likely to take place outside a single company or organisation because *"they often require the transformation, replacement or establishment of complementary infrastructures"*[40].

The concept and application of innovation systems analysis has been well developed to suit a variety of technological, sectoral or spatial situations. The regional innovation systems approach places *"importance on the role of spatial organisation alongside other actors, structures and interactions involved in innovation processes. The region is increasingly perceived as the level at which innovation is produced through regional networks of innovators, local clusters and the cross-fertilising effects of research institutions"*[41].

As shown in Figure 1, (next page) adapted from Hekkert et al. (2007), an innovation system comprises different functions with the overall aim to generate and diffuse innovations that lead to technological change[42]. These innovations consequently result in socio-economic and political change that forms part of a dynamic and constantly evolving system. Therefore, such systems are best defined in terms of knowledge or competence flows rather than ordinary goods and services, and better characterised by investigation of the networks actively involved in the process[43]. Thus, emphasis should be placed on the investigation of the structure and functions of the 'living' system through evaluation by key stakeholders and experts active with in the innovative system under scrunity[44].

Territorial capital refers to the geographical distribution of physical and non-physical features in the built and natural environment. Physically, this could reflect local concentrations and flows of natural capital, people and goods. Non-physically, it embraces synergies and differences in socio-economic, political and cultural aspects of development, such as distributions of wealth or health, demographic patterns, administrative boundaries or different types of governing structures for planning and decision making[45].

The *OECD Territorial Outlook 2001* is an attempt to formalise the importance of territorial perspectives and capital in understanding the development of countries and regions and their economies. Different aspects of economic development theories are contrasted with cohesion and governance issues in developing a nuanced picture of what matters for regions and coun-

34) Danish Ministry of Business and Growth (2012)
35) Cleantech Finland (2013)
36) Intpow (2013)
37) VINNOVA (2013)
38) The Federation of Icelandic Industries (2014)
39) Beltramello et al. (2013)
40) Beltramello et al. (2013), p. 18
41) Lundvall and Borrás (1997)
42) Hekkert et al. (2007)
43) Carlsson and Stankiewicz (1991)
44) Hekkert et al. (2011)
45) Duhr et al. (2010)

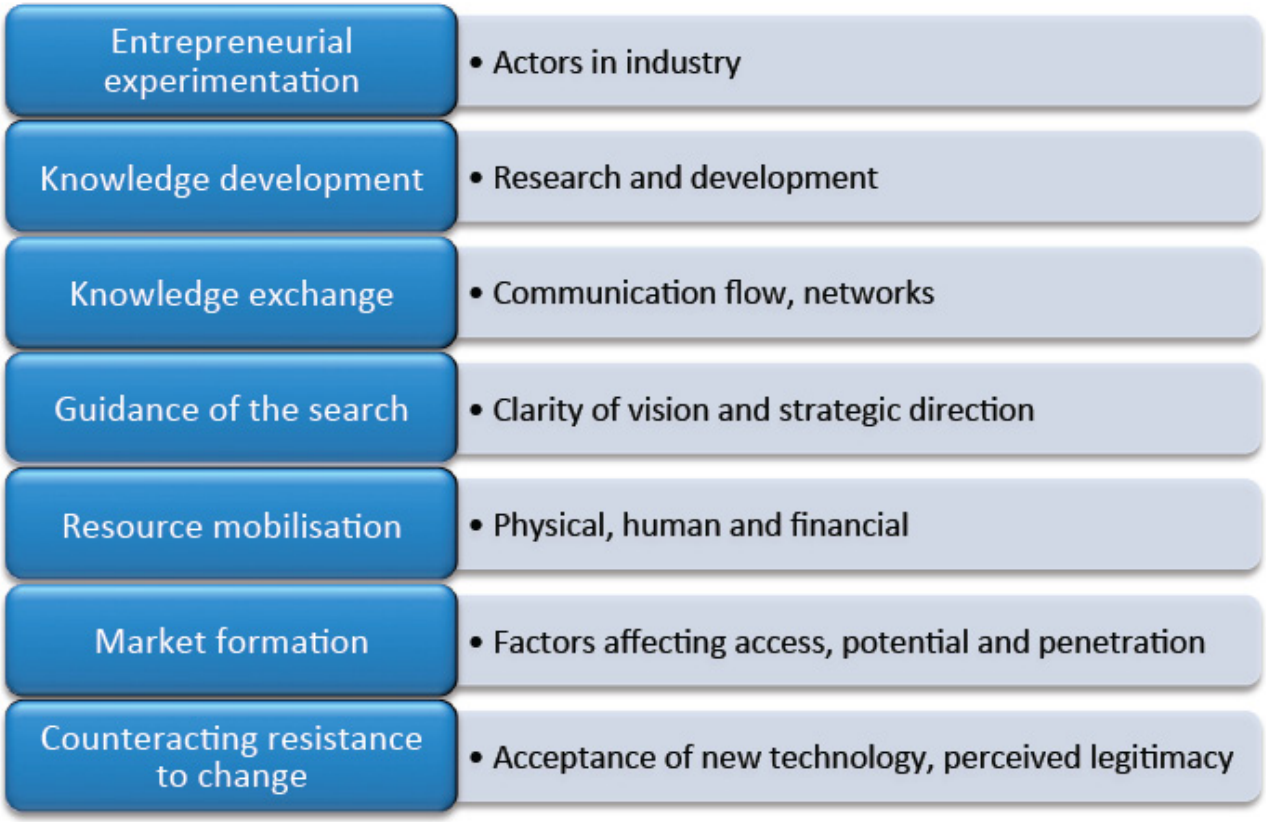


Figure 1 *Seven functions of an innovation system*[46)]

tries, and the interplay between society, territory and the economy in development. The discussion of territorial implications starts from the fact that returns on investment are closely related to the place where the investment is made.

The impact of place or territory on the development of an activity is determined by numerous factors. First, it is recognised that each area has specific capital – its *"territorial capital"* – that is determined by many factors and is unique to a specific place. These factors may include the area's geographical location, size, endowment of factors of production, climate, traditions, experiences, natural resources, quality of life or the agglomeration economies provided by its cities. But it may also include its business incubators and industrial districts or other business networks that reduce transaction costs and provide a favourable economic climate.

Other factors may include *"untraded interdependencies"* such as understandings, customs and informal rules that enable economic actors to work together under conditions of uncertainty. This *"territorial capital"* generates a higher return for certain kinds of investments than for others, because some investments are better suited to the area and use its assets and potential more effectively. This also holds for investments in environmental improvements or protection, which will be efficient to varying degrees due to regional characteristics.

According to the OECD, public policies aimed at promoting territorial development and limiting territorial disparities should first and foremost help areas to develop their territorial capital[47)]. This principle constitutes the very foundation of the new territorial development policy, which is primarily aimed at finding more effective means of strengthening economic dynamism in the present-day economy. Accordingly, achieving balanced and sustainable development requires preparing territories to support economic and social activities; geographical (re)distribution of infrastructure and public services across the territory; and the management of natural and cultural resources embedded in each part of the territory.

Different regions have different territorial capital, and have already developed different activities related to the green economy (both historically and more recently, within the new era of the green economy). The development of the green economy (integrated with other paths of development in the regions) will ultimately lead to the evolution of different development trajectories. These trajectories might for example involve varying degrees of internal regional value creation based on the territorial capital of each region,

46) Adapted from Hekkert et al. (2007)

47) OECD (2001)

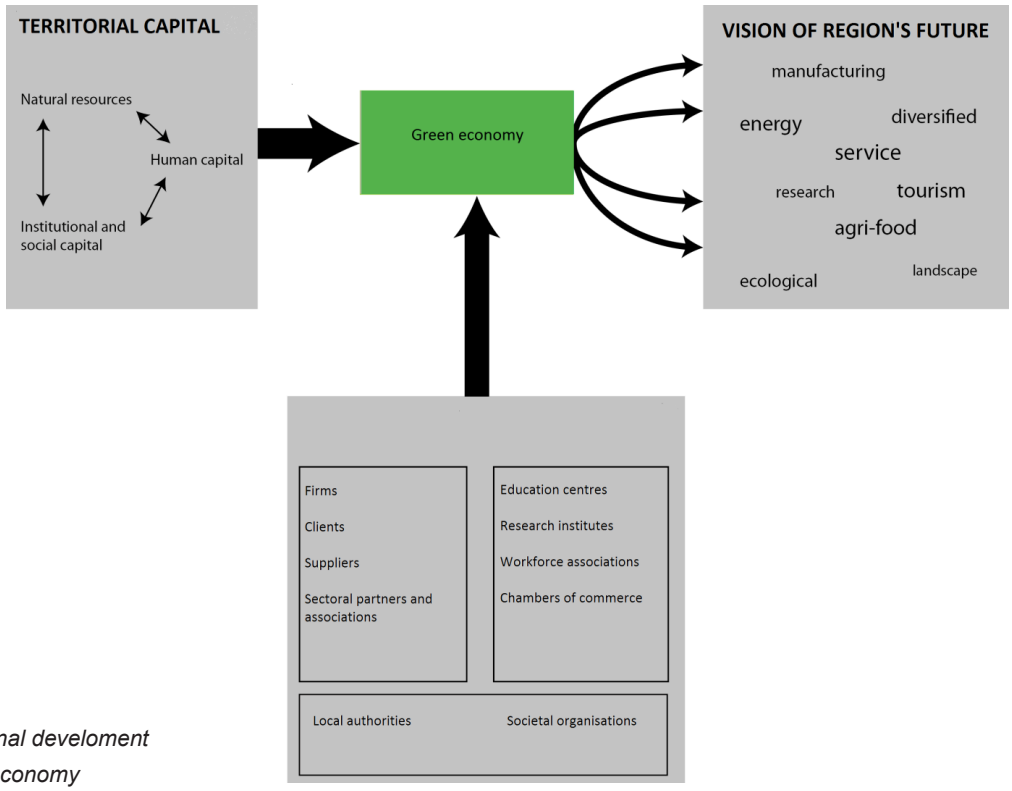


Figure 2 *Regional develoment and the green economy*

development of the dynamic components of territorial capital (human capital, infrastructure, innovation climate, etc.) or the creation of a service economy. Territorial capital and the resource base available in a region are not static. Some aspects may be more static than others, but many dimensions can be developed and shaped over time by policy and active strategies. Such development trajectories also ultimately relate to more fundamental drivers of development, such as migration, demography and globalisation.

In relation to this dynamic way of thinking about regional development and the bioeconomy, we must not forget the aspects related to policy and global impacts. Both of these may act as either hindering or enabling conditions. Policies can be dynamic, even within a region, and play a crucial role in explaining different development trajectories.

As described in Figure 2 (above), our understanding is that regional development trajectories are influenced by how innovation systems transform the region's territorial capital within the green economy. To this end, policy and strategy are seen as the means to change such systems – we may call them catalysts – by stimulating actors to develop new products, systems thinking, projects, markets or visions. Policies and strategies should not be considered in isolation, but rather as part of regional systems.

Tödtling and Trippl (2005) suggest that different levels of government may play a significant role "*in encouraging learning and innovation shifts from direct intervention towards stimulation, intermediation, brokering, promoting regional dialogue and building up social capital*", i.e. intervening on different dimensions of the regional innovation system and at different stages of its evolution. Governments should do the following:

- Give priority to organisational and technological 'catch-up learning' (new organisational practices, products and process technologies) and targeting SMEs and their innovation weaknesses.
- Stimulate entrepreneurial attitudes and risk-taking[48].
- Strengthen potential clusters in the region.
- Improve the region's endowment of innovation support organisations.
- Design knowledge transfer in a demand-led way.
- Help firms to 'import' ideas and knowledge not available in the region.
- Encourage transition to new fields and trajectories and stimulate product and process innovations for new markets.
- Embed foreign direct investment, bringing complementary knowledge into old and new clusters.
- Induce and support the transformation of the region's network structure.

48) Also in Laestadius and Nuur (2010)

2.4 Working definition of green growth

For the purpose of this report we find it useful to provide a working definition of green growth.

As a starting point, we refer to the OECD definition of the term, which focuses on *innovation* as an important tool to foster sustained growth. In line with the Nordic Working Group on Green Growth – Innovation and Entrepreneurship, we apply a broad definition of innovation and entrepreneurship: the introduction of any new or significantly improved product (good or service), process, organisational change or marketing solution[49]. We furthermore argue that in order to achieve green growth, the development of environmental technology is crucial.

We also argue that eco-innovation is an important pre-requisite for achieving green growth. Eco-innovation as a concept is broader than technological innovation. However, we argue that technological change is a significant enabling factor for eco-innovation and green growth from an innovation systems perspective, as is evident both in the regional studies literature and in analyses and policy documents produced by the OECD and the EU.

It follows that environmental technology, or cleantech, which has been identified by the Nordic Working Group on Green Growth – Innovation and Entrepreneurship as one important area of green growth in the Nordic countries, is an important driver of green growth and the transition to a greener economy. Another important driver, which has also been identified by the working group, is the bioeconomy, focusing on developing an economy that is based on the sustainable utilisation of renewable resources to develop new processes and products.

The development of environmental technology and the bioeconomy to promote green growth requires a cross-sectoral approach with a broad range of system-level changes and innovations. This is also evident from the Nordic green strategies presented in the next chapter.

