

**NORDIC MARINE THINK TANK**

**Synthesis Report**

**Blue Growth in the North East  
Atlantic and Arctic**

**- Working paper -**



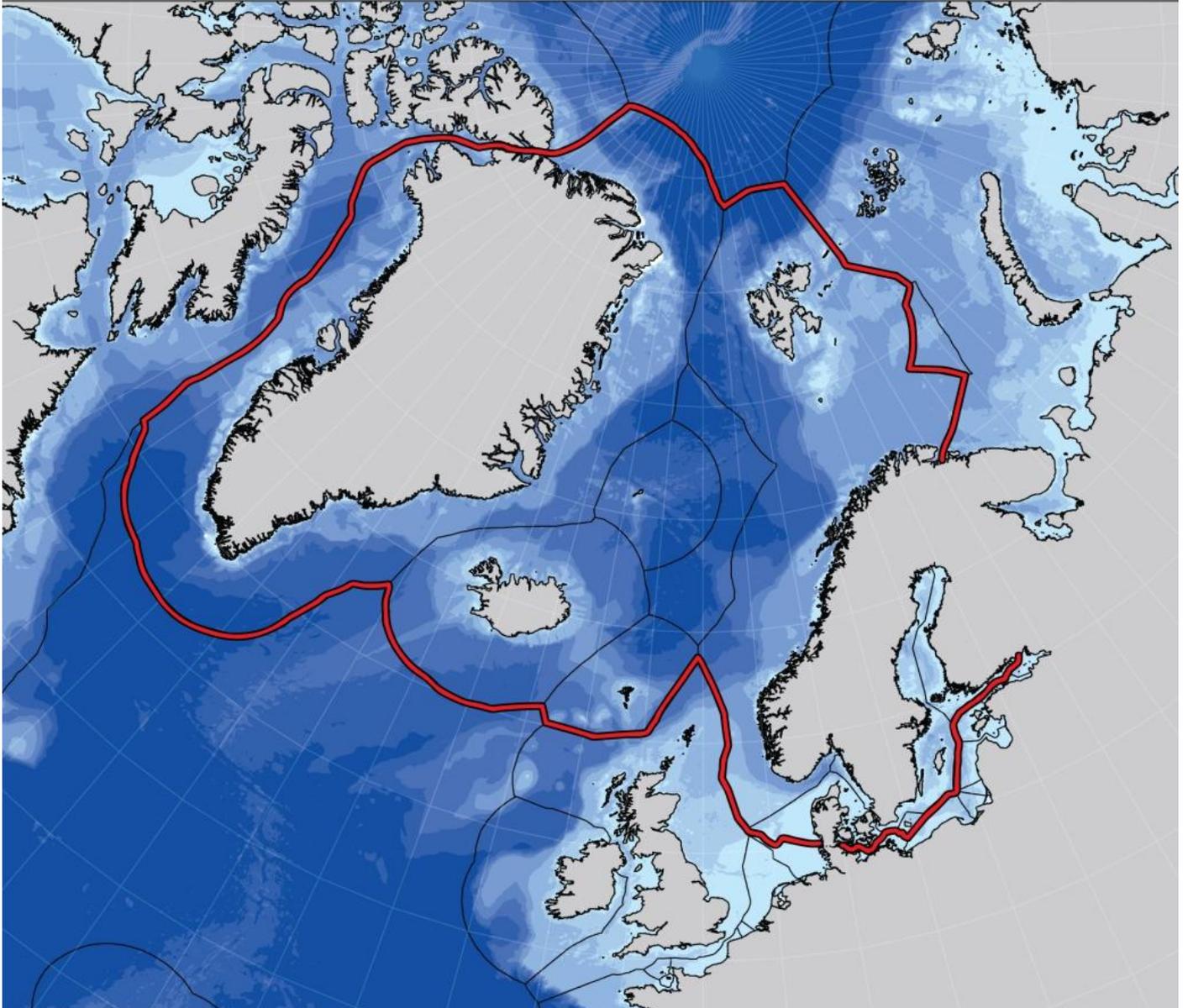
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# 1. Arctic and the Nordic Sea

This report deals with the blue bio-economy in the Nordic Sea, a part of the North East Atlantic, and especially the EEZs of Norway and the three West Nordic Coastal States, the Faroe Islands, Iceland and Greenland and the relevant ABNJ areas.



*The Nordic Sea*

## 2. Introduction

Bio-economy has climbed up the global, regional and national agendas in recent years. A grab of headlines from various media outlets in the boxes on this and the next page give an impression of this.

This report is part of the program of the Faroe Islands chairmanship of the Nordic Fisheries and Aquaculture Cooperation under Denmark's Presidency of the Nordic Council of Ministers in 2015. It was commissioned from the Nordic Marine Think Thank<sup>1</sup>, which tasked Kjartan Hoydal with drafting the report.

### Terms of reference

The synthesis report is a review of relevant literature (books, report, etc.) on blue bio-economy in the North East Atlantic and Arctic. The review identifies and describes challenges (obstacles and potentials) to growth in blue bio-economy. Challenges may be in policy, but also in research and technology.

The review covers relevant Nordic and national literature. It also covers some relevant international reports on this topic.

Anker Pedersen drafted a preliminary study, which has been used in this report<sup>2</sup>.

The report is available to participants at the International Conference, Growth in Blue Bio-economy, at the Nordic House, Tórshavn Faroe Islands, 2-3 June 2015.

## 3. Executive Summary

### The Global Scene – Fisheries, Nature Conservation, Sustainability, Blue Bio-economy

The first part of the report is a narrative that describes governance of fisheries and nature conservation within two parallel and interacting streams of events and decisions on a global scale. These developments have defined the international and national legal framework under which the fisheries jurisdictions in the North East Atlantic work.

The streams of international cooperation focus on sustainability. Blue bio-economy initiatives contribute significantly to the responsible and sustainable use of marine ecosystems. They ensure that countries can obtain the highest possible level of economic growth while conserving the natural resource base upon which that growth depends. The roles of FAO

### Nordic Region Jun 26, 2014

At their joint meeting in May, the Nordic prime ministers called for strengthening Nordic bio-economy co-operation and the Ministers for Food followed up on this at their meeting on 26 June. A major investment in the circular economy may protect the environment and also create local development and green jobs. New report indicates great bio potential in the Nordic Region.

*Parliamentarist,*  
13.02.2015  
EU Commissioner  
Karmenu Vella

One of Vella's final points is to highlight the importance of exploiting the 'blue' economy, which he says, "represents roughly 5.4 million jobs and generates a gross added value of almost €500bn a year. There is a lot of potential and we are already working to multiply those numbers. Blue growth and the green economy will be key building blocks of the competitive Europe of jobs, growth and fairness, both because of the jobs that they will create and because of the potential for reducing Europe's dependence on imported resources."

### The Blue Economy is Africa's Future

Madagascar – 3 March 2015– [allafrica.com](http://allafrica.com)

Antonio Pedro, the Director of UNECA in Eastern Africa says that the Blue Economy is a timely framework to coordinate policy action in many sectors and institute integrated development plans.

<sup>1</sup> <https://www.linkedin.com/groups/Nordic-Marine-ThinkTank-4582700>

<sup>2</sup> Opportunities for growth in blue bio-economy – a Nordic perspective

and OECD in promoting green and blue bio-economy are reviewed as well as the importance of Regional Fisheries Bodies, especially those responsible for management (RFMOs).

The situation in the North East Atlantic is unique, with two convention-based regional organisations, the OSPAR Commission, for the protection and conservation of the North East Atlantic Ocean and its resources and the NEAFC convention for the management of fisheries resources in the area. They both receive scientific advice from the International Council of the Sea (ICES), as do all fisheries jurisdictions in the North East Atlantic. There is extensive cooperation between the Coastal States in the region formulated in regional, bilateral and coastal state agreements.