49) Edquist (1997)

3. Policy overview

Policy actions to promote green growth and the transition to a greener economy span a wide range of policy fields. In this chapter, we present existing Nordic national-level bioeconomy and cleantech strategies, their main focuses and their explicit (or implicit) mentions of challenges and government interventions related to green growth. Finally, we summarise findings from previous studies about obstacles and priorities for policy intervention related to the green economy in Nordic regions. These findings set the background for the development of our survey of challenges and government interventions in Nordic regions.

3.1 Green growth strategies in the Nordic countries

The majority of the Nordic countries have bioeconomy-related strategies and cleantech strategies. Some of the strategies are more oriented towards research and development (R&D) and innovation (Norway and Sweden), whereas others focus more on policy-level issues (Denmark and Finland). Norway and Iceland are also currently drafting national bioeconomy strategies. According to Rönnlund et al. (2014), policy-level strategies are more concerned with the supporting environment, including a wide variety of policy measures, while research strategies are more focused on identifying potential areas for R&D and innovation. Existing green growth policy documents related to the bioeconomy and cleantech are listed in Tables 1 and 2.

Table 1 *Overview of existing bioeconomy strategies*

Country	Name of strategy	Type of document (policy-level strategy research strategy)[50]	Main focus
Denmark	*Plan for Growth for Water, Bio and Environmental Solutions (2013), Growth Plan for Food (2013)*	Research strategies	Business development, creation of jobs, identification of potential groowth areas
Finland	Finnish Bioeconomy Strategy (2014)	Policy-level strategy	A competitive operating environment for the bioeconomy, new business from the bioeconomy, a strong bioeconomy competence base, accessibility and sustainability of biomasses
Iceland	*Iceland 2020 – governmental policy statement for the economy and community (2011)*	Policy-level strategy	How eco-innovation and its products *can* become Iceland's main growth sector, and how eco-innovation can contribute to sustainable development
	National bioeconomy strategy (will be presented during 2016)	Policy-level strategy	Business development, eco-innovation, public procurement

50) Categorisation based on Rönnlund et al. (2014), p. 24

Norway	*BIONÆR Research Programme on Sustainable Innovation in Food and Bio-based Industries (2012)*	Research strategy	Innovation and entrepreneurship, research
	National bioeconomy strategy (will be presented during 2016)[51]	Policy-level strategy	Priorities for a national effort to accelerate the Norwegian bioeconomy
Sweden	*Research and Innovation Strategy for a Bio-based Economy (2012)*	Research strategy	Research, business development, innovation
	Strategic collaboration programme on a circular and bio-based economy (2016)	Policy-level strategy	Innovation to stimulate the circular economy and the bio-based economy

***Table 1** Above: (Continues from previous page)*

***Table 2** Below: Overview of existing cleantech strategies*

Country	Name of strategy	Type of document (policy-level strategy research strategy)[52]	Main focus
Denmark	*Environmental Technology Development and Demonstration Programme* (MUDP) (2016)	Research strategy	Innovation, technology testing and development
Finland	*Government Strategy to Promote Cleantech Business in Finland* (2014)	Policy-level strategy	Business development, innovation
Norway	*National Strategy for Environmental Technology* (2012)	Policy-level strategy	Commercialisation and technology tes ting, research and competence development, networks and collaboration, environmental regulations, procurement
Sweden	*Research Strategy for Environmental Technology* (2008)	Research strategy	Research business development, innovation
	Environmental Technology Strategy (2012)	Policy-level strategy	Knowledge development/ innovation, export of Swedish technology

51) The Norwegian Government's bioeconomy strategy "Kjente ressurser– uante muligheter" was published on November 29, 2016

52) Categorisation based on Rönnlund et al. (2014), p. 24

3.1.1 Bioeconomy

Nordic bioeconomy strategies focus on both concrete policy measures and the potential areas for R&D and innovation.

The Danish National Bioeconomy Panel was established in 2013 to to effectively promote the development of a sustainable Danish bioeconomy[53]. The panel consists of leading firms and researchers, NGOs, key organisations and authorities, and its main task is to provide input for concrete action to promote the bioeconomy in Denmark[54]. In terms of available policy documents, the bioeconomy in Denmark is being pursued through broader policy frameworks for growth, innovation and the environment[55], e.g. the *Plan for Growth for Water, Bio and Environmental Solutions*[56] and the *Growth Plan for Food*[57], anchored with the Danish Ministry of Business and Growth. *The Plan for Growth for Water, Bio and Environmental Solutions* aims to strengthen and develop the Danish and European markets for resource-efficient solutions and to support targeted initiatives in the form of research, demonstration, testing and international marketing. The plan seeks to strengthen the basis for Danish companies and promote their involvement in this growing international market, and thus contribute positively to growth and new jobs[58]. The overall objective of the *Growth Plan for Food* is for Denmark to become an international powerhouse for the food sector that can attract companies, entrepreneurs, investors and researchers[59]. The plan has five main focal areas, of which one is *"sustainable and resource-efficient food production"*. This will be achieved by ensuring greater availability and better use of sustainable biomass through, among other things, the development of new business models that limit food waste and utilise excess resources.

Finland has adopted a national-level bioeconomy strategy (2014)[60], with a strong focus on how Finland can become a forerunner for the sustainable bioeconomy, and how to enable the bioeconomy to contribute to considerable economic output and the creation of new jobs. The main goals highlighted in the strategy are i) to create a favourable operating environment for the bioeconomy, ii) to support the creation of new businesses in the bioeconomy, iii) to develop and maintain a competence base for the bioeconomy and iv) to ensure the ability to use renewable biomass. These goals are to be achieved through several measures highlighted in the strategy. For example, one measure is to increase equity financing and innovation inputs in the bioeconomy by ensuring the availability of risk financing as well as public finance providers. Another measure is to ensure the availability of funding for piloting and demonstration projects through adjusting operating models for finance providers. The *Finnish Bioeconomy Strategy* has many linkages and synergies with other national strategies, e.g. on agriculture and forestry, energy and climate, natural resources and other policy areas[61]. Like Denmark, Finland has established a bioeconomy panel to support the implementation and further development of the bioeconomy strategy. The panel is chaired jointly by the Ministry of Employment and the Economy and the Ministry of the Environment.

In Iceland, the main policy document related to the bioeconomy is the *Iceland 2020 Strategy*. The strategy specifically focuses on how eco-innovation and its products can become Iceland's main growth sector, and how eco-innovation can significantly contribute to sustainable development. Green economic activity is mentioned more generally as a means to ensure sustainable development. Iceland also has a law on public procurement (84/2007) and an agreement on eco-friendly public procurement, which indicates that public procurement is regarded as an important means to stimulate green growth. The Ministry of Fisheries and Agriculture has established a working group to oversee the work of developing a national bioeconomy strategy. The Icelandic Food and Biotech Research and Development Institute (Matis) acts as the group's secretariat. The strategy is expected to be finalised during 2016.

In Norway, policies to foster green growth have two main focus areas: i) to support entrepreneurs (the government's entrepreneurial plan says that entrepreneurs should contribute to green growth or the *"green shift"*) and ii) to support *"basic research"* and *"excellent research"* (as defined by Norway's Productivity Commission)[62]. The *BIONÆR Research Programme on Sustainable Innovation in Food and Bio-based Industries* is the Norwegian research strategy to promote bioeconomy-related activities. The strategy specifically focuses on promoting research that increases the level, profitability and sustainability of production in the value chains for agriculture, forestry and nature-based in-

53) Danish Ministry of Environment and Food (2016)

54) Rönnlund et al. (2014)

55) Winther (2016)

56) Danish Ministry of Business and Growth (2013a)

57) Danish Ministry of Business and Growth (2013b)

58) Rönnlund et al. (2014)

59) Danish Ministry of Business and Growth (2013b)

60) Finnish Ministry of Employment and the Economy/Ministry of the Environment (2014)

61) Rönnlund et al. (2014)

62) Isaksen (2016)

dustries as well as seafood[63]. The programme does not, however, cover the entire Norwegian bioeconomy, and the Norwegian Research Council also has other funding instruments and programmes for other parts of the bioeconomy[64]. The national bioeconomy strategy for Norway is under development and will be presented during 2016. The Ministry of Trade, Industry and Fisheries and the Ministry of Agriculture and Food are responsible for the drafting, in cooperation with the Prime Minister's Office[65]. The strategy will identify overall priorities for a national effort to accelerate the Norwegian bioeconomy, and set out long-term objectives and measures. The national bioeconomy strategy will not replace national white papers for the different sectors like seafood, forestry and agriculture; rather it is meant to add to and facilitate cross-sectoral cooperation and innovation[66].

In 2012, the Swedish *Research and Innovation Strategy for a Bio-based Economy* was adopted[67]. The strategy focuses on the efforts needed in R&D and innovation to develop the skills necessary for the transition to a bio-based economy. The driving forces behind the strategy were the need to reduce the dependency on fossil-fuel-based raw materials and the need to reduce emissions of carbon dioxide and other GHGs[68]. The strategy defines four R&D needs: i) the replacement of fossil-fuel-based raw materials with bio-based raw materials; ii) smarter products and smarter use of raw materials; iii) change in consumption habits and attitudes; and iv) the prioritisation and choice of policy measures. The strategy also emphasised that R&D must be complemented by innovation-fostering initiatives and measures that specifically address bioeconomy challenges, and that the nature and extent of these challenges necessitate widespread collaboration among actors in different sectors.

In 2016, the Swedish government launched a strategic collaboration programme on a circular and bio-based economy[69]. The programme focuses on innovations (including circular business models) that deliver solutions for using products and raw materials in a resource-efficient and smart way.

The Swedish government is also currently working on an agenda for bio-based industrial development. The Budget Bill for 2016 states that activities that promote a transition to a bio-based economy shall be prioritised, including the development of an agenda for sustainable bio-based industrial development.

3.1.2 Cleantech

Both Finland and Norway have adopted national cleantech strategies. The Norwegian *National Strategy for Environmental Technology*, which was adopted in 2011, focuses on how cleantech can contribute to both economic development and environmental goals. The strategy is central to both industrial policy and environmental policy. The government's vision is for Norway to develop into a key provider of environmental technology solutions, and the strategy stresses how this will be done by focusing on the following dimensions: commercialisation and technology testing; research and competence development; networks and collaboration; environmental regulations; and procurement in public and private enterprises[70].

The Finnish government's cleantech strategy[71] of 2014 also has a strong focus on business development. The strategy's main aim is to accelerate growth in Finnish cleantech businesses and to renew traditional industries through innovations in clean technology. The vision is that in 2020, Finland will be a global superpower in the cleantech business. To achieve these goals, the Finnish government focuses on maintaining cooperation between different levels of government on priority actions and the development of the operating environment for cleantech businesses.

In Denmark, there has been broad political backing in the parliament for agreements to promote the development, demonstration and deployment of new, efficient environmental technology solutions. In 2016, the *Environmental Technology and Demonstration Programme* (MUDP)[72] was implemented. The programme is characterised by close focus on the current challenges of environmental policy nationally, in the EU and globally, and by its connections with environmental, business and innovation policy. The aim of the MUDP is to promote the development and demonstration of sustainable technological solutions that ensure efficient use of resources and manage natural and environmental challenges in Denmark and globally. The programme's objectives are pursued primarily through subsidies and the direct testing and demonstration of new environmental technologies, with a focus on companies working in areas such as water, climate, soil, air, waste, chemicals, etc. The programme will also fund

63) Rönnlund et al. (2014)

64) Rönnlund et al. (2014)

65) Winther (2016)

66) Winther (2016)

67) Formas (2012)

68) Rönnlund et al. (2014)

69) Swedish Ministry of Enterprise and Innovation (2016)

70) Norwegian Ministry of Trade and Industry/Ministry of Climate and Environment (2011)

71) Finnish Ministry of Employment and the Economy (2014)

72) Ministry of Environment and Food of Denmark (2016)

several large demonstration projects in selected areas.

Sweden has a stronger focus on the export potential of cleantech. In the 2011 *Strategy for Environmental Technology*, the Swedish government emphasises that this sector is crucial to economic growth and higher export levels, and states its aim to make it easier to exploit the potential of the Swedish environmental technology field. The strategy includes both short- and long-term initiatives – targeting everything from research and innovation to exports – to make Sweden a green-tech pioneer. The strategy outlines 12 proposed assignments, initiatives and measures designed to boost the Swedish environmental technology sector. These include steps to intensify research and innovation, facilitate financing and business development, support and assist with market analyses/start-ups in export markets for small and medium-sized businesses, and improve coordination among government agencies and other actors of relevance to development in the environment sector[73].

Sweden also has a *Research Strategy for Environmental Technology* from 2008[74]. The purpose of the research strategy is to have an integrated approach to R&D on environmental technologies through the activities of the Swedish Research Council (Formas) and the Swedish Innovation Agency (VINNOVA). The strategy intends to promote the development of new knowledge and strengthen expertise in environmental technology, and to promote Swedish competitiveness in the global market for environmental technology.

3.2 Challenges and interventions addressed in the strategies

The following section opens a discussion on some of the challenges and interventions related to green growth that are commonly mentioned in the national-level Nordic strategies.

3.2.1 Challenges

The main challenges to developing green growth are often related to economic barriers, and a general challenge for small and medium-sized enterprises (SMEs) especially is *the lack of funding* for companies who want to commercialise their operations. The lack of funding is linked to the fact that such investments have a long life-cycle and are capital intensive, and that emerging sectors are not familiar to investors or potential customers[75].

Support related to new business development and growth is another identified challenge. Pilot projects, including technology verification and demonstration, often require large investments, and at the same time they are associated with high risk. Many companies that work with technologies and projects with large start-up and overall investment costs have limited access to public funding[76]. All the Nordic green growth strategies have a strong focus on financial instruments to support green growth development. For example, public R&D has been used to stimulate companies to increase their innovation activities, as well as to encourage R&D organisations to focus research on e.g. the bioeconomy[77].

Market access is also a key challenge in the Nordic countries because these countries' home markets are relatively small[78]. Furthermore, the market for bio-based products and services is partly still being created through regulations and other measures. The Norwegian *National Strategy for Environmental Technology* highlights that the phases during which new technology is being tested and launched in the market are a challenge for companies. As long-term future demand is uncertain and depends on binding international agreements, investments by companies will be subject to considerable uncertainty. In this situation, the public sector can operate as a central 'engine', improving possibilities for commercialisation by securing finance and by creating demand through public procurement[79]. However, in several of the Nordic countries, public procurement policy is not regarded by the business community as sufficiently effective.

Lack of cross-sectoral industry networks is also regarded as a significant obstacle to green growth development. Because many activities in the emerging green economy require cross-sectoral cooperation, new ways of thinking are called for in terms of cluster development and industry networks. In Norway, few cross-sectoral networks exist within some parts of the environmental technology industry. This is to some extent explained by the fact that the field is new and immature, but it is also because companies are spread geographically and differ in size, degree of innovation, etc.[80]

Other obstacles impeding the entry to market of new, innovative solutions are related to the need for *streamlining the licensing process*. The regulations linked to e.g. cleantech need to encourage companies

73) Government Offices of Sweden (2011)

74) Formas/VINNOVA (2008)

75) Nordic Innovation (2014)

76) Norwegian Ministry of Trade and Industry/Ministry of Climate and Environment (2011)

77) Nordic Innovation (2014)

78) Nordic Innovation (2014)

79) Finnish Ministry of Employment and the Economy (2014)

80) Norwegian Ministry of Trade and Industry/Ministry of Climate and Environment (2011)

to developadvanced solutions that are better for the environment and to encourage public and private sector customers to bring these solutions into wider use[81].

Lack of access to the right competencies can also impede the development of green growth industries. In the *Finnish Bioeconomy Strategy*, sustainable bioeconomy solutions are understood to require multidisciplinary competence and a combination of expertise. Further education, upskilling and re-training programmes are some of the measures identified to overcome this obstacle.

3.2.2 Interventions

In the context of this report, "*interventions*" are understood to comprise all the incentives and enablers that drive green growth. In the Nordic bioeconomy and cleantech strategies, we have identified two main types of interventions: namely, regulations and economic instruments. Regulations are designed to achieve the government's objectives through the use of laws and other regulatory measures. *Economic instruments* are a range policy tools that encourage changes in behaviour through their impact on market signals. In addition, other key interventions that aid green growth fall under the heading of the *promotion of cooperation and the competence base*.

Regulations

Companies rely on public authorities, through the implementation of policies, to control demand and thereby the environmental technology market. Legislation and regulations, including environmental taxes and quotas, are important for the sale of existing and the development of new environmental technologies. Without such regulation, there will, in many cases, be no demand for such technology. Studies confirm that strict environmental policy, seen from a company's standpoint, is crucial for corporate investment in environmental measures[82]. For example, the Norwegian *National Strategy for Environmental Technology*[83] highlights EU regulations and economic instruments as a key incentive for Norwegian actors to develop and implement environmental technology. For example, the EU's comprehensive *2020 Climate and Energy Package* provides incentives for the faster development and use of climate-friendly energy technologies. Other relevant EU rules include the Water Framework Directive, the chemicals legislation REACH, the Waste Framework Directive, and rules on state aid and public procurement. If the business community is at the forefront of national and international environmental requirements, it can give individual businesses a better strategic beginning and early access to new market opportunities.

The markets for environmental technologies are often created through policy. Legislation, regulation, fees and economic incentives are important pre-requisites for the sale of existing and development of new environmental solutions. Several of the Nordic green growth strategies identify government leadership as crucial for creating a market and demand for new environmental technology solutions.

A long-term and predictable operating environment is also particularly important for companies that work with technologies and projects requiring large start-up and overall investment costs. Concrete measures to deliver this could include measures to stimulate demand and increases in public support for technology testing and demonstration. Increased coordination of public policy instruments for environmental technology is also regarded as a key enabler by the business community.

Economic instruments

The demand for green solutions is also influenced by the financial penalties for polluting, and such penalties are crucial for green technology to become viable in the long term. Without active policy, there is a risk that important technologies will not be developed. Green development should therefore be viewed in connection with regulations, quotas and taxes that increase the cost of polluting.

Support for new business development is a key enabler of green growth. The Nordic green growth strategies all highlight the need for new business models and new businesses to arise to support green growth. This can be supported through access to seed funding and venture capital. For example, the *Finnish Bioeconomy Strategy* highlights an important measure: government solutions to ensure the availability of risk financing for bioeconomy growth companies, with the aim to increase enterprise growth.

Strategic public research and R&D funding are also key enablers in all the Nordic countries. This applies to both pilot and demonstration projects and large-scale plants.

Promotion of cooperation and the competence base

Cooperation between actors across different niches and sectors is valuable, especially to find new uses for services/products in other sectors' value chains. The special importance of this enabler for green growth is due to the cross-cutting nature of the bioeconomy. Facilitated cooperation and networking could be helpful in

81) Finnish Ministry of Employm ent and the Economy (2014)

82) Norwegian Ministry of Trade and Industry/Ministry of Climate and Environment (2011)

83) Norwegian Ministry of Trade and Industry/Ministry of Climate and Environment (2011)

connecting companies from different industries. The development of bioeconomy cooperation platforms is an example of a measure to stimulate cross-sectoral activities that can foster innovative solutions and improve competitiveness[84].

Finally, the competence base of green growth industries is a key enabler, and this requires multidisciplinary competencies and a combination of expertise. Several of the Nordic strategies focus on educational programmes, deepening research cooperation and the encouragement of participation in international research programmes.

3.2.3 Policy support

How can policy actions help overcome green growth challenges and support government interventions promoting green growth?

Tables 3 and 4 summarise the main challenges and enablers identified in the Nordic green growth strategies, and highlight the forms of policy interventions that can help spur green growth in Nordic regions. It is evident that the major opportunities for policy interventions are on the demand side (e.g. public procurement, standards and regulations) or broader policies to foster innovation (e.g. R&D support, access to finance, skills development, cluster support).

Green growth challenges	Policy interventions
Market entry: pilot project stages, including technology verification and demonstration, often require large investments, while at the same time being associated with high risk	Demand-side support: the public sector can operate as a central 'engine', improving the possibilities for commercialisation through financing and regulatory and legal incentives
Lack of industry networks	Support for cluster development
Ineffective public procurement policy	Funding and investment support
Uncertain future demand/unstable operating environment	Regulations to encourage companies to develop advanced solutions that are better for the environment
Inadequate competence base for green growth industries	R&D support, development of educational programmes focusing on green growth, offering re-training programmes

***Table 3** Green growth challenges and policy interventions addressed in the Nordic green growth strategies*

Green growth enablers	Policy interventions
Technology verification and demonstration	R&D funding
Start-ups/new business development	Seed funding and venture capital
Demand for environmental technologies	Regulations, quotas and taxes that are designed to increase the cost of polluting
A long-term, predictable operating environment	Stimulate demand and increase public support for technology testing and demonstration; increase coordination across public policy instruments
Cooperation between actors across niches and sectors	Support cluster development and cross-sectorial cooperation
A competence base for green growth industries	Develop educational programmes, deepen research cooperation, encourage participation in international research programmes

***Table 4** Green growth enablers and policy interventions addressed in the Nordic green growth strategies*

84) Finnish Ministry of Employment and the Economy (2014)

3.3 Previous findings about enablers of and challenges to green growth

3.3.1 Findings from Nordic regions

From previous studies on the green economy and the bioeconomy in the Nordic countries[85], we have collected evidence showing how regional clusters, initiatives and industries have developed and how they have been influenced by regional and national structures, both positively and negatively. We have used these findings to inform the development of our study of challenges and interventions related to the development of a greener economy in Nordic regions.

The main factors that contribute to the development of the green economy and the bioeconomy within Nordic regions

- Facilitated cooperation and multi-stakeholder involvement in the development and planning stages of bioeconomy activities
- Strong political support from regional authorities
- Access to funding for R&D and preparatory activities such as establishing bioenergy plants, training SMEs and project development
- Cooperation locally, regionally, nationally and internationally between different actors in the field of the bioeconomy
- Access to a highly skilled workforce
- The strong R&D background of the region (also in other sectors)
- Access to local resources, which implies lower transport costs and thus increases the competitiveness of the industry
- Strong industrial cluster organisations
- Research at universities and collaboration with industry

The main challenges to the development of the green economy and the bioeconomy within Nordic regions

- Economic barriers related to a significant difference in the costs of fossil-fuel-based feedstock and products versus biomass-based production chains and products
- SMEs and innovation potential are often overshadowed by big industries and traditional fields of the bioeconomy
- Lack of risk finance and venture capital
- Local education is falling behind compared with the demand for technology expertise in bioeconomy-related fields
- Lack of marketing support
- Lack of specialised support for the internationalisation of firms and products
- An uncertain operating environment at the national and international levels due to unstable support instruments, shifting policies and unclear regulatory systems
- A lack of R&D funding, and an excessively short time limit on funding
- Changing political priorities
- Insufficient entrepreneurial spirit

It is evident from the previous studies that enabling factors for the development of the green economy include, in most cases, a solid anchoring in existing regional policies and development programmes, and in some cases also in national-level strategies. Furthermore, accumulated know-how and expertise in green growth activities pave the way for additional investments and initiatives. The availability of a qualified workforce is also one of the key enabling factors, especially in regions with universities and research centres. Some regions emphasise the role and importance of public–private partnerships and cluster structures (e.g. the Paper Province in Värmland) and promoting regional cooperation.

Challenges in developing a regional green economy include the difficulty of attracting a qualified labour force, especially in smaller and rural regions. Another key obstacle mentioned frequently during the interviews is the inadequate economic profitability of green growth initiatives compared with (fossil-fuel-based) traditional solutions. A common challenge when promoting the creation of new companies is the difficulty of attracting companies with bio-based expertise to set up activities at the regional level. For smaller regions, the lack of local markets and funding opportunities is seen as an obstacle. For example, national tax policies have a considerable effect on regional economic development.

3.3.2 Findings from European studies

Star-COLIBRI, a collaborative biorefinery initiative that linked European technology platforms and major research centres, delivered the first comprehensive list of obstacles and priorities for policy intervention in the bio-based economy[86]. The European Commission's lead market initiative later published an initial report and delivered a number of priority recommendations that further explored demand-side innovation[87]. These initiatives subsequently fed into what became the *European Bioeconomy Strategy*[88].

85) Teräs et al. (2014); Johnsen (Ed.) et al. (2015); Lindberg et al. (2015)

86) Star-COLIBRI (2011)

87) European Commission (2009b, 2011)

88) European Commission (2012)

As these consultation studies are often developed independently, the results from different projects are often difficult to collate, compare and utilise in a complementary way, particularly when it comes to comparing results between regions and/or measuring changes over time. This causes significant difficulties when interpreting information to inform policy. The areas of particular difficulty are as follows:

- Whether identified barriers are ubiquitous or specific to certain sectors or regions
- The source or level at which the identified barriers predominate (e.g. EU, national, municipal)
- Taking into consideration economic factors
- Considering the relative merits of any prior interventions to address identified barriers that could be used as exemplars of good practice

Utilisation of a common design or framework for constructing such studies could provide a solution to these difficulties of interpretation and would make the results from separate studies more readily comparable and their differences measurable. A number of frameworks are frequently used in strategic and market analysis to examine the effects of macro-environment externalities or for use in *"horizon scanning"* exercises. Frameworks commonly used for this purpose include aggregation by factors of political, economic, social or technological (PEST) influence, and now frequently also include environmental (STEEP) and legal (PESTLE) factors. The development of the green economy, however, involves a deeply interconnected series of actors and value chains operating at international, national, regional, municipal and sectoral levels as well as on different spatial scales, all of which are developing in parallel with innovations in enabling technologies and fluctuations in energy and commodity prices[89]. These types of frameworks may be too simplistic to adequately capture and analyse all relevant aspects of green growth. For this reason, a systems approach to analysis and interpretation may be more appropriate.

89) Biohorizons (2015)

4. Methodology

4.1 The Biohorizons project – a European perspective

The Biohorizons project (2015) experimented with utilising the underlying concepts of system functions as a framework for developing a multi-regional stakeholder consultation study based on the identification of failures and successes in innovation systems. The project did not attempt to perform or recreate a full innovation systems analysis but instead used innovation systems theory as a conceptual framework to provide a cross-sectional overview of key barriers and perceived solutions based on stakeholder responses, which could be used subsequently to allow further in-depth innovation systems analysis. These concepts were integrated into a framework from which a methodology for an online survey, diagnostic interview and desk-based study was developed. This was then used to consult bioeconomy stakeholders across Europe to identify opportunities for and barriers to green growth.

This study and our regional survey have built on the framework used in the Biohorizons project and made use of the domains and content of these domains, in light of the list of enablers and barriers from our previous Nordic cases.