### **The Promotion of Blue Bio-economy**

A number Nordic Institutions and Nordic initiatives promote Blue Bio-economy, especially in the Arctic and West Nordic parts of the North East Atlantic Ocean.

In the West Nordic countries and the Arctic – and in general in the North East Atlantic – the residues from the fish processing industry represent big amounts of marine biomass. This biomass can be the basis for increased value of the catch. There are also big potentials in the harvesting and farming of macroalgae. Compared to other Nordic countries, the blue bio-economy in the West Nordic countries is a significant part of the GDP. The marine not terrestrial bioresources thus are the most important and of common interests to the West Nordic countries.

Fish oil and meal are fairly low-value products while a higher value per biomass unit is possible if marine biomass is used as raw material for the chemical industry. This would in particular be true if guts and entrails, normally returned directly to the sea, could be processed. There is technology available for the use of these raw materials, but the economic interest of landing entrails is low.

Access to biotechnology is important when aiming at high value products. Cooperation involving West Nordic countries and Nordic and European facilities, and sharing of infrastructure is necessary. A small travel budget allowing visits to different infrastructures will go a long way.

Small and medium size enterprises, SME's are crucial in the blue biotechnology value-chain, bridging the gap between public sector research & development (R&D) activities and commercialisation of products, mainly by large private, often multinational companies.

BioMarine clusters are an important element in making use of marine bio-resources thus enabling the realization of the marine biotechnology's promise for providing breakthrough products to feed the world, keeping the environment clean, and improving health and nutrition.

There is a huge interest in the possibilities to substitute renewables for fossils in the chemical industry. Biomass is among the standard raw materials for chemical production. Chemical industry is currently largely, but not exclusively, based on mineral oil.

The Nordic Algae Network aims to develop the utilisation of algae for energy and commercial exploitation of high value compounds from algae. Macroalgae are mostly harvested but there are also examples of farming of macroalgae. Microalgae are used to produce electricity, bio fuel, soil fertilisers and food. Integrated multithrophic aquaculture has been tried in Canada and could reduce environmental impacts, while also producing other seafood species. Algae, fish and shellfish are used for medical human healthcare ([dietary supplements](#)) and cosmetics etc. There is also a large potential in other marine species. One example is tunicates.

Two business cases are described. The Icelandic Ocean Cluster as an example of a successful networking organisation and the cooperation between Chitinor AS (Norway) and DuPont Nutrition Biosciences Ltd. (Denmark) is an example of cooperation between a company that only controls a small part of the value chain and a multinational company, working in the field of functional ingredients and having the ability to control the entire value chain.

## **Organisation of biopanel and involving stakeholders**

The West Nordic countries have agreed to cooperate with the Nordic Bio-economy Panel. Nordic cooperation, like NORA, could be activated to support the process. It could start immediately with a clear action plan with deadlines and road-maps. Funding could be regional (NORA & Northern Periphery Programme) or structural (Horizon 2020).

## **Removing obstacles for Blue Growth**

There are a lot of expectations with respect to the potential for growth of blue bioeconomy. A number of countries have launched programmes to support bio-economy, sometimes "Green Growth, "Green economy" or just "Industrial Biotechnology".

The Nordic countries outside the EU have launched programmes. The West Nordic countries and territories have moved in the same direction with programmes supported by the Nordic Council of Ministers.

There is a strong tradition for cooperation between the North East Atlantic coastal states, but at present the cooperation is at a long time low because of the lack of agreement on quota allocations for the three major straddling pelagic stocks in the area between the coastal states.

## **Policy Initiatives to Pave the Way for Blue Bio-economy in the Arctic and North East Atlantic**

The first steps must be to set up policies that secure cooperation between the West Nordic countries aiming at facilitating the access to and the exploitation of residual fish biomass.

A number of obstacles are summarised in the report "Innovation in Nordic Bio-economy" by I. Rönnlund.

These obstacles should be addressed in appropriate policy initiatives, especially to remove obstacles to commercialisation of higher value products from marine biomass.

## **4. Food for thought**

1. The coastal states in the North East Atlantic should consider introducing legislation to get all parts of the fish, after bleeding, ashore for further processing. It should open up for processing at various levels of value adding.

2. The coastal states in the North East Atlantic should agree on an action plan, with deadlines and road-maps, to set up cooperation with bio-panels, involving stakeholders and to map regional and structural funding, especially aiming at seed money, to bridge the innovation gap. The action plan should also investigate business models involving cooperation between a SME that only controls a small part of the value chain and multinational companies, having the ability to control the entire value chain.

3. The coastal states in the North East Atlantic should exchange information and best practices, building up bio-based value chains, including bio-refining and, most importantly, securing an uninterrupted supply of biomass.

4. Farming of macroalgae, and other marine species than salmon, calls for spatial planning and new legislation to secure licenses for these activities as stable as those already in place for salmon farming.

## 5. The Global Scene and Governance – Fisheries, Nature Conservation, Sustainability, Blue Bio-economy

Governance of fisheries and nature conservation has developed within two parallel and interacting streams of events and decisions at a global scale for many years.<sup>3</sup> One historical starting point is the UN Conference on Human Environment (UNCHE) in Stockholm in 1972 marking the formal birth of the sustainable development concept. But already in the 1960s there were growing concerns in the North Atlantic about overcapacity and inefficient technical measures as the only tools for regulating fisheries. In 1973 the FAO Technical Conference on Fishery Management and Development took place in Vancouver followed by the UNCLOS III process, which ended with the adoption in 1982 of the Law of the Sea Convention. The FAO Technical Conference warned against the impact of fishing on resources, overcapitalisation, incomplete science, free and open access, and pollution. In the late 1970s many countries extended their jurisdiction to 200 miles. The formal adoption of the UNCLOS legalised this. In the period thereafter there were growing concerns regarding the collateral effects of fishing, which in 1992 resulted in several significant events for fisheries and conservation. The 1992 Rio Declaration, its principle 15 on the Precautionary Approach and Agenda 21 provided new guidelines for fisheries and marine conservation. The newly established Commission on Biological Diversity (CBD) played a growing role in the interface between fisheries and conservation and enhanced the concept of sustainable use of biodiversity, as in the case of fishery resources.

From 1993 to 2002 the sustainability challenge was at the centre of global discussions. This led to a significant strengthening of the international institutional framework. The 1993 the FAO Compliance Agreement and the 1995 UNFSA strengthened the Regional Fisheries Management Organisations and the Port States in Monitoring Control and Surveillance (MCS). The UNFSA also called for a precautionary approach and set up the system of biological reference points, including the changing the role of MSY from target to limit reference value. In 1995 the FAO Code of Conduct for Responsible Fisheries provided a code of ethics for fishing all aquatic species. In 1999, the United Nations open-ended Informal Consultative process (UNICPOLOS or ICP) was established under UNGA to facilitate an annual review of developments in ocean affairs and the law of the sea<sup>4</sup>. The Ecosystem Approach to Fisheries (EAF) was internationally adopted at the 2001 Iceland-FAO Conference on Responsible Fisheries in the Marine Ecosystems.

In the period 2003 to 2012 biodiversity has been the centre of attention global debate. UNGA focused on seamounts biodiversity and vulnerable marine ecosystems in areas beyond national jurisdiction (ABNJ). The 2005 Millennium Ecosystem Assessment depicted a negative state of environment and biodiversity. At the same time the collaboration increased between FAO, CBD, UNEP, CITES and IUCN and some of the most important Environmental Non-governmental Organisations (ENGOS).