The survey in the Biohorizons project focused on identifying areas of consensus and disagreement between industrial, research and policy communities in multiple regions. The survey was provided in six European languages and received around 500 credible responses in total[91]. Innovation system functions were used to structure the survey and identify barriers or system failures based on where the greatest amount of policy intervention was required. The results yielded region and stakeholder group profiles that highlighted areas of consensus or disagreement between responses, and particular failures in the innovation system that may require policy intervention; an example is given in Figure 3.

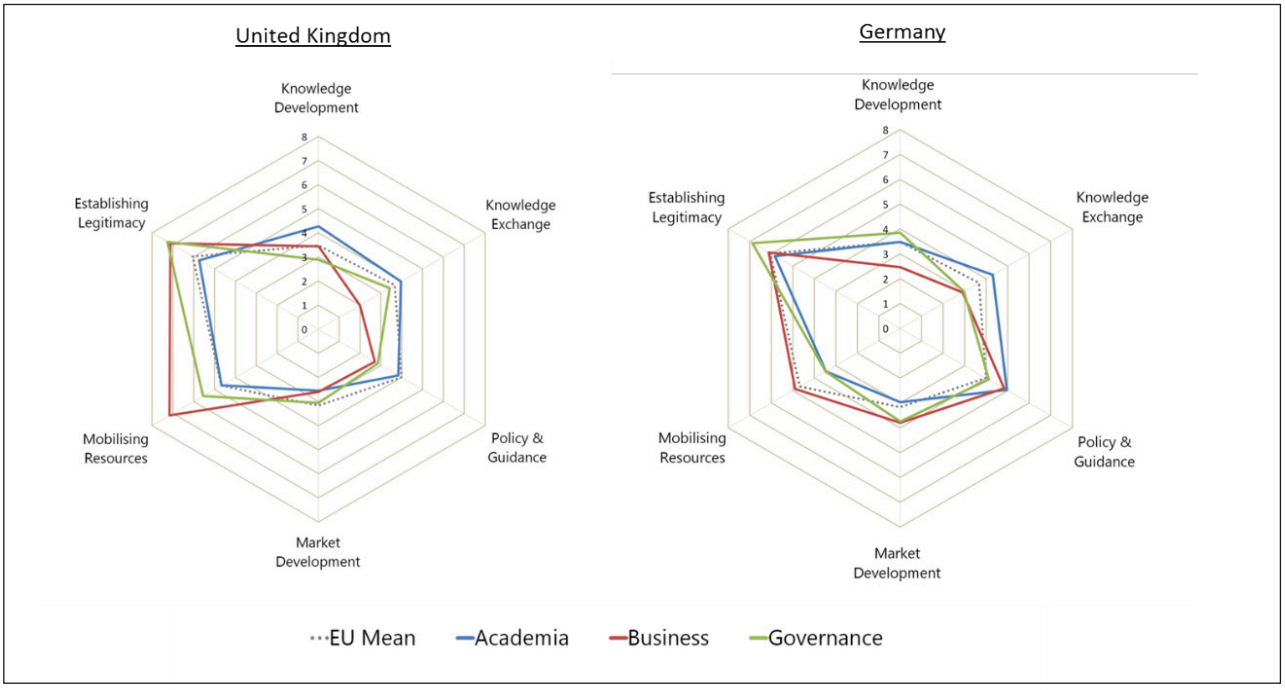


Figure 3 *Perceived barriers to the development of the bio-based economy, by stakeholder group and region* [90]

90) Hodgson et al. (2016)

91) Biohorizons (2015)

Assessing the responses from the two countries, it can be clearly seen that there are differences between these countries and between stakeholder groups within each country regarding the system functions perceived as requiring the greatest intervention (Figure 3). Responses from Germany showed a much greater degree of consensus between the stakeholder groups. Overall, establishing legitimacy (i.e. combatting resistance to change) was viewed as the key barrier in both countries. In the UK, however, it was clear that there were greater disparities in perception regarding the main barriers, particularly between business and other stakeholder groups, with the business community viewing mobilisation of resources as the greatest barrier. The interventions most urgently required to address perceived barriers were included in the survey in a format referred to as *"Best-Worst"* scaling or *"MaxDiff"*, which provides a more statistically robust framework for multiple choice question sets. In this format, respondents rank all presented interventions as better or worse than each other. For example, results from the UK study are presented in Figure 4.

Barriers and interventions deemed most critical could then be compared and contrasted between stakeholder groups and regions, and further examined through diagnostic interviews and a desk-based policy review to identify justifiable reasons for areas of failure or best practices in overcoming specific barriers and supporting innovation and green growth.

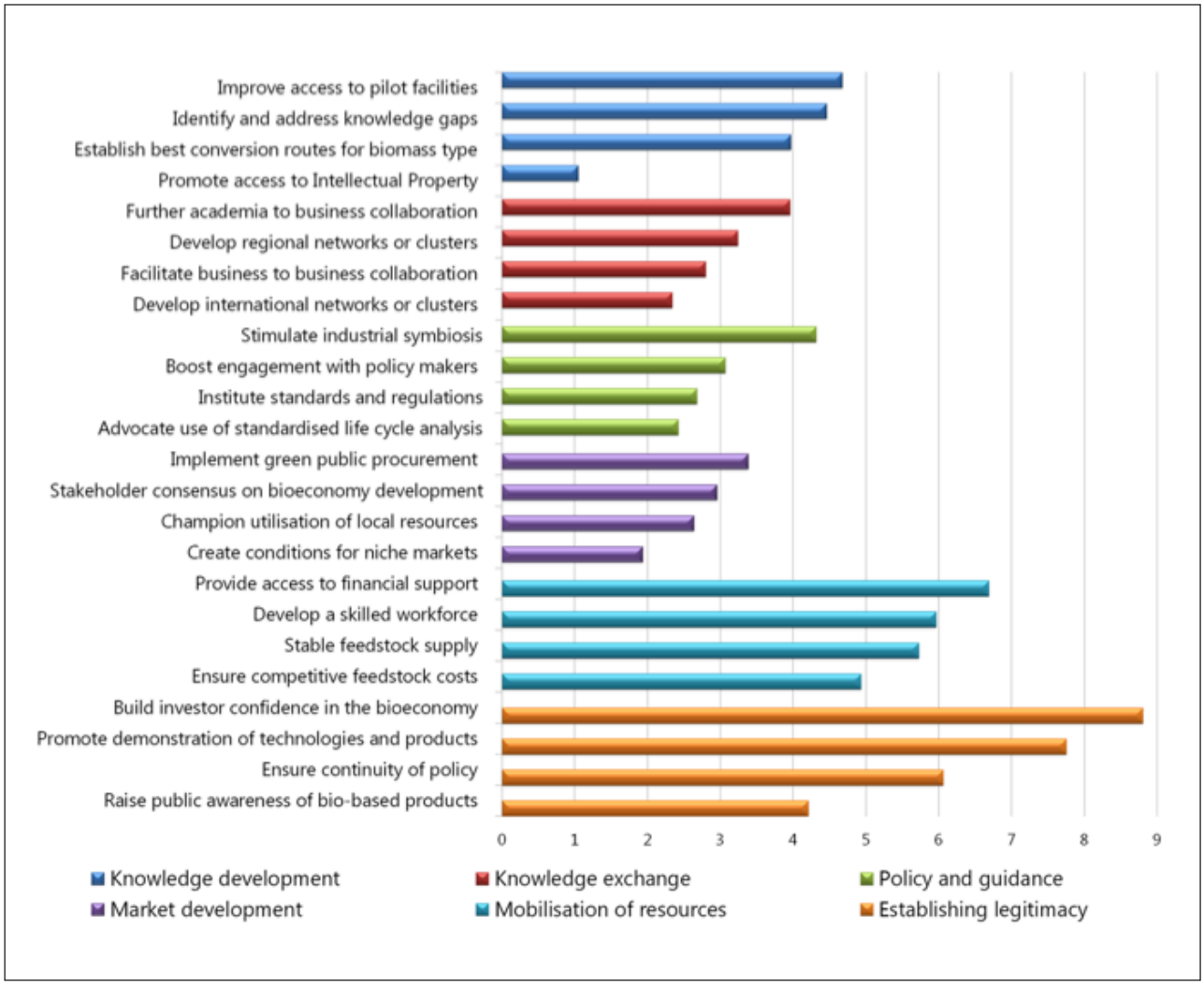


Figure 4 *Interventions ranked by UK bio-based economy stakeholders (Biohorizons, 2015)*

4.2 Conceptual survey design

The methodology of our Nordic study was partly inspired by the Biohorizons project; however, the design of our study differs somewhat from the Biohorizons study design. *First*, our survey is intended to be applied to multiple regions, but the initial target stakeholder groups include public sector actors only. *Second*, the scope of the survey encompasses the broader remit of *"green growth"* and those public sector officials who have responsibilities relating to one or more of the following sectors, as summarised in Figure 5 below.

Third, innovation system functions were adapted to better match the division of policy frameworks and government departments being approached, and also for ease of understanding, as they would be presented to respondents to improve clarity regarding where challenges were encountered and to provide the context for suggested interventions. One major adaptation to functions used in innovation systems studies was made regarding *"establishing legitimacy or counteracting the resistance to change"*[92]. This function is embedded within the concept of green growth itself and its emphasis is apparent in responses to other system functions. In addition, the *"resource mobilisation"* function encompasses material, financial and human resources, making it far more complex than the other functions. Therefore, in our study, the function was split into *"education and skills"* and *"finance/funding"* to be more in line with the delineations of policy fields. The aspiration was to facilitate comparison between different regions more easily.

4.2.1 Perceptions of barriers and interventions

A series of proposed interventions was developed based on the results of previous stakeholder engagement studies. For balance, four interventions were presented under each topic/function, and respondents were requested to rank them by relative importance. For each function, respondents were also given the opportunity to suggest additional interventions that were not included among the four presented, but which the respondent believed would better address the identified challenges. Where significant challenges were identified, further inquiry could be made as to whether official action had already been undertaken to address them, and if so, whether that action was perceived to have had any measure of success. Figure 6 (next page) illustrates the structure used to aggregate sources of challenges and targets for intervention, and presents further description of the categories and interventions presented in the survey.

Figure 5 *Sectors included in the survey*

92) Hodgson et al. (2016)

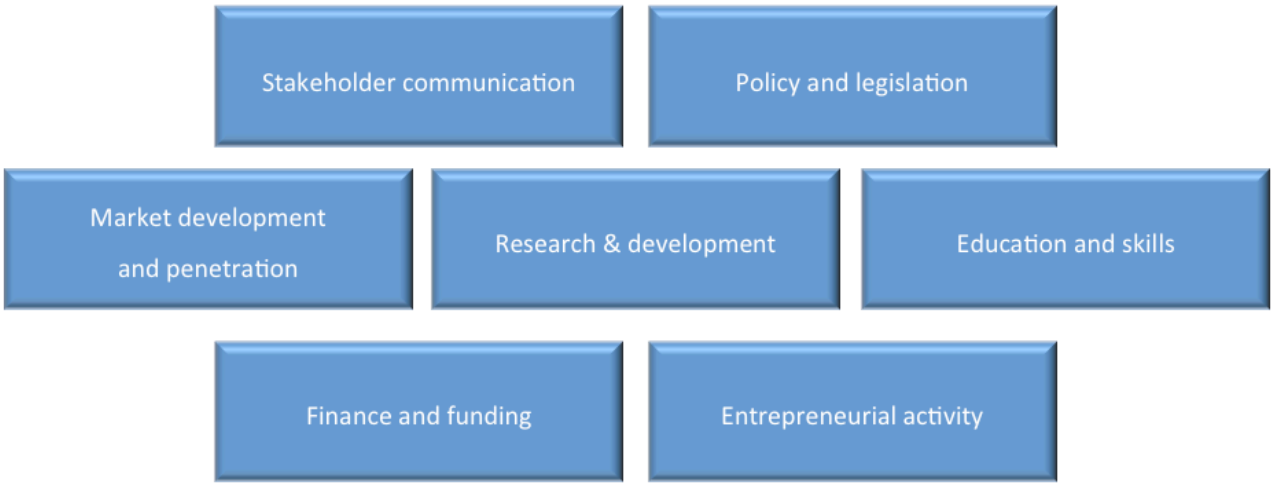


Figure 6 *Structure used to aggregate challenges and interventions in the Nordic study*

We also provided examples of how these different types of challenges and interventions were presented in the regional cases that we studied previously (shown in the blue boxes below).

Entrepreneurial activity is the fundamental driver of innovation. From a policy stakeholder perspective, it can be measured in terms of the number of established companies, the rate of new company registrations as green businesses and which sectors are seeing the highest levels of growth. These figures provide a means of comparison on a spatial and sectoral level, and also allow assessment of the effects of any active, ongoing policy initiative within sectors or regions.

- *Raise awareness of opportunities* – What level of awareness is there regarding the potential opportunities offered by green growth markets and support that may be available?
- *Provide mentorship schemes* – Are mentorship schemes available and is mentorship required to support entrepreneurs developing new products and niche markets?
- *Improve start-up support* – What level of support is available and is it required?
- *Improve diversification support* – Aside from a focus on new businesses, is there any additional support encouraging the diversification of existing businesses into green products or processes?

Example: Entrepreneurship

Despite promising signs regarding the development of the bioeconomy in the Westfjords region of Iceland, there are large obstacles. First and foremost, there is a significant lack of capable, educated entreprenaurs in the region (Lindberg et al., 2015).

Research and development refer to the level of R&D within specific sectors and regions that directly contributes to green growth, and how effectively it is translated from academic centres into industrial applications.