The Green Growth Concept of economic development was adopted in 2005 at the UN Economic Social Commission for Asia and the Pacific (ESCAP). It is based on a more extensive use of economic incentives and market-based instruments to shift economic activity towards more

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<sup>3</sup> This description of the historical development of two interacting streams of governance is based on chapter one: "Governance of marine fisheries and biodiversity conservation: A history" in "Governance of Marine Fisheries and Biodiversity Conservation. Interaction and Co-evolution." Edited by Serge M. Garcia, Jake Rice and Anthony Charles. Wiley Blackwell 2014.

<sup>4</sup> Two annual UNGA resolutions: "The Resolution on Oceans and Law of the Sea" and "Resolution on sustainable fisheries", including through the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, and related instruments"

sustainable use. At the global level, green economy was called on by the Rio+20 Summit in 2012. This could be relevant for reducing the impact of fisheries on non-target species and ecosystems.

The Organisation for Economic Cooperation and Development (OECD) has promoted the concept of green growth. The OECD green growth road-map sets out a five-step process to follow. This begins with building a green growth model that prepares the way for change - identifying the risks in continuing business as usual instead of identifying the potential in green growth. The next step is to promote the transition to greener growth by removing barriers to it and facilitating change by improving how governments and stakeholders organise themselves to manage fisheries. Step three is enabling change by dealing with the practical consequences of reform, such as by assisting displaced workers to find new employment, helping with adjustment costs through supporting measures or other actions that ensure that the benefits of change are inclusive. Fourth, measuring progress through the development of an appropriate set of indicators provides essential feedback on what works and what does not. Finally, a “policy loop” should ensure that delivering on green growth by using lessons learned establishes a new policy set that confirms that reforms work and are durable. Following this roadmap means that the process of developing policies for the fisheries and aquaculture sectors must be more systematic in identifying risk, using market-based instruments and building institutions accountable for delivering green growth. It also means that the process has to be more expansive, involving a broad reach of communities dependent on the fisheries and aquaculture sectors. A central challenge of the GGS is to bring together economic and environmental policy making, bridging between these two policy domains that are often kept separate. This will, *inter alia*, require investing in better data and science to support managing a more complex system while building networks to ensure policy coherence and inclusiveness.<sup>5</sup>

Green Growth Strategy outlines policy principles to help countries ensure that they can obtain the highest possible level of economic growth while conserving the natural resource base upon which that growth depends<sup>6</sup>.

The Food and Agriculture Organization of the United Nations, FAO, is also promoting Blue Growth<sup>7</sup>.

Building on the challenges identified in the Rio+20 outcome document “The Future We Want” and the post-2015 development agenda, FAO is promoting “Blue Growth” as a coherent approach for the sustainable, integrated and socio-economically sensitive management of oceans and wetlands. For FAO, this means focusing on four components: capture fisheries, aquaculture, ecosystem services and trade and social protection of coastal communities. Investing in Blue Growth – the sustainable management and use of aquatic resources and the adoption of ecosystem approaches – can help to reduce stressors and restore the functions and structure of aquatic ecosystems. The initiative is of particular significance to small-island developing States and to coastal areas and wetlands around the globe. It offers an integrated approach in response to the increasing need for cooperation and coordination among all stakeholders and at all levels for more sustainable fisheries management and more effective conservation. It is an approach that could reap an estimated potential economic gain of US\$50 billion per year for fisheries alone. In addition, Blue Growth can further the capacity development efforts needed to strengthen the policy environment, institutional arrangements and the collaborative processes that empower fishing and fish farming communities, civil society organizations and public entities.

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5 TAD/FI(2014)21/FINAL GREEN GROWTH EXECUTIVE SUMMARY

6 TAD/FI(2014)3/FINAL, approved by the OECD COFI at its 114th session on the 27-29 October 2014

7 FAO Inputs in Relation to Resolution A/Res/68/70 Concerning Oceans And The Law Of The Sea General to the Sixty-Ninth Session of the United Nations General Assembly, 2014. [http://www.un.org/depts/los/general\\_assembly/contributions\\_2014\\_2/FAO.pdf](http://www.un.org/depts/los/general_assembly/contributions_2014_2/FAO.pdf)

Grounded in the principles of the Code of Conduct for Responsible Fisheries and its associated guidelines, Blue Growth provides a global framework to promote responsible and sustainable fisheries and aquaculture. Building on recent international and national initiatives, FAO will assist its members and regional institutions in developing, fostering and implementing the blue economy agenda to help turn commitment into action. Blue Growth builds on the three pillars underpinning sustainable development by addressing the environmental, social and economic issues and challenges facing the sustainable and responsible management of aquatic resources. This translates into recognizing and addressing the rights of those dependent on fisheries and aquaculture for their livelihoods – some 12 per cent of the world’s population. Their rights relate to tenure, income, market access, and decent living and working conditions.

Following the 2002 World Summit on Sustainable Development in Johannesburg, South Africa, the United Nations set up a regular process to review the environmental, economic and social aspects of the world’s oceans and seas – the three pillars of sustainable development<sup>8</sup>. The first assessment is now in its final stages. It is out for review and cannot be quoted for the time being. It is, however, known that in the assessment there is a chapter on the “Use of Marine Genetic Resources” with an impressive overview of marine genetic material and natural products.

### **Governance as a sum of global streams -Blue Bio-economy emerges**

In addition to the two historical streams of exploitation (fisheries) and nature conversation, a new stream, Blue Bio-economy, is emerging forcefully. By dynamically supporting an integrated approach, the new stream can foster and sustain the valuable contribution of oceans, seas and coasts to food security, nutrition and decent employment for future generations.

As we have seen, the stream of international cooperation stresses sustainability. Blue Bio-economy initiatives contribute significantly to the responsible and sustainable use of marine ecosystems. It ensures that countries can obtain the highest possible level of economic growth while conserving the natural resource base upon which that growth depends<sup>9</sup>.

### **Regional Fishery Bodies (RFB)**

RFBs are groups of States or organizations that are parties to an international fisheries arrangement that can play a critical role in promoting long term sustainable fisheries where international cooperation is required in conservation and management. FAO, in recognizing that the collaboration is crucial in order to accomplish the goal of responsible and sustainable fisheries, fosters and promotes the work of RFBs.

A map of the around RFB is found at <http://www.fao.org/fishery/rfb/search/en>. The RFMOs (Regional Fisheries Management Organisations) in this group have the strongest management mandate.

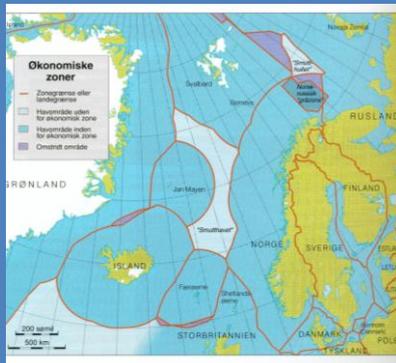
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<sup>8</sup> <http://www.worldoceanassessment.org>

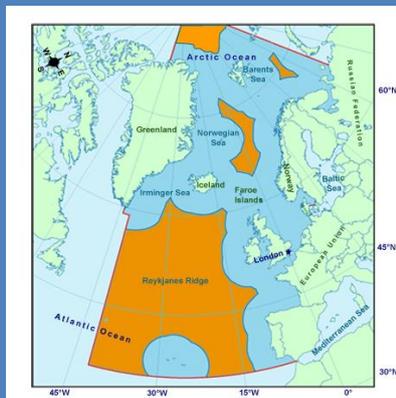
<sup>9</sup> <http://www.fao.org/fishery/topic/2940/en>

## The Institutional Framework in the North East Atlantic and Arctic

NORTH EAST ATLANTIC:  
NEAFC Convention area. ABNJ is orange, corresponding to the NEAFC



ry Area



UNCLOS assigns a coastal state the exclusive right of fish harvesting in its economic zone (EEZ). This means that fish in the zone belongs to the coastal state, as long as it is in the zone. In its EEZ the coastal state may itself manage the stock by allowing, prohibiting and regulating the fishery. Accordingly each state, targeting the same stock, may unilaterally set its own total allowable catches (TAC). Where the same stock or stocks of associated species occur both within the EEZ and in an area beyond and adjacent to the zone, the coastal state and the states fishing for such stocks in the adjacent area, shall seek, either directly or through appropriate organizations, to agree upon the measures necessary for the conservation of these stocks.