- *Identify applied research gaps* – Is there a need to identify and raise awareness of key research gaps that are not being addressed but which present persistent barriers to innovation and entrepreneurship?
- *Better facilitate the commercialisation of research* – Intellectual property (IP) exists, but is there a need for mechanisms to better support its translation and licensing and/or for matchmaking to support the development of commercial partnerships?
- *Improve capacity for demonstration and prototyping* – Is support available to bridge the gap between a concept and the demonstration/prototyping needed to secure further investment?
- *Improve business access to R&D* – To what extent are industrial actors engaging with existing research facilities, and is support required?

Example: Strengthening the innovation milieu in the region

Over the past years, the bioeconomy has been high on the political agenda in the Värmland region. Developing the bioeconomy also contributes to the realisation of the overall strategic priorities of Värmland, such as enhancing innovation and strengthening cluster organisations. Cluster policies have become an integrated part of the regional development strategies of Värmland, as have policies to promote the bioeconomy (Lindberg et al., 2015).

Stakeholder communication refers to the effectiveness of communication between and within stakeholder groups. This could be improved through mechanisms such as knowledge transfer networks, trade associations, research hubs or business clusters. This also relates to the degree of consensus or disagreement regarding the identification of key issues and challenges and the interventions most needed to address them.

- *Research and business* – How effective is communication between stakeholder groups regarding research gaps, translation and commercialisation opportunities for existing IP?
- *Research and governance* – How effective is the communication between research and policy communities regarding opportunities and threats, and how well does public research funding reflect research priorities?
- *Business and governance* – How effective is the communication between industry and policy makers regarding political/legislative barriers that are hampering green growth?
- *Between businesses (supply chain)* – How effective is communication between industrial actors within the supply chain regarding opportunities presented by green growth, and is there a need to support better communication, for example by encouraging business clusters?

Example: Stakeholder communication and mobilisation

The success of bioeconomic development in the Region of Zealand in Denmark can be attributed to intensive cooperation among different actors in the region. Several policy instruments were developed and used in Zealand to support such collaboration. Examples include the Regional Sparring Group on the Bioeconomy, which comprises all key actors in the field of biomass/the bioeconomy, and regional business advisory activities. The function of the sparring group is to contribute to the development of new bioeconomy projects and imagining possible regional bioeconomy futures (Lindberg et al., 2015).

Policy and legislation refer to how existing policies and legislation are regarded by stakeholders operating in different regions and sectors. In some cases, specific interventions may be needed to address potential problems; in other cases, it may be desirable simply to follow best-practice examples already set by particularly effective strategies employed within specific regions/sectors.

- *Provide better incentives for green enterprises* – Do such incentives exist, and does more need to be done to incentivise growth in related sectors (i.e. in addition to simply raising awareness of opportunities)?
- *Lift restrictive legislation* – Does existing legislation present barriers to growth, and are these barriers region and/or sector specific?
- *Resolve conflicts in existing legislation* – Do contradictions and conflicts exist between current pieces of legislation that are causing confusion in interpretation and hence presenting a barrier to green growth, and are these barriers region and/or sector specific?
- *Ensure continuity of policy* – Has there been inconsistency or a great degree of change in policy and legislation that has been viewed as a barrier to green growth?

Example: The need for long-term stability of policies and legislation

Biogas production is a current priority of the government in Denmark, with the result that a larger share of public funding goes into biogas plants at the regional level compared with other energy initiatives. This creates more favourable market conditions and lower economic barriers for biogas production. Setting up a biogas plant is, however, a time-consuming process, and this is seen as an important obstacle. The decision-making process can take up to 5–7 years due to the legal complexity and strict regulatory measures, such as the need for environmental impact assessments and permits. It is important that the playing field is perceived to be stable for the entire life-cycle of the financial investment (Lindberg et al., 2015).

Education and skills relate to factors concerning human resources and the levels of required skills and capabilities to maintain green growth within the regions of interest.

- *Address skills gaps in the workforce* – Do skills gaps exist, do they relate to particular regions or sectors and is there a need for public sector intervention to address these gaps?
- *Improve public understanding and acceptance* – Do the public/consumers have sufficient awareness and understanding of what green growth means and the benefits that may be achieved by supporting it?
- *Better provision of vocational training* – Is skills training provided at the appropriate levels to fill gaps in the workforce, and is there a need to provide additional support for vocational training programmes?

■ *Improve access to the migrant labour market* – Is there a need to attract expertise and skills from outside the region to build the workforce and maintain growth in green sectors?

Example: Education and skills – in the longer run

Central Finland has successfully integrated the bioeconomy into its regional educational strategies, and local universities are educating experts for the needs of the region's bioeconomy. However, in terms of bioeconomy-related higher technology, Central Finland is still dependent on external expertise and workforce migration (Lindberg et al., 2015).

Finance and funding relate to the availability and accessibility of finance to support the development of green growth, and the perceived effectiveness of current structures and initiatives.

■ *Facilitate greater capital investment* – Is capital investment a particular problem, and if so, in which sectors and regions?
■ *Improve access to finance for start-ups and SMEs* – Is finance for business start-up and scale-up readily available or does this present a problem, and if so, in which regions and sectors?
■ *Increase funding for R&D* – Is there a need to better support R&D, for example through collaborative partnership funding targeting key regions and sectors?
■ *Provision of additional subsidies* – Are specific sectors unable to compete without subsidisation, and if so, which sectors?

Example: Economic barriers

The higher costs and greater complexity of value and production chains for bio-based products compared with fossil-fuel-based feedstock today represent an overall economic barrier and challenge to the development of the bioeconomy, limiting the market uptake of bio-based products. The opportunities lie in combining different benefits in order to convince companies that bioeconomy investments are profitable despite their higher costs. Feasibility studies provide important support for advancing the bioeconomy and helping to put such thinking into practice (Lindberg et al., 2015).

Market development and penetration relate to challenges that are encountered as a result of market forces. These questions explore whether markets for green products and services are undeveloped or at present only niche markets, or whether these markets do exist but penetration into them is more of an obstacle.

■ *Implement strategies for green public procurement* – Would the establishment of green public procurement criteria support the development of and demand for green products and services, and help to develop new markets and penetrate existing ones?
■ *Institute green product standards and regulations* – Is there a need for improved standards and regulations such as certification schemes and labelling to improve the competitiveness of green products and open opportunities for the creation of niche markets?
■ *Identify and develop new products* – Is there a demand for new products and is there a need for intervention to support their development and promotion?
■ *Identify new channels and customers* – Is market penetration more of an issue than market development? Do markets exist already, and if so, are there barriers to the identification of new channels for trade and marketing to expand the customer base? Is this frequently cited by industrial contacts, and is there a need for public sector intervention?

Example: Market development

According to interviewees, the main obstacles to the growth of the biotech industry in the capital city region of Iceland are a lack of specialised marketing support, a lack of support regarding the registration of products in foreign markets and an unclear regulatory system (Lindberg et al., 2015).

Identification of challenges and responses to intervention ranking may subsequently be used to compare and contrast responses from stakeholders. This can be done through surveys and responses from diagnostic interviews with experts active in the field. Combined with desk based research, this methodology can help identify trends and make recommendations for Nordic regions based on the degree of consensus or disparity between perceptions between regions and sectors, and the policy framework in place to stimulate green growth.

5. Nordic survey of challenges and interventions

5.1 What are the Nordic regions working on?

In this chapter, we present the main results of our Nordic survey in 2015–2016 on challenges and interventions related to the development of a greener economy in Nordic regions.

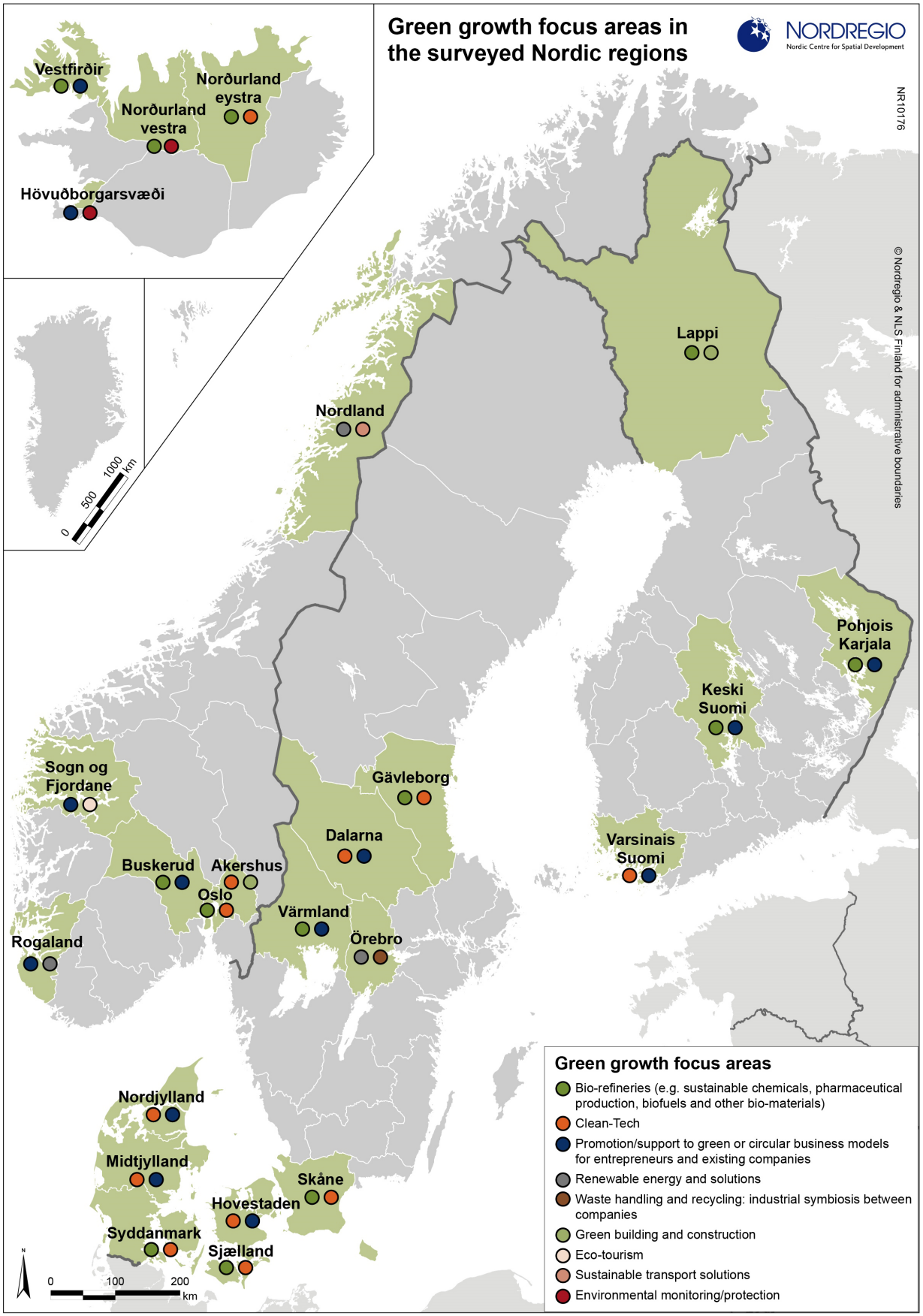
The national policy review presented in Chapter 3 demonstrates that common national-level interventions in the Nordic countries for fostering green growth development focus on regulation (i.e. legislation and regulations, including environmental taxes and quotas), economic instruments (i.e. regulations, quotas and taxes that increase the cost of polluting, and access to seed funding and venture capital) and access to a competence base (a focus on educational programmes, deepening research cooperation and cross-sectoral cooperation).

Based on the survey results, Tables 5 summarises the top challenges and interventions for green growth activities in the surveyed Nordic regions, with the most persistent challenges and most important interventions presented at the top of the list, and the least common challenges and least crucial interventions presented at the bottom (the challenges and interventions are further discussed in Sections 5.2 and 5.3)

The map (next page) presents an overview of the top two green growth focus areas for each Nordic region that responded to the survey. As the map shows, Nordic regions have a wide scope of activities in the green economy and bioeconomy.

Most persistent and frequently encountered challenges	Interventions
■ Policy and legislation	■ Add green entrepreneurship and innovation to the school curriculum in high schools
■ Finance and funding	■ Raise awareness of green business models and opportunities
■ Stakeholder communication	■ Improve access to finance for micro enterprises and SMEs
■ Market development	■ Improve the capacity for demonstration and prototyping
■ Education and skills	■ Improve communication between the research and business sectors
■ Entrepreneurial activity	■ Provide better incentives for green solutions, products and enterprises
■ Research and development	■ Introduce green product and service standards and regulations

Table 5 *Top challenges and interventions to green growth activities in the surveyed Nordic regions*



Map 1 *Green growth focus areas in the surveyed Nordic regions*[93)]

93) Julien Grunfelder, Nordregio (2015)

Chart 1 below illustrates the green growth topics respondents rated as most relevant *(green bars)* and least relevant *(blue bars)* in their respective regions. The top five responses (above the 50% mark) indicated by the survey respondents were as follows:

1. Renewable energy and solutions
2. Waste handling and recycling: industrial symbiosis between companies
3. Promotion/support for green or circular business models for entrepreneurs and existing companies
4. Sustainable transport solutions
5. Primary production (e.g. the bioeconomy: agriculture, forestry, fisheries etc.)