The catalyst for bringing about international cooperation in the management and conservation of fish species—particularly species that traverse large swaths of the oceans—such as tuna and sharks—is the 1995 United Nations Fish Stocks Agreement, which took effect in 2001. The treaty sets forth the principles, legal tools and mechanisms now being employed to maintain sustainable levels of high seas fish stocks.

At the heart of these efforts is a growing network of Regional Fisheries Management Organisations known as “RFMOs”, which ensure cooperation between coastal states in various regions. These organisations have management responsibilities for fish stocks in various areas and provide the forum for countries to agree on fishing allocations. They also adopt, implement and enforce control and enforcement measures and measures to combat illegal, unreported and

unregulated (IUU) fishing. Besides NEAFC there are three other RFMOs in the North East Atlantic, NASCO and ICCAT.

Domestic legislations and agreements on shared fish stocks in the North East Atlantic are based on the UNCLOS principles and agreed through negotiations between the involved parties. There is extensive cooperation based on multilateral and bilateral agreements for exchanging fishing opportunities between jurisdictions. Faroe Islands and Greenland have full jurisdictions and are accepted as coastal states in NEAFC. However, they are not considered Contracting Parties of NEAFC in their own right, as they are part of the Danish Kingdom.

The situation in the North East Atlantic is unique. A convention based organisation dealing with the protection of biodiversity, The OSPAR Commission, and a RFMO, NEAFC, also convention based cover the same geographical area and have almost the same Contracting Parties<sup>10</sup>. Furthermore, both Commissions receive scientific advice from the International Council of the Sea, (ICES), as do all the RFMOs and coastal states in the North East Atlantic.

NEAFC and the OSPAR are very different multilateral environmental agreements. NEAFC was established as a sectoral resource management Convention, OSPAR as a Convention to prevent

<sup>10</sup> The Russian Federation is not a Contracting Party to OSPAR and Switzerland is not a Contracting Party to NEAFC.

pollution and control adverse impacts of human activities including where appropriate restoration. Traditionally NEAFC has been concerned with regulating the exploitation of fish stocks and OSPAR with regulating the sources, discharges and concentrations of pollutants. In this sense both organizations initially took a rather narrow, specific and focused remit. For a more thorough analysis of convergence between fisheries management and biodiversity conservation in the North East Atlantic, see “Regional governance: the case of NEAFC and OSPAR”, K. Hoydal, D. Johnson and A.H. Hoel.<sup>11</sup>

The coastal states in the North East Atlantic have, by ratifying international law and arrangements, committed themselves to a common platform.<sup>12</sup> The Contracting Parties of NEAFC updated the 1980 Convention in 2004 (dispute settlement procedures) and 2006 (bringing the Convention into line with developments in international law since the 1980 Convention was negotiated). The preamble of the “New” Convention lists the international instruments of importance and stresses that NEAFC - in addition to managing fisheries - has an important role in conservation and integrating environmental concerns into its management of fish stocks. The international commitments are well reflected in the amendments to the NEAFC Convention in 2006,<sup>13</sup> which thus is the common ground for governance of the North East Atlantic waters, both nationally and in areas beyond national jurisdiction, ABNJ.

Coastal State Groups play an important role in the North East Atlantic. They cooperate on stocks that straddle into international waters.

Blue whiting: EU, Faroe Islands, Iceland and Norway;

Mackerel: EU, Faroe Islands, Iceland and Norway;

Norwegian Spring Spawning (Atlanto-Scandian) herring: the EU, the Faroe Islands, Iceland, Norway and the Russian Federation and

Pelagic redfish in the Irminger Sea: Greenland, Iceland and the Faroe Islands.

The coastal state groups meet annually and discuss TACs and allocations for each stock. The results of the coastal state meeting are reported to NEAFC. It should be noted that Greenland and the Faroe Islands are represented in NEAFC as the Contracting Party, “Denmark in respect of the Faroe Islands and Greenland”, but in coastal state groups Greenland and the Faroe Island are parties in their own right.

## **Bilateral arrangements in the North East Atlantic**

The Russia-Norway Agreement

The EU-Norway Agreement

The Norway - Faroe Islands Agreement

The Norway - Greenland Agreement

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<sup>11</sup> “Governance of Marine Fisheries and Biodiversity Conservation”. Interaction and Co-evolution”. Edited by Serge M. Garcia, Jake Rice and Anthony Charles. Wiley Blackwell 2014.

<sup>12</sup> NEAFC Fisheries Status Report 1998-2007 Edited by Kjartan Hoydal NEAFC Secretariat.  
[http://www.neafc.org/system/files/%252Fhome/neafc/drupal2\\_files/fisheries\\_status\\_report\\_1998\\_2007.pdf](http://www.neafc.org/system/files/%252Fhome/neafc/drupal2_files/fisheries_status_report_1998_2007.pdf)  
Northeast Atlantic NEAFC high seas fisheries <http://firms.fao.org/firms/fishery/479/en>

<sup>13</sup> Recognising the relevant provisions of the United Nations Convention on the Law of the Sea of 10 December 1982; the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, 1995; the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, 1993, and taking into account the Code of Conduct for Responsible Fisheries adopted by the 28th Session of the Conference of the Food and Agriculture Organisation of the United Nations in October 1995.

Desiring to promote the long-term conservation and optimum utilisation of the fishery resources of the North-East Atlantic area, and in doing so to safeguard the marine ecosystems in which the resources occur, and accordingly to encourage international cooperation and consultation with respect to these resources.

Article 2 of the Convention states that “the objective of this Convention is to ensure the long-term conservation and optimum utilisation of the fishery resources in the Convention Area, providing sustainable economic, environmental and social benefits”.

Agreement between the Soviet Union and the Faroe Islands (later the Russian Federation and the Faroe Islands) (1977)

Agreement between Iceland and the Faroe Islands.

Agreement between Greenland and the Faroe Islands.

Agreement between the EU and Greenland

Agreement between the EU and the Faroe Islands.

### Coastal State agreements in the North East Atlantic for the three major pelagic stocks from 1996 to 2014.

Agreement between some coastal states.	
No agreement	
Agreement between all coastal states	

Stock/year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
NSS Herring	Red	Green	Green	Green	Green	Green	Green	Red	Red	Red	Green	Green	Green	Green	Green	Green	Green	Green	Green
Mackerel	Red	Red	Red	Red	Green	Yellow	Yellow	Yellow	Yellow	Yellow									
Blue Whiting	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green	Green	Green	Green	Green	Green	Green	Green	Green

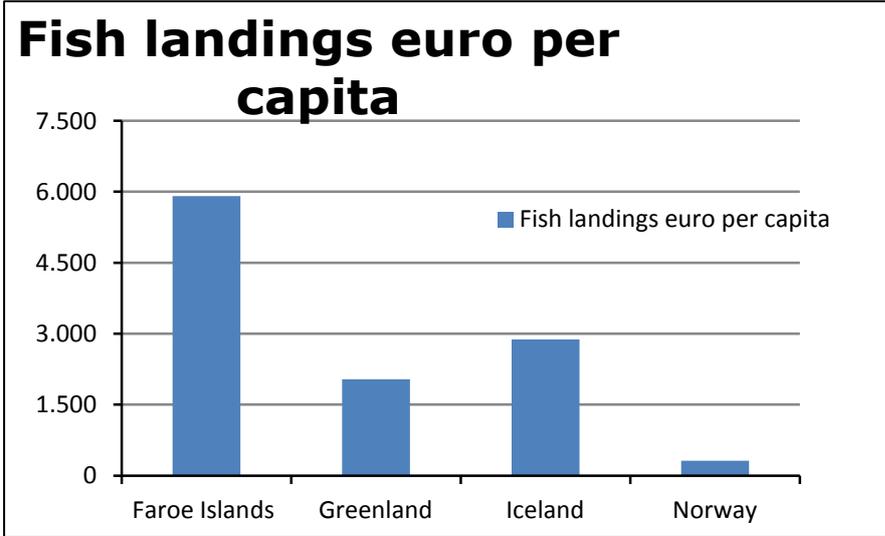
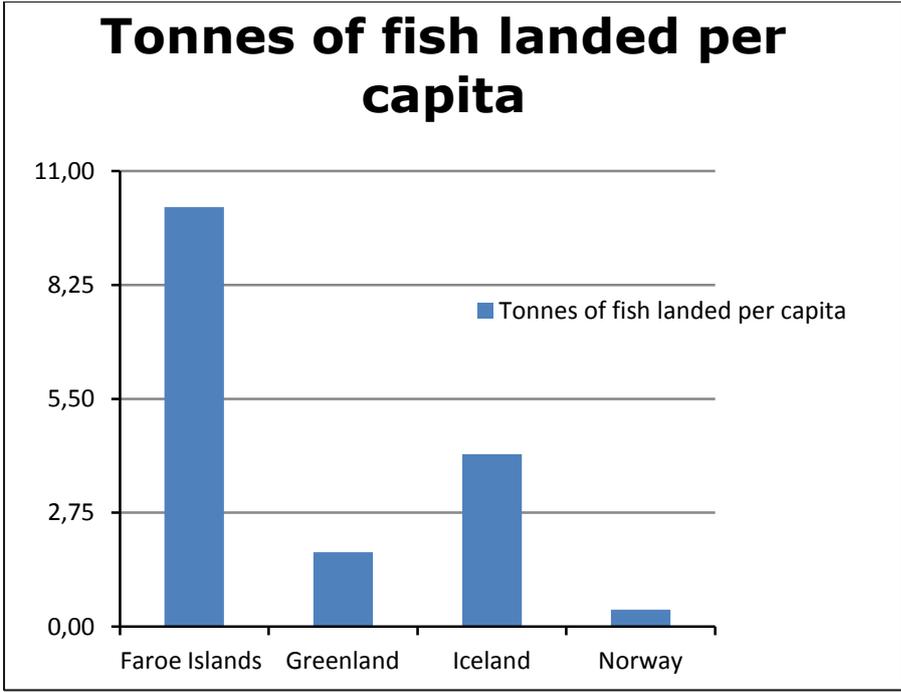
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### National Fisheries Dependency

National fisheries dependency is measured as the fishery sector's contribution to Gross Domestic Product (GDP). Before turning to the statistical analysis we observe that data is from different sources and contain figures compiled with slightly different methods. Among the Nordic coastal states those with highest fisheries dependency are Greenland, Iceland and the Faroe Islands.

The figures below show this in a different way. They show the landings and value of landings per capita in the Faroe Islands, Greenland, Iceland and Norway. The Faroe Islands is a class of its own with over 10 tonnes of fish landed per capita and a value of 44.000 DKK. The numbers for Iceland are over 4 tonnes and 22.000 DKK, Greenland about 2 tonnes and 15.000 DKK and Norway 315 kilos and 2.000 DKK. These are quite remarkable figures in a league of its own in global context.

<sup>14</sup> Allocation of Fishing Rights in the North East Atlantic in the Medium and Long Term, Nordic Marine Think Tank, NMTT, 2015, in press.



In the Faroe Islands fisheries and aquaculture account for 20% of GDP and 95% of total commodity exports<sup>15</sup>. In Greenland fisheries in 2011 contributed 13% of GDP<sup>16</sup>.

Including fisheries and fish processing, the Icelandic sector contributes to about 10% of GDP in 2010<sup>17</sup>. Norway, Denmark and Sweden differ substantially from the Faroe Islands, Greenland and Iceland as fisheries contribute less than 1% of GDP. Norwegian fishing and fish farming represented

<sup>15</sup> Ministry of Fisheries and Natural Resources, the Faroe Islands.

<sup>16</sup> Fiskeriets økonomiske fodaftryk i Grønland (The economic footprint of fisheries in Greenland) Copenhagen Economics, 2013. In Danish.

<sup>17</sup> Source: <http://www.fisheries.is/economy/fisheries-impacts/gdp/>

0.7 per cent of the GDP in 2010<sup>18</sup>. In Sweden the fish catching and processing sectors contributed 0.2 per cent of the GDP in 2003 and in Denmark these sectors contributed 0.15% in 2010.

All these figures should give a rough indication of the economic potential in the Nordic coastal states in industries based on fisheries and aquaculture.

## **6. The Promotion of Blue Bio-economy Nordic Initiatives**

The Nordic Council is the official inter-parliamentary body in the Nordic Region. The Nordic Council was formed in 1952. The Council has 87 elected members from Denmark, Finland, Iceland, Norway and Sweden as well as from the Faroe Islands, Greenland and Åland. The 1962 Helsinki Treaty was amended to confirm the Council of Ministers as the official joint organ of intergovernmental co-operation in the Region. At the same time, a number of action plans were adopted for the individual sectors.

The Nordic Council of Ministers is the forum for Nordic governmental co-operation. The Prime Ministers have the overall responsibility for Nordic Co-operation. In practice, responsibility is delegated to the Ministers for Nordic Co-operation and to the Nordic Committee for Co-operation, which co-ordinates the day-to-day work of the official political Nordic co-operation.

The Nordic Council of Ministers has in recent years set focus on bio-economy. This has been realised through various initiatives and Nordic institutions.

### **The Prime Ministers' "Green Growth Initiative 2011"**

The Nordic Region – leading in green growth” is the Nordic Prime Ministers shared green growth initiative under the auspices of the Nordic Council of Ministers.

Green growth is a key priority for Nordic co-operation in the next few years and Nordic partnerships in this field have the potential to create a larger regional market, give a political lead in the EU, improve joint infrastructures and provide critical mass for future developments. The Nordic Prime Ministers' green growth initiative is a vision based on the joint utilization of Nordic strengths in a number of areas.<sup>19</sup>

### **The Nidaros Declaration 2012**

Important challenges to green growth and the bio-economy were addressed in the Nidaros declaration at the meeting of the Nordic Council of Ministers for Fisheries and Aquaculture, Agriculture, Food and Forestry on 28 June 2012 in Trondheim, addressing the responsibility of the primary industries and the food sector in terms of green growth<sup>20</sup>.

### **The Nordic Bio-economy Initiative 2013-2018**

The Nordic Bio-economy Initiative is a direct follow-up of the Nidaros declaration, and aims at creating a common Nordic policy platform for the exchange of viewpoints and development of the Nordic bio-economy.