According to the survey results, renewable energy solutions were the top priority in the Nordic context, which is consistent with the 2020 renewable energy targets presented in the Renewable Energy Directive[94] and reflects the common ambition to create an efficient energy system with low GHG emissions. The concept of the circular economy is also high on the political agenda in Nordic regions, indicating a growing trend towards circular business models. By contrast, eco-tourism, cleantech and biorefineries are rated below the 50% mark. This can be partly attributed to the small number of respondents in the sample, which may slightly distort the overall distribution of green topics across Nordic regions. The respondents also highlighted the importance of public procurement in stimulating local economic development linked to the green economy as well as activating different stakeholders within the circular economy.

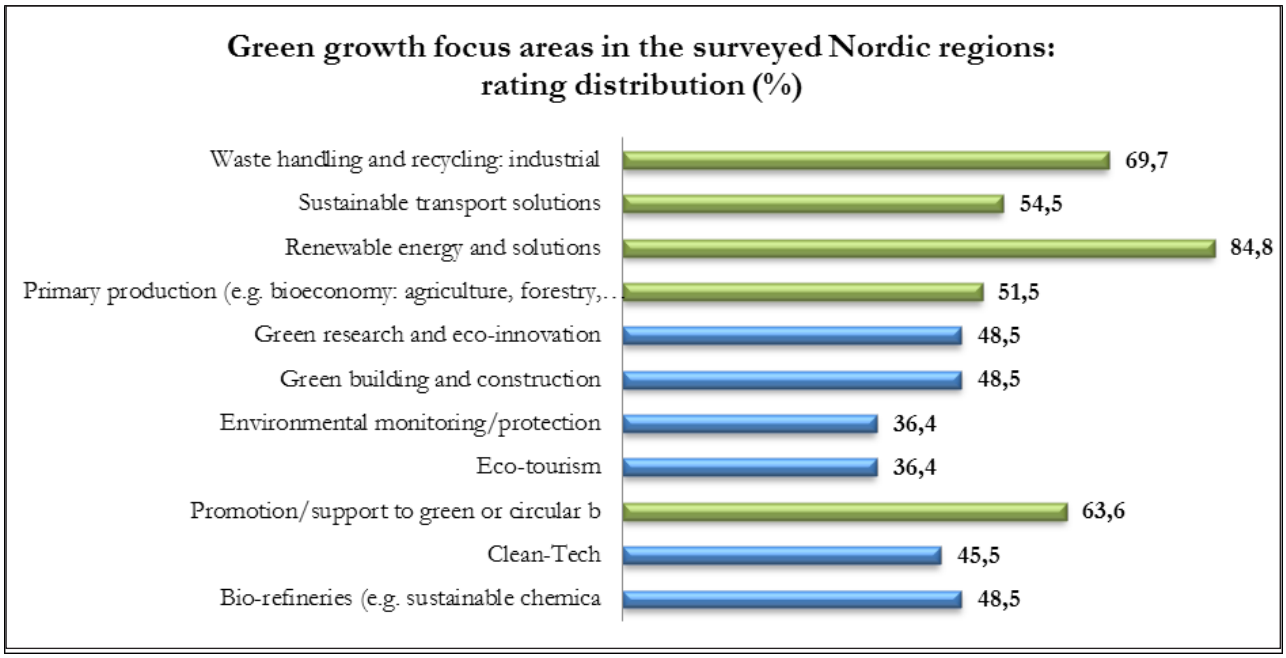


Chart 1 *Green growth focus areas in the surveyed Nordic regions: rating distribution*

94) European Commission (2009a)

5.2 What are the most commonly encountered challenges?

A majority (61%) of respondents reported the existence of barriers to green growth in Nordic regions, compared with 36% of respondents reporting no barriers. Assessing the responses from the surveyed regions it can be clearly seen that *"policy and legislation"*, *"finance and funding"* and *"stakeholder communication"* are the most persistent and frequently encountered barriers. The "policy and legislation" challenge is primarily related to the inadequate coordination of green growth initiatives on both national and regional/local levels, as well as conflicting legislation between EU and national/regional levels. Nordic regions are generally too small to independently affect the EU and international policy development and outcomes. The establishment of common frameworks and public procurement will better enable all five countries to promote green solutions in the entire Nordic region. Likewise, the *"finance and funding"* challenge is partly attributable to the lack of coherent national strategies for green growth, which in turn hinders the long-term private investment necessary for generating broad social and economic benefits as well as facilitating the internationalisation of green businesses. In this context, the challenge related to *"stakeholder communication"* also sometimes appears as a missing link in the development of green growth programmes and strategies. Involvement of diverse stakeholders and their partnerships, networking and experience-sharing across all levels, as well as the establishment of an inclusive dialogue between the public and private sectors, are all required for identifying and developing appropriate green economy policies.

From the respondents' perspective, *"entrepreneurial activity"* and *"research and development"* were not perceived as a persistent or frequently encountered challenge to green growth activities. One possible reason for this is that the level of entrepreneurship is rather high in Nordic regions. Denmark, for instance, has a large network of public and private entrepreneur supporters, accelerators and incubators that provide support at every stage of the start-up process. Therefore, the main challenges remaining are not in launching start-ups but rather in growing existing enterprises, and this challenge is not generally linked to green growth issues but rather to the overall business development climate[95].

A further general barrier – *"the lack of willingness to work across sectors and institutions"* – was added by the survey respondents. However, this might be the result of a lack of appreciation of the value of cross-sectoral cooperation rather than a lack of will. The survey respondents also indicated that public procurement rules frequently hinder the growth of local green capacity. Furthermore, given the relative newness of the concept of *"green growth"*, there is a clear need to integrate network activities (e.g. green growth clusters, business associations, etc.) into regional policy frameworks in order to streamline the implementation process[96].

5.3 Incentives and enablers for overcoming existing challenges

Interventions required to lift existing barriers were included in the survey in a format referred to as *"drag and drop"* ranking, which provides multiple choice options, starting from the top choice down. Respondents' ranking of the most important interventions needed to address existing challenges in Nordic regions is presented below in a series of bar charts (Charts 2 through 8).

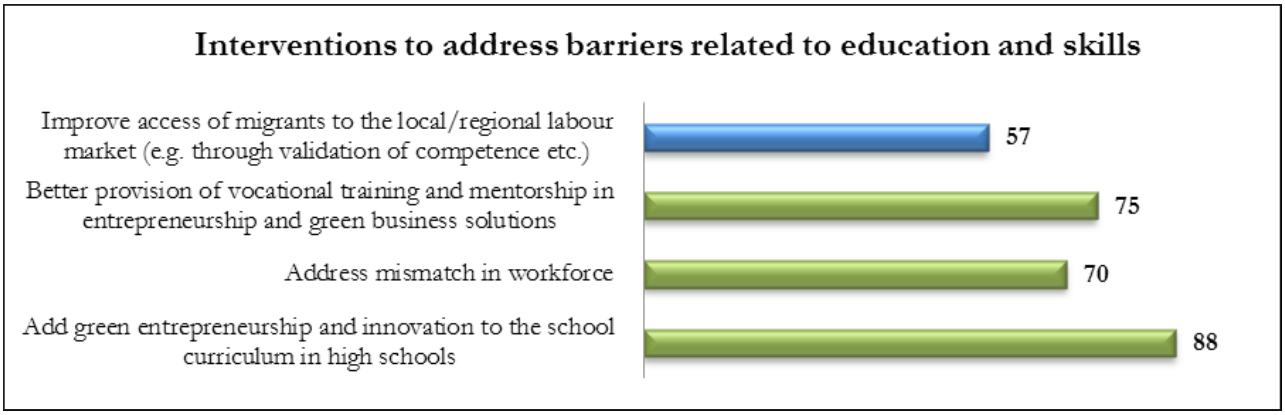


Chart 2 *Interventions to address barriers related to education and skills*

95) Interview with a national expert, 20.9.2016

96) Interview with a national expert, 19.10.2016

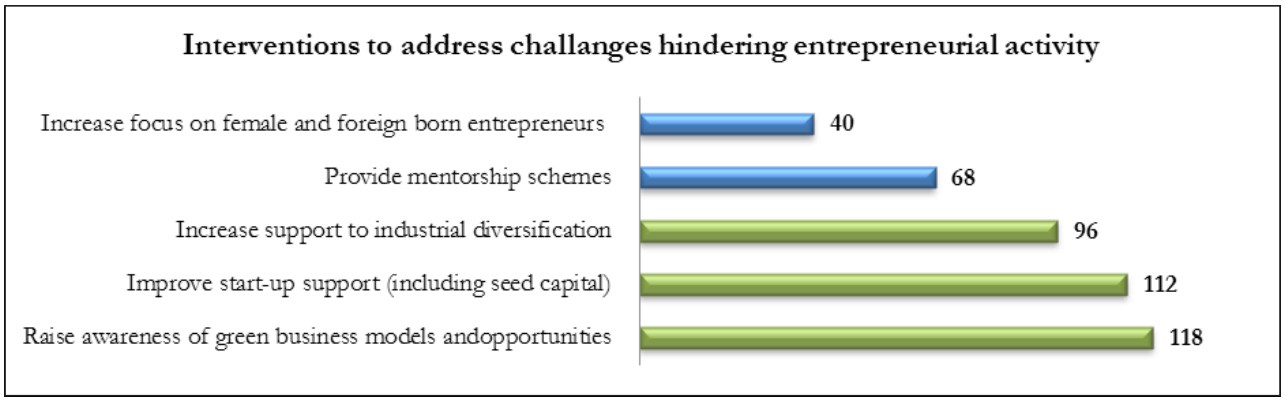


Chart 3 *Interventions to address challenges hindering entrepreneurial activity*

Green growth and sustainable development depend on several interlinked factors. An important factor (yet to be realised) is better integration of green growth into national curricula (Chart 2). Moreover, a cross-sectoral and systemic approach to the green economy requires an improvement to the supply of vocational specialists, trained in subject areas that have been identified by the value chain stakeholders. Further improvement of the balance between the demand and supply of vocational skills, as well as adjusting the whole education system in terms of better use of existing competences (e.g. engineers, life scientists, etc.), will be designed with explicit links to the desired paradigm shifts and new development towards a green growth model[97].

Given that many innovative and green business models focus on solutions that cover a wider range of the value chain than do traditional business models, a focus on developing and strengthening cooperation along the value chain as well as a focus on ensuring the presence of public partners (as consumers of green goods and services) were considered important policy interventions for overcoming the barriers to entrepreneurial activity. This is also in line with the systemic focus on innovation (see Chapter 2) that emphasises the importance of cross-sectoral cooperation through regional innovation networks, local clusters and research institutions.

By contrast, entrepreneurial mentoring (Chart 3) is not rated by the respondents as an equally important intervention. This can be partly attributed to unawareness by business of certain needs, calling for a more proactive role for public actors in facilitating and catalysing discussions on how to foster support systems for entrepreneurial development[98]. Furthermore, the digitisation of business processes and the development of online platforms for green entrepreneurship might encourage further dialogue and knowledge exchange among various groups of local actors[99].

SMEs' strong ties to local communities place them in a good position to promote and disseminate knowledge and innovative practices in the field of green growth. Given their limited resources, however, it is essential to establish a strong link between the financing community and SMEs needed for exploring new (green)

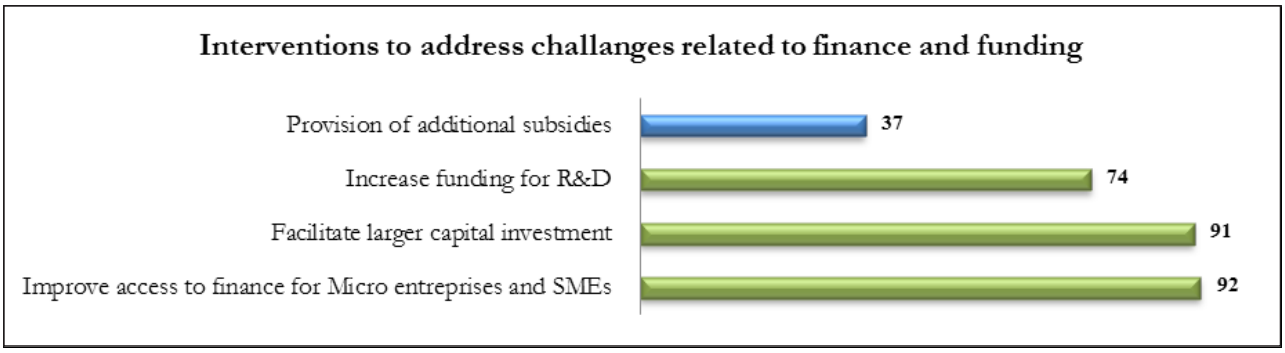


Chart 4 *Interventions to address challenges related to finance and funding*

97) Interview with a national expert, 23.9.2016

98) Interview with a national expert, 20.9.2016

99) Interview with a national expert, 19.10.2016

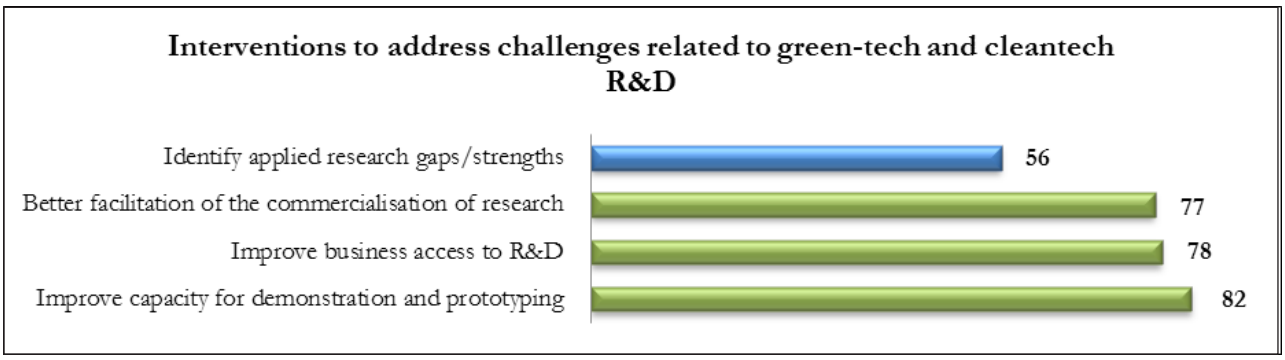


Chart 5 *Interventions to address challenges related to green-tech and cleantech R&D*

business models, setting up demonstration projects and the like. Providing support for the internationalisation of businesses was also indicated as an important policy intervention (Chart 4). Provision of additional subsidies is not seen as a crucial intervention, probably because subsidies usually also impose substantial additional administrative burdens on entrepreneurs. A more urgent issue for SMEs (particularly those located in peripheral regions) is to ensure that they have sufficient risk capital to enable an expansion of production and make a larger social and economic impact[100].