The initiative takes as its point of departure the fundamental idea that developing the bio-economy in the Nordic countries must be a sustainable choice. The platform is intended for application across sectors and national borders

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<sup>18</sup> FAO, <http://www.fao.org/fishery/facp/NOR/en>

<sup>19</sup> <http://www.norden.org/en/theme/green-growth/the-prime-ministers-green-growth-projects>

<sup>20</sup> <http://www.norden.org/en/nordic-council-of-ministers/council-of-ministers/nordic-council-of-ministers-for-fisheries-and-aquaculture-agriculture-foodstuffs-and-forestry-mr-fjs/declarations-statements-and-decisions/nidaros-declaration>

The Nidaros declaration emphasises the role of bio-economy, including the processing industries as a key factor in green growth. The Nordic Bio-economy Initiative intends to strengthen green economic growth. The initiative identifies central thematic areas considered to be important at the Nordic level.<sup>21</sup>

Following up the Nordic Council of Ministers has in 2013-2015 made a number of efforts to promote the transition towards the bioeconomy. This happens through activities in the Arctic Region; in the Nordic region (i.e. among the members states of the Nordic Council of Ministers); and in the Baltic Sea Region.

As regards cooperation in the Arctic and Nordic regions, the Nordic Council of Ministers is cooperating within the 2014-2017 framework for NordBio which unites efforts among the Nordic Councils of Ministers for Environment; Fisheries and Aquaculture, Agriculture, Food and Forestry; Trade, Energy and Regional Policies; Education and Research; and finally Culture. NordBio pools efforts by policy makers, practitioners and experts in a number of projects to promote sustainable utilisation of the living natural resources. Activities target the interests of both society at large and the environment per se, and facilitate the structuring of a competitive economy as well as new methods in youth education in the Arctic and Nordic regions.

In the Baltic Sea Region efforts are being pursued within the context of the Nordic Council of Ministers being Horizontal Action Leader for Bioeconomy under the European Union Strategy for the Baltic Sea Region (EUSBSR) and associated Action Plan.

### **NordForsk**

NordForsk is an organisation under the Nordic Council of Ministers that provides funding for Nordic research cooperation, as well as advice and input on Nordic research policy<sup>22</sup>.

NordForsk works to enhance added value to existing research activities in the Nordic countries thereby strengthening the position and influence of Nordic research, both in Europe and globally. With the purpose to promote excellence in research, the organisation launches strategic initiatives which bring together national research groups in large-scale Nordic programmes based on common potential.

### **Nordregio - Nordic Centre of Spatial Planning**

Nordregio is a leading international Nordic research institute in the broad field of regional studies, based in Stockholm, Sweden. One of Nordregio's most important tasks is to contribute to the development of regional policy and growth in the Nordic countries. Good policy decisions can only be made on the basis of reliable information. Regional development, urban and rural systems, demography, governance and gender, innovation and knowledge, green growth, international energy policy, global climate change and local adaptation are among major areas of interest. Nordregio research competencies include the production of high-quality maps and the development of state of the art statistical databases<sup>23</sup>

The Nordic Council of Ministers for Regional Policies met on 12 November in Iceland and launched work on a new development strategy for the West Nordic Region, which includes a greater focus on bio-economy in Nordic regional co-operation.

The 2014 Nordregio Forum was held in Iceland November 2014 and focused on Nordic Bio-economy and Regional Innovation<sup>24</sup>.

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21 [http://nkj.nordforsk.org/copy2\\_of\\_NBIstrategydocENG.pdf](http://nkj.nordforsk.org/copy2_of_NBIstrategydocENG.pdf)

22 <http://www.nordforsk.org/en/about>

23 <http://www.nordregio.se/en/Metameny/About-Nordregio/>

24 <http://www.nordregio.se/System/News/Nordregio-Forum-2014/>

"There is a shift underway in regard to the new bio-economy, but how should we meet it? Should we be reactive and concerned about costs or proactive and seize the new opportunities?" said the Secretary General for the Nordic Council of Ministers, Dagfinn Høybraaten in his speech at the conference.

He referred especially to the transition from a fossil-based economy to a bio-based one, with focus on a more sustainable but at the same time innovative and more cross sectoral use of natural resources.

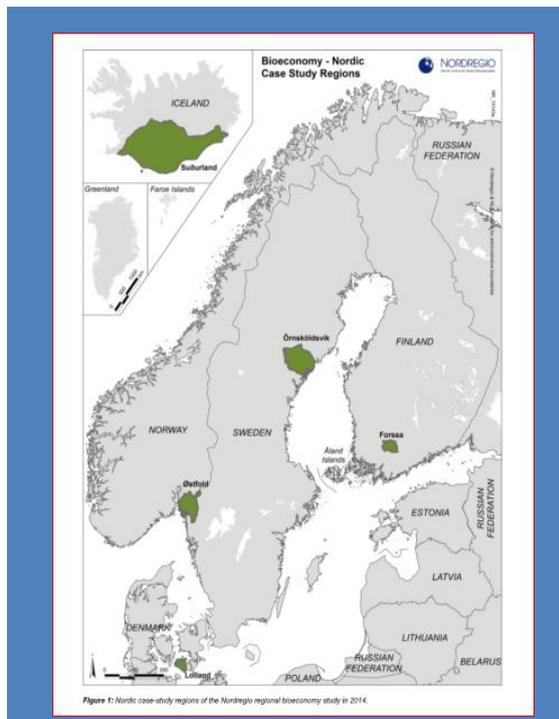


Figure 1: Nordic case-study regions of the Nordregio regional bioeconomy study in 2014.

Nordregio has issued two publications relevant to this issue<sup>25</sup>. Bio-economy and Regional Economic Development, Nordregio News Issue 4, 2014, and Bio-economy in the Nordic region: Regional case studies.

The latter working paper by Nordregio presents the results of five case studies on bio-economy in Nordic regions. It contributes to the discussion on bio-economy in the Nordic countries by focusing on its implications for regional development and policy.

The report does not review bio-economy in the Arctic, Greenland and the Faroes Islands. It has the following description of the bio-economy in Iceland and Norway.

### **The bio-economy of Iceland**

#### ***Current key branches of bio-economy and areas with identified potential***

Food industry dominates; other strong sectors: fisheries and aquaculture, food industry and agriculture. There are many opportunities for utilizing by-products, biotechnology and marine resources more efficiently.

#### **National bio-economy strategies and initiatives**

The Iceland 2020 strategy includes eco-innovation as one of the main future growth sectors.

#### **Examples of innovative bio-economy activities**

Utilizing by-products from fisheries, local-level food innovation Pink Iceland bio-economy services, e.g. tourism.

#### ***The bio-economy of Norway***

#### **Current key branches of the bio-economy and areas with identified potential**

The food industry is dominant. Other important sectors are fisheries, agriculture and forestry

#### **National bio-economy strategies and initiatives.**

<sup>25</sup><http://www.nordregio.se/en/Publications/Publications-2014/Bio-economy-and-Regional-Economic-Development/>  
<http://www.nordregio.se/en/Publications/Publications-2014/Bio-economy-in-the-Nordic-region-Regional-case-studies/>

BIONÆR 2012–2021, Norway’s research programme on Sustainable Innovation in Food and Bio-based Industries.

Examples of innovative bio-economy activities

Borregaard bio refinery Østfold; NorZymeD - Enzyme development for Norwegian biomass.

Nordregio notes that behind the term 'bio-economy' lies a political ambition. It is not only the integration of traditional primary sectors such as agriculture, forestry and fisheries with the biotech industry, but something more. First, it is the ambition of replacing fossil fuel and other limited resources with *"the production of renewable biological resources and the conversion of these resources and waste streams in value added products"*, as stated by the European Commission in its strategy entitled "Innovation for sustainable growth: A bio-economy for Europe". Second, the bio-economy is expected to boost the productivity of agricultural and industrial processes, as stated in an OECD report entitled "The Bio-economy to 2030: Designing a policy agenda". Finally, in the Arctic region, the bio-economy plays a definite role in the development of sparsely populated areas where for a long time people have lived by utilizing biotic natural resources, as stated in a forthcoming report financed by the Nordic Council of Ministers, "Future opportunities for bio-economy in the West Nordic region".

They further note that from the Nordic view-point, some countries have recently launched national bio-economy strategies. From the case-studies, we note that there is a common need in the Nordic countries and regions for a focus on true implementation and definite action on the bio-economy, including measures such as up-scaling demonstrator plants to larger-scale facilities and opening up new export-markets to bio-economy products and services. That is, there needs to be a focus on specific policy in many sectors and public policy domains linked to these national strategies<sup>26</sup>.

## **NORA, Nordic Atlantic Cooperation**

NORA (Nordic Atlantic Cooperation) is an intergovernmental organization under the Nordic Council of Ministers. It cooperates with the Northern Periphery Programme (NPP), an inter-regional EU programme that is dedicated to addressing the special challenges facing peripheral and remote communities in the Arctic and North Atlantic region.

The NORA region includes the Faroe Islands, Greenland, Iceland, and Coastal Norway (the 9 coastal counties of Norway, from Finnmark in the north to Rogaland in the south). The NORA countries are associated by their geographical location and by shared characteristics, common challenges and historical, institutional and cultural links.

NORA considers cooperation with the neighbouring countries to be of great importance. Consequently, NORA in the past few years has sought to strengthen the relationship with Canada and Scotland and will continue to do so in the future. NPP cooperates with adjacent regions of Russia, Murmansk, Karelia and Arkhangelsk, and the adjacent regions of Canada, primarily Labrador, Newfoundland and Nova Scotia.

NORA’s goal is to contribute to the creation of a vital and dynamic North Atlantic region, characterized by a strong and sustainable economy. To reach this goal, NORA supports collaboration between businesses and research and development organizations in the region. NORA links together many of the Nordic activities in the North Atlantic and the Arctic. Among these are projects under NordBio, the Icelandic Nordic Council of Ministers chairmanship initiative. Initiatives have also been taken to reduce fuel consumption in the transport sector and fishing fleet.

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<sup>26</sup> <http://www.nordregio.se/en/Metameny/Nordregio-News/2014/Bio-economy-and-Regional-Economic-Development/Intro/>

## **A New Development Strategy for the West Nordic Region**

As mentioned earlier The Nordic Council of Ministers for Regional Policies met on 12 November 2014 in Iceland and launched work on a new development strategy for the West Nordic region, which includes a greater focus on bio-economy in Nordic regional co-operation.

The Nordic co-operation programme for regional development focuses on sustainable welfare development, a sustainable business strategy in the Arctic and, in particular, green growth. Based on a recommendation from OECD and on the work done in the regional sector in the Nordic Council of Ministers, a new development strategy for the West Nordic region is planned to supplement the co-operation programme.

The goal is to create more effective co-operation around areas of strategic development and ensure better use of resources given to existing projects in the region. According to the OECD, it is important to focus on sustainable development in the fishing sector, economic diversification and an improved communication network, as well as increased co-operation to meet climate challenges.

The Nordic Council of Ministers' body for Nordic Atlantic Co-operation, NORA, will be one of the focal points for the strategy, in co-operation with the organisations, regions and countries in the North Atlantic.

### **The Arctic and new opportunities**

At a conference on Arctic bio-economy the day before the ministerial meeting in Iceland, Dr Christian Paternmann stated clearly that bio-economy opens up new opportunities. In the West Nordic region in particular, with its huge fishing sector and great opportunities in aquaculture and other sectors within bio-economy, there is considerable potential for development, the conference stressed.

"There is a great need for a common strategy and a regional policy forum, not least to explore the opportunities across the sectors and strengthen regional and local development", underlined the project manager for the Nordic Council of Ministers' work with bio-economy in the Arctic, Sigrún Elsa Smáradóttir, who welcomed the new strategy for West Nordic co-operation.

The development strategy will now be discussed in the Committee of Senior Officials for Regional Policy up to the next ministerial meeting in 2015 and the finalisation of the strategy in 2016<sup>27</sup>.

### **NordBio**

The Icelandic Presidency of the Nordic Council of Ministers 2014 aimed to utilise the enormous potential in building on bio-economy in the Nordic Region. NordBio is a program uniting a broad spectrum of sectors in this effort.

The final meeting of the project ,Arctic bio-economy, place at Mátís Institute on 10-11 November 2014. The final report provides an overview of bio-resources in the region, their utilisation and future opportunities based on green growth, providing good basis for strategic identification of beneficial projects in the region<sup>28</sup>. The report is also published in the Nordic Council of Ministers TemaNord series (TN 2015:505).

Other projects will be carried out in 2015 and 2016 supporting growth in the blue bio-economy of the North<sup>29</sup>.

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<sup>27</sup> <https://www.norden.org/sv/aktuellt/nyheter/vestnordisk-utviklingsstrategi-i-stoepeskjeen>

<sup>28</sup> <http://www.matis.is/media/matis/utgafa/Bio-economy-in-the-West-Nordic-countries-37-14.pdf>

<sup>29</sup> Green Growth - WEB Magazine The Nordic way February 2015 <http://nordicway.org/2015/02/growth-in-the-blue-bio-economy-of-the-north/#.VPwdHvsX9o>

The Nordbio project was initiated to prepare the West Nordic countries for active participation in Nordic and European initiatives in the field of Bio-economy. This final report provides an overview of bio-resources in the region, their utilisation and future opportunities based on green growth, providing good basis for strategic identification of beneficial projects in the region.

### **Blue Growth and Marine-based bio-economy - Circular Bio-economy Based on Marine Resources. Faroese Ministry of Fisheries 2015 Nordic Council of Ministers Chairmanship Program.**

Growth, welfare and values are the overall themes of the 2015 Danish Presidency of the Nordic Council of Minister under which The Faroe Islands is chairing the Nordic Fisheries and Aquaculture Cooperation. The Faroe Islands have decided to focus the Nordic programme of fisheries and aquaculture cooperation in particular on blue growth and marine-based bio-economy.

It will continue to explore the innovation and growth potential of the circular bio-economy, following up on Iceland's presidency project, NordBio, from 2014.

*Growth in Blue Bio-economy* has been set up to seek ways to create more value from products and services that originate from or are otherwise linked to the marine ecosystems in the North East Atlantic and Arctic. The programme will focus on five elements of the marine economy: the pelagic industry, whitefish fisheries, salmon aquaculture, seaweed and biotechnology, and governance.

The programme emphasises the optimised utilisation of already exploited marine resources, innovative use of underutilised resources and residual biomass, as well as innovation across value chains, such as fisheries and tourism. The political framework should encourage bio-economy innovation.

The Faroese Fisheries Ministry hosts an international conference on policy aspects of a well-functioning blue bio-economy at the Nordic House, the Faroe Islands on 2-3 June 2015, organised by the Ministry of Fisheries in co-operation with the Nordic Marine Think Tank, NMMT.

## **7. Potentials**

In the West Nordic Countries and the Arctic – and in general in the North East Atlantic, big volumes of marine biomass are found in the residues from the fish processing industry. There are also big potentials in the harvesting and farming of macroalgae. The first step is to secure access to the residue and other marine biomass.