There is evidence of a consensus among the respondents that in order to fully realise the potential of green business models, technological solutions should be more flexible (small-scale), providing an opportunity for improving and expanding local economies[101] (Chart 5). Examining existing applied research gaps to set priorities for future research was not considered a top priority intervention, probably because the link between research and industrial applications is not yet strong enough.

A green economy demands the collaboration of multiple stakeholders across businesses, government and the research sector. Building an effective dialogue between the research sector and government was not one of the top three interventions indicated by respondents (Chart 6). This can be partly attributed to a general communication mismatch between the research community and the political system, caused by a lack of constructive and continuous feedback on research outcomes and their integration into political dialogue. Furthermore, research communities usually are insufficiently active in making themselves politically relevant[102]. To further strengthen the links between diverse groups of actors needed to drive the green economy agenda forward as well as strengthen network cohesion (e.g. through coordinating supply–demand relations between government, companies and research/R&D units), the role of intermediary organisations should be clearly acknowledged in national and regional policymaking[103].

Chart 6 *Interventions to address challenges related to stakeholder communication*

100) Interview with a national expert, 20.9.2016

101) Interview with a national expert, 20.9.2016

102) Interview with a national expert, 20.9.2016

103) Interview with a national expert, 19.10.2016

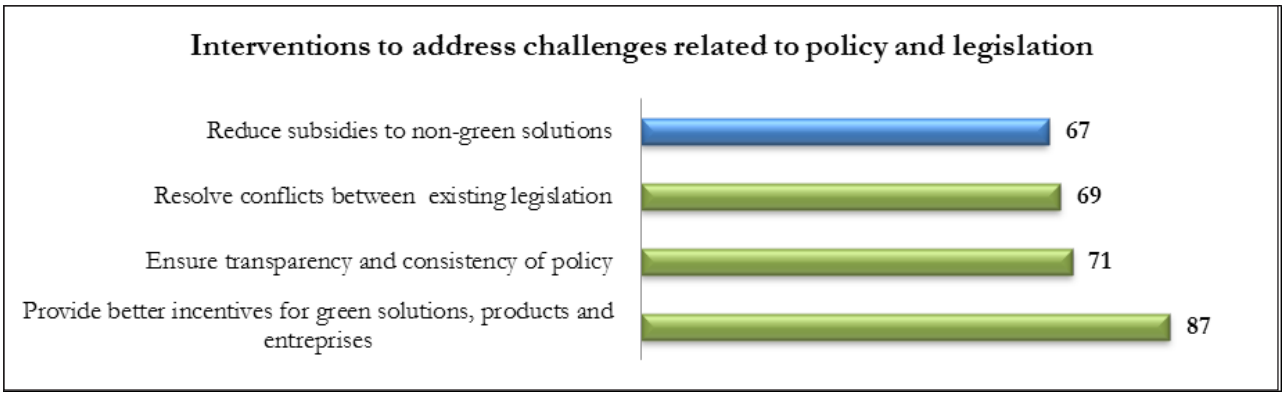


Chart 7 *Interventions to address challenges related to policy and legislation*

Despite the rather strong political commitment of Nordic regions to green growth, there is still a need for a more proactive public response to further enhance implementation efforts towards green growth (Chart 7). As policy sets the scene for the green economy, many existing initiatives should be fine-tuned to balance the policy goals related to green growth with new behaviours by firms, i.e. the introduction of new processes and technologies. Furthermore, these new developments call for a more coherent and comprehensive regulatory framework to 'level the playing field' so that non-green solutions enjoy reduced support compared with today's levels[104].

As the survey results reveal, there is still a need to realise higher levels of market research when commercialising new ideas (Chart 8). On one hand, this can be explained by a lack of consensus about the meaning of the *"green market"*; on the other hand, however, it reflects the Nordic concept of *"entrepreneurship"*, which places more emphasis on being innovative than on using market research to drive innovations[105]. The search process should start with end-user needs and work backwards to determine the required inputs and optimal product designs, in order to further advance green development.

Comparing the survey results with the outcomes of the Biohorizons project reveals certain similarities. In all cases, the survey respondents indicated that mobilising resources through better access to finance and funding, especially for micro enterprises and SMEs, was one of the most frequently perceived barriers to green growth and sustainable development[106]. Establishing legitimacy (counteracting resistance to change) was also indicated in the Biohorizons project as an important barrier. This can be addressed through building investor confidence (through the promotion and demonstration of new technologies) and ensuring continuity of policy. This echoes the findings of the current study into Nordic regions, where the investigated challenges related to policy and legislation can be ad-

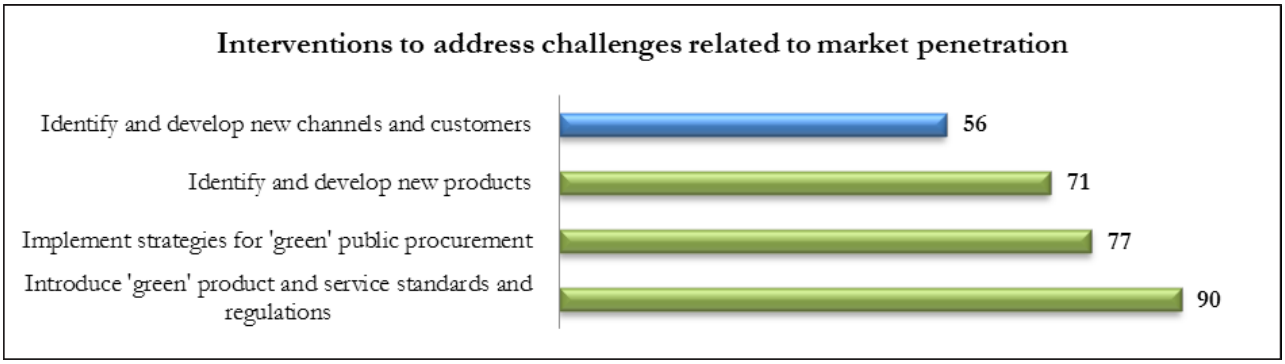


Chart 8 *Interventions to address challenges related to market penetration*

104) Interview with a national expert, 23.9.2016

105) Interview with a national expert, 23.9.2016

106) Interview with a national expert, 19.10.2016

dressed through resolving conflicts between existing pieces of legislation and increased transparency and consistency of policy, as well as providing better incentives for green solutions, products and enterprises. The respondents from Nordic regions also indicated that ineffective stakeholder communication is one of the most frequently encountered challenges. One of the identified keys to overcoming this barrier was to maximise the involvement of different groups of stakeholders, as well as to improve the effectiveness of communication between businesses, the research sector and government.

6. Conclusions and policy recommendations

The objective of this third in-depth study was to provide an analysis of the state of play, practices and needs of Nordic regions in promoting innovation and entrepreneurship for a greener economy. The study was based on a survey and interviews, focusing on the main challenges that impede green growth in Nordic regions, and identifying potential ways of overcoming these obstacles and driving the green growth agenda forward.

In the following we will present the conclusions from the empirical data as well as policy responses related to the identified challenges.

6.1 What are Nordic regions currently doing in the field of green growth?

The survey results show that Nordic regions have a wide scope for *"green economy"* and *"bioeconomy"* activities. The green growth topics that respondents rated to be most relevant/significant were as follows:

1. Renewable energy and solutions
2. Waste handling and recycling: industrial symbiosis between companies
3. Promotion/support for green or circular business models, for entrepreneurs and existing companies
4. Sustainable transport solutions
5. Primary production (e.g. the bioeconomy: agriculture, forestry, fisheries etc.)

According to the survey, the three highest-ranked barriers to green growth and Nordic green transition are *"policy and legislation"*, *"finance and funding"* and *"stakeholder communication"*.

At the national level, the majority of the Nordic countries have green growth strategies on the bioeconomy and/or cleantech that focus on R&D and innovation as well as regulation issues.

Both Denmark and Finland have a strong focus on innovation and entrepreneurship related to the bioeconomy. Denmark has established a national bioeconomy panel/council, and the bioeconomy in Denmark is being pursued through broader policy frameworks for growth, innovation and environment. *The Finnish Bioeconomy Strategy* from 2014 focuses on creating a favourable operating environment for the bioeconomy, to support the creation of new bioeconomy businesses, to develop and maintain bioeconomy skills and to ensure the ability to use renewable resources sustainably. Sweden and Norway have a stronger focus on research; the *BIONÆR Research Programme on Sustainable Innovation in Food and Bio-based Industries* is the Norwegian research strategy to promote bioeconomy-related activities by promoting research that increases the level, profitability and sustainability of production in the value chains for agriculture, forestry and nature-based industries, as well as seafood. The 2012 Swedish *Research and Innovation Strategy for a Bio-based Economy* focuses on the efforts needed in R&D and innovation to develop the skills necessary for the transition to a bio-based economy.

In the field of cleantech, national-level strategies have three core focus areas: economic development, the environment and innovation.

Finland and Norway have adopted national cleantech strategies. Both strategies have a strong focus on how cleantech can contribute to economic development. Sweden also has a strong focus on the economic potential of cleantech, and its cleantech strategy specifically focuses on how to promote the export potential of Swedish cleantech. A range of short- and long-term initiatives, targeting everything from research and innovation to exports, are intended to make Sweden a green-tech pioneer.

The Norwegian *National Strategy for Environmental Technology* also has a strong focus on environmental goals. The strategy is central for both industrial and environmental policy. Similarly, through the MUDP, Denmark focuses on creating a connection between environmental, business and innovation policy. The aim is to promote the development and demonstration of sustainable technological solutions that ensure the efficient use of resources and manage natural and environmental challenges in Denmark and globally.

From a regional perspective, the survey results show that Nordic regions perform a variety of green growth activities ranging from renewable energy solutions, industrial symbiosis and waste handling to supporting

the development of biorefineries, primary production sectors and green circular business models for entrepreneurs and existing companies. Renewable energy solutions came up as the one priority in the Nordic context reflecting the common ambition to transform Nordic energy systems towards renewables.

6.2 What are the major challenges and government interventions for developing a greener economy in Nordic regions?

Based on the survey, interviews with key national experts and the national policy review we have identified several challenges and interventions for green growth in Nordic regions. We summarise the identified challenges and interventions below.

The main challenges to the development of the green economy were as follows:

- The issue of sustainability often appears to be secondary to basic economic problems in national *"sustainability"* strategies, and **priority is usually given to technological solutions that are easy and cost-effective** (to avoid imposing extra costs on businesses).
- **Localised perspectives are often insufficiently integrated into national policymaking**, thereby imposing a 'one-size-fits-all' approach to the bioeconomy and green growth.
- **Market entry**. Pilot project stages, including technology verification and demonstration, often require large investments, while at the same time being associated with high risk.
- **Lack of industry networks**. Collaboration within and across sectors is important for identifying new projects, value chains, etc.
- **Ineffective public procurement policy**. Public procurement can drive green growth development through active policy that gives priority to green solutions.
- **Uncertain future demand/unstable operating environment**. Instability may lead to lack of investment in new green solutions.
- **The need for streamlining of the licensing process**. Given the highly competitive environment, a streamlined approach to licensing will help biotech companies (particularly start-ups) to reduce time and costs for launching a new technology onto the market.
- **Lack of a competence base in green growth industries**. Access to competent staff is a key challenge for companies. There is a need for a stronger focus on educational programmes, research cooperation and participation in international research programmes to ensure skilled workers are available with the right competencies to develop green growth industries.
- **Communication mismatch between the research community and the political system**. Intra- and cross-sectoral cooperation involving research, business and public sector actors is not yet strong enough to sufficiently facilitate the optimisation of synergies between different sectors, which is essential for advancing green growth.
- **The structure and style of the dialogue between national and regional authorities are insufficiently balanced**. Shifting from a competitive to a collaborative relationship between national interests and regional perspectives will increase interaction and communication, even addressing some issues related to skills and capacity.

The main government interventions for the development of the green economy were as follows:

- Green growth should (usually) be achieved at the lowest cost possible (not imposing extra costs on businesses).
- Support for technology verification and demonstration.
- Start-up/new business development. Entrepreneurship and innovation are key drivers of the green economy. The research results revealed examples of different support mechanisms to foster start-ups and new businesses, such as funding schemes, industry networks, incubators, etc.
- Stimulate demand for environmental technologies. Examples of policies to achieve this include public procurement policies that favour green solutions and taxes that increase the price of fossil-fuel-based solutions.
- Creation of a stable and predictable operating environment. This involves concrete measures to stimulate demand and to increase public support for technology testing and demonstration, such as coherent policies and access to long-term funding schemes.
- Cooperation between actors across niches and sectors. This is encouraged by supporting cluster development and industrial networks.
- Ensuring the competence base of green growth industries.

6.3 Policy recommendations

Based on the findings from the empirical data (the survey, interviews and policy review) we have identified possible interventions to address green growth issues at local, regional and national levels in the Nordic countries, as follows:

■ **Integrating green growth objectives into broader economic policymaking**. The green growth objectives should be integrated into national development strategies (rather than creating stand-alone policy strategies) to enhance policy coherence and certainty. There should be dialogue between government and businesses for identifying common goals and challenges, as well as developing concrete initiatives to improve conditions for green growth. This will help create a favourable milieu for private engagement in long-term green projects.

■ **A coherent framework for green public procurement.** Public procurement is an important instrument for promoting green growth. However, to achieve sustainable development goals, public procurement should not just stipulate and consider environmental criteria when agreements for public goods or services are allocated to private suppliers; it should also consider social and economic impacts. Regarding sustainable development goals, a new rural paradigm should be created based on the principle of "investing instead of recompensing", aiming to leverage local resources and maximise investment in peripheral areas to achieve development (rather than just handing out development grants).

■ **Facilitating inter-sectoral linkages**. Improved communication and interaction between sectors (i.e. between different industrial sectors, the public and private sectors, old industrial sectors and start-ups, etc.) will yield many positive and tangible outputs. For example, the creation of innovation platforms is a good illustration of a small-scale intervention to address challenges related to stakeholder communication.

■ **Place-based marketing**. Regional marketing should be seen as essential to regional green growth agendas, as it applies inside–outside approaches to strategic planning (based on market studies and research).

■ **'Greening' of the school curriculum**. Revising and adapting current school curricula to offer in-depth education on green growth at different educational levels will help raise public awareness of green growth and sustainable development.

■ **Promotion of green business models**. The transition to a green economy requires eco-innovation solutions as well as green and innovative business models (involving more complex value and production chains) that act as catalysts for disseminating these innovations throughout the market. Given the complexity of new business models, government interventions supporting their development must comprise a broad mix of policies (not just a few selected measures) aligned across national, regional and local levels.

■ **Cluster development** can support new business opportunities that arise from green innovation projects through e.g. increased (cross-sectoral) cooperation.

■ **Regions should build on their strengths**. Businesses should drive green growth development by focusing on their core competitive advantage.

■ **Market support**. Policymakers seeking to promote innovation and entrepreneurship within green growth areas should note that there is a greater chance that companies will succeed if they are part of a market that to some extent is created and/or supported by the government, at least initially.

References

Beltramello, A et al. (2013). Why new business models matter for green growth. *OECD Green Growth Papers*, 2013-01.

BIOTIC (2015). The bioeconomy enabled: A roadmap to a thriving industrial biotechnology sector in Europe. *European Union*, Brussels.

Carlsson, B and Stankiewicz, R (1991). On the nature, function and composition of technological systems. *Journal of Evolutionary Economics* 1(2): 93–118.

CLEAN (2016). Website, available on http://cleancluster.dk/en/whatiscleantech/. Accessed 17 August 2016.

Cleantech Finland (2013). Cleantech industry in Finland 2013. Presentation available on http://www.slideshare.net/cleantechfinland. Accessed 5 March 2014.

Danish Energy Agency; Ministry of Climate, Energy and Building; Danish Business Authority; Ministry of Business and Growth; Danish EPA; Ministry of the Environment (2012). *Green Production in Denmark – and its significance for the Danish economy*. November 2012.

Danish Ministry of Business and Growth (2012). *Vækstplan for vand, bio og miljøløsninger. Anbefalinger*. November 2012.

Danish Ministry of Business and Growth (2013a). *Danmark i arbejde. Vækstplan for vand, bio & miljø- løsninger*. March 2013.

Danish Ministry of Business and Growth (2013b). *Danmark i arbejde. Vækstplan for Fødevarer.* December 2013.

Danish Ministry of Environment and Food (2016). Website, available on http://agrifish.dk/fileadmin/user_upload/Natur-Erhverv/Filer/Tvaergaaende/Biooekonomi/Fact-sheet_The-National-Bioeconomy-Panel.pdf. Accessed 31 August 2016.

Duhr, S et al. (2010). *European Spatial Planning and Territorial Cooperation*. Routledge, London and New York.

Eco-Innovation Observatory (EIO) (2010). Methodological report. Autumn 2010.

Eco-Innovation Observatory (EIO) (2012). Closing the eco-innovation gap. An economic opportunity for business. *Annual Report* 2011, February 2012.

Edquist, C (1997). Introduction. In Edquist C (Ed.) *Systems of Innovation: Technologies, Institutions and Organizations*. Printer, London.

European Commission (2006). *The Environmental Technologies Action Plan (ETAP).*

European Commission (2009a). *Directive 2009/28/EC*.

European Commission (2009b). Taking bio-based from promise to market. Measures to promote the market introduction of innovative bio-based products. *A report from the Ad-hoc Advisory Group for Bio-based Products in the framework of the European Commission's Lead Market Initiative*. 3 November 2009.

European Commission (2011). *Lead Market Initiative Ad-hoc Advisory Group for Bio-based Products – Priority recommendations.*

European Commission (2012). *Innovating for sustainable growth: a bioeconomy for Europe.*

European Commission (2013). *Bio-based industries, towards a public–private partnership under Horizon 2020*.

European Commission (2016). Website, available on https://biobs.jrc.ec.europa.eu/. Accessed 18 August 2016.

Finnish Ministry of Economic Affairs and Employment; Finnish Ministry of the Environment (2014). *Sustainable growth from bioeconomy. The Finnish bioeconomy strategy*. May 2014.

Finnish Ministry of Employment and the Economy (2014). *Government Strategy to Promote Cleantech Business in Finland*. May 2014.

Formas (2012). Forsknings- och innovationsstrategi för en biobaserad samhällsekonomi. Rapport: R2: 2012.

Formas; VINNOVA (2008). Forskningsstrategi för miljöteknik. Redovisning av regeringsuppdrag till Formas och VINNOVA. *Rapport:* 3:2008.

Government Offices of Sweden (2011). *Environmental Technology – 13 Swedish Solutions*. September 2011.

Hekkert, M et al. (2007). Functions of innovation systems: A new approach for analysing technological change. *Technological Forecasting and Social Change* 74(4): 413–432.

Hekkert, M et al. (2011). *Technological Innovation System Analysis. A manual for analysts*. November 2011.

Hodgson, E et al. (2015). *Biohorizons – Horizon scanning the European biobased economy.*

Hodgson, E et al. (2016). Horizon scanning the European bio-based economy: a novel approach to the identification of barriers and key policy interventions from stakeholders in multiple sectors and regions. *Biofuels, Bioproducts and Biorefining* 10(5): 508–522.

Hodgson, E et al. (forthcoming). Horizon scanning the European bio-based economy: a novel approach to the identification of barriers and key policy interventions from stakeholders in multiple sectors and regions. Submitted October 2015, *under review*.
Icelandic Prime Minister's Office (2011). *Iceland 2020 – governmental policy statement for the economy and community. Knowledge, sustainability, welfare*. January 2011.

Intpow (2013). The Norwegian Cleantech Industry – Statistics 2011. *Report* no. 01/2013.

Johnsen, I H G (Ed) et al. (2015). The potential of industrial symbiosis as a key driver of green growth in Nordic regions. *Nordregio Report* 2015:1.

Kaae, B C (2011). Inspirationskatalog: Gode eksempler på bæredygtig og innovative turismeudvikling i nordiske yderområder. *TemaNord* 2011:557.

Lindberg, G et al. (2015). Regional Economic Impact and Potential of Nordic Bioeconomy. *Report*. June, 2015.

Lundvall, B-Å and Borrás, S (1997). The globalising learning economy. Implications for innovation policy. *Report* based on contributions from seven projects under the TSER programme. DG XII, Commission of the European Union.

Mikkola, N, Randall, L and Hagberg, A (Eds) (2016). Green growth in Nordic regions. 50 ways to make it happen. *Report*. Nordregio, 2016.

Ministry of Environment and Food of Denmark (2016). Website, available on http://ecoinnovation.dk/bestyrelsen/strategi-og-handlingsplan/. Accessed 6 September 2016.

Nordic Innovation (2012). Green business model innovation – Conceptualization report. *Nordic Innovation report* 2012:16, November 2012.

Nordic Prime Ministers' Working Group for Green Growth (2011). The Nordic region – leading in green growth. *Report* by the Nordic Prime Ministers' Working Group for Green Growth.

Norwegian Ministry of Trade and Industry/Ministry of Climate and Environment (2011). *Næringsutvikling og grønn vekst. Regjeringens strategi for miljøteknologi*. Juni 2011.

Norwegian Research Council (2016). Website, available on http://www.forskningsradet.no/prognett-bionaer/Forside/1253971968584. Accessed 30 August 2016.

Nuur, C and Laestadius, S (2010). Development in peripheral regions: case studies in Sweden. *European Urban and Regional Studies* 17(3): 293–307.

OECD (2001) OECD *territorial outlook*. 2001 edition.

OECD (2009). The Bioeconomy to 2030: Designing a Policy Agenda. Main Findings and Policy Conclusions. OECD *International Futures Project*.

OECD (2010). Cities and climate change. *OECD Publishing*.

OECD (2011a). Towards green growth. *OECD Publishing*.

OECD (2011b). Better policies to support eco-innovation, OECD studies on environmental innovation. *OECD Publishing*.

OECD (2013). Green innovation in tourism services. *OECD Tourism Papers* 2013/01, OECD Publishing.

Olsen, L S and Weber, R (Eds.) (2012). Integrating Green Growth in Regional Development Strategies. *Nordregio Report* 2012:6.

Olsson, A and Spjuth, H (2012). Regional Collaboration in Värmland. *Nordregio News*, Issue 2, 2012.

Rönnlund et al. (2014). Creating value from bioresources. Innovation in Nordic bioeconomy. *Nordic Innovation Publication* 2014:01.

Star-COLIBRI (2011). *Joint European Biorefinery Vision for 2030, the Seventh Framework Programme of the European Union.*

Swedish Ministry of Enterprise and Innovation (2016). Regeringens strategiska samverkansprogram. *Faktablad* oktober 2016.

Teräs, J et al. (2014). Bioeconomy in the Nordic region: Regional case studies. *Nordregio Working Paper* 2014:4.

The Federation of Icelandic Industries (2014). Clean Tech Iceland – CTI. Website, available on http://www.si.is/starfsgreinahopar/graen-taekni/clean-tech-iceland---cti/. Accessed 6 March 2014.

UNEP (2011). *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*.

VINNOVA (2013). Företag inom miljötekniksektorn 2007–2011. *VINNOVA Analys* VA 2013:06.

Winter, T (2016). State of Play: Bioeconomy strategies and policies in the Baltic Sea Region countries. *Working Paper* no. 1 – The Baltic Sea Regional Bioeconomy Council.

List of charts

Chart 1 Green growth focus areas in the surveyed Nordic regions: rating distribution 36
Chart 2 Interventions to address barriers related to education and skills 37
Chart 3 Interventions to address challenges hindering entrepreneurial activity 38
Chart 4 Interventions to address challenges related to finance and funding 38
Chart 5 Interventions to address challenges related to green-tech and cleantech R&D 39
Chart 6 Interventions to address challenges related to stakeholder communication 39
Chart 7 Interventions to address challenges related to policy and legislation 40
Chart 8 Interventions to address challenges related to market penetration 40

List of figures

Figure 1 Seven functions of an innovation system 16
Figure 2 Regional development and the green economy 17
Figure 3 Perceived barriers to the development of the bio-based economy, by stakeholder group and region 28
Figure 4 Interventions ranked by UK bio-based economy stakeholders (Biohorizons, 2015) 29
Figure 5 Sectors included in the survey 30
Figure 6 Structure used to aggregate challenges and interventions in the Nordic study 31

List of maps

Map 1 Green growth focus areas in the surveyed Nordic regions, Julien Grunfelder (Nordregio) 35

List of tables

Table 1 Overview of existing bioeconomy strategies 19
Table 2 Overview of existing cleantech strategies 20
Table 3 Green growth challenges and policy interventions addressed in the Nordic green growth strategies 25
Table 4 Green growth enablers and policy interventions addressed in the Nordic green growth strategies 25
Table 5 Top challenges and interventions to green growth activities in the surveyed Nordic regions 34

National experts consulted, 2016

Arne Isaksen, Professor, University of Agder
Sigridur Kristjansdottir, Innovation Centre Iceland
Sirpa Kurppa, Professor , Natural Resources Institute Finland (Luke)
Mads Randbøll Wolff, Senior Advisor at Selvstændig, Copenhagen
Murat Mirata, Assistant Lecturer at Linköping University, Sweden

ISSN 978-91-87295-41-6
ISBN 1403-2503

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

NORDREGIO
Nordic Centre for Spatial Development

norden
Nordic Council of Ministers