Compared to other Nordic countries, the bio-economy of the West Nordic countries is a larger part of the GDP. The marine bio-resources are the most important part and a common feature in the West Nordic countries, which calls for a close cooperation within the region. Cooperation with the Nordic Bio-economy panel is one platform for promoting common policy, identifying opportunities and setting a common strategy for the region. The economies in the West Nordic countries can also be reinforced by developing industries, further based on sustainable and responsible utilization of available resources. The aim should be to create multiple value streams from each resource, to improve processes and to develop and apply new technologies with the goal of minimising waste and maximising value. The knowledge available in the West Nordic fishing industry has increased over the last decade and further cooperation, knowledge and technological transfer between the countries would strengthen the West Nordic countries. It is important to maximise processing yields within the fisheries and transform residues into valuable by-products. A substantial increase in value addition would require a synergy between fisheries and biotechnology. Combining a strong industry, such as the fishing industry, with research, development and innovation in the biotechnology sector will benefit the economy of the West Nordic countries and in addition turn the region into an attractive area for young innovators.

Along with the fishing industry, aquaculture is a growing sector in the Faroe Islands and Iceland and sharing knowledge and experiences will benefit both countries. The strong aquaculture industry in northern Norway is also an important partner for Iceland and Faroe Islands in further developing the aquaculture industries in the West Nordic region.

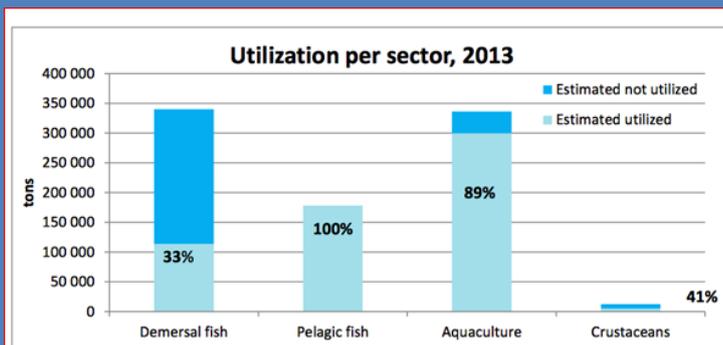
The world produces annually about 150 million tonnes of fish products of which the marine catch sector contributes with about 90 million tonnes. Less than half of this biomass is used directly for food.

A significant amount of the marine catch is used directly in the oil and fish-meal industry. Gutting and offal from filleting and pilling are products that are either returned directly to the sea or processed for fish oil and meal.<sup>30</sup>

There has been a very significant development in refining the fish oil and meal products over the last decades, increasing the value of these products. However, fish oil and meal are fairly low-value products and a higher value per biomass unit might be possible if the biomass was used as raw material for the chemical industry. This would in particular be true if entrails normally returned directly to the sea could be processed. Technology is available for the use of these raw materials, but the economic interest of landing entrails is low.

Macro-algae are growing in abundance in the coastal waters of the West Nordic countries and have promising properties for future utilization. Macro-algae can be used as bio refinery feedstock for bioconversions to speciality chemicals, energy carriers (e.g. ethanol or butanol) and bulk carbohydrates, proteins and derivatives can funnelled into various value streams.

### Use of marine biomass



Source: Directorate of Fisheries, Statistics Norway, Norwegian Seafood Council, Sales organizations, Kontali Analyse og SINTEF

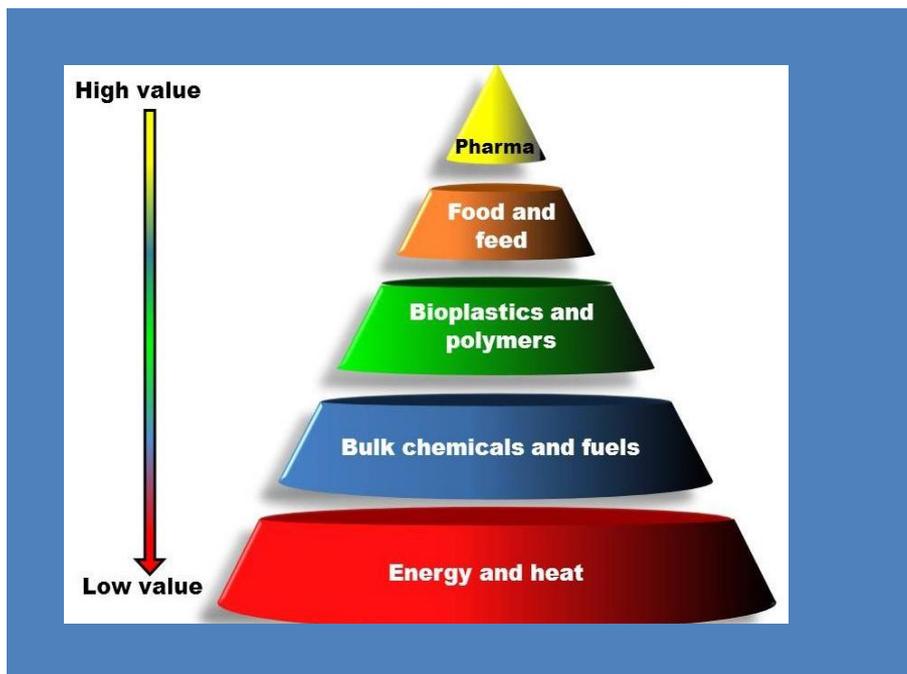
Figure 23. Percentage utilization of the fish by different sectors in Norway

<sup>30</sup> Hans Lassen (personal communication)

Marine biomass has a lot of uses. There are already companies in Iceland and the Faroe Islands that utilise parts of the fish not used for fillets, for example the heads, entrails, backs etc. The products are mostly food for low-price markets e.g. in Africa<sup>31</sup>. Another use is fish-meal and oil, important in aquaculture fish-feed. Other processes have the potential for considerable value adding as illustrated by the figure below.

There are large unrealised opportunities within the different sectors in the West Nordic countries. However, when each sector is operating separately in “its own silo”, the growth potential might be limited. If interdisciplinary cooperation is enhanced, the growth potential of the economy is far greater. Innovation, supported by strong infrastructure, is another key element in enhancing the bio-economy, by exploring underutilized possibilities and growth opportunities within the West Nordic countries.

The initiatives supporting bio-economy in the West Nordic countries whether local,



regional or Nordic will have most impact if they can be paralleled with European and other international research and innovation programs. It is important for the West Nordic countries to promote common interests, provide inputs and influence agendas in international research and European innovation programs. Further, it is important to monitor calls under the Horizon 2020<sup>32</sup> framework and identify collaboration opportunities for innovation in the region. It is also important to use the

supporting West Nordic infrastructure to strengthen development by promoting projects of regional interest to a larger European platform<sup>33</sup>.

In the article “Bio-economy by-products represent enormous value”, Sigrún Elsa Smáradóttir, research group leader at Matís Business Development Unit, explains that the bio-economy’s side streams generate value in various ways in terms of food ingredients and materials used for the production of pharmaceuticals, cosmetics and chemicals.

*“Our approach to product development in the bio-economy is to look at the side streams and think of ways to transform them into products that can be sold on the market,” she says. 30 products are now being developed as part of the initiative, under guidance from Matís, Inuili School in Greenland and INOVA in the Faroes ”.*

<sup>31</sup> Iceland produced the following volumes (tonnes) dried heads 47.433, salted heads 2.142 and liver oil 2.756, Norway has also a significant export to Nigeria.

<sup>32</sup> Horizon 2020 is the biggest EU Research and Innovation programme ever with nearly €80 billion of funding available over 7 years (2014 to 2020).

<https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020>

<sup>33</sup> <http://www.norden.org/en/theme/nordic-bio-economy/nordbio/projects/innovation-in-the-nordic-bio-economy>

**Marinnox** is an Icelandic innovation company that produces **UNA skincare™** cosmetic brand. The research and development of the products was done in close cooperation with Matís.

The products contain unique bioactive substances derived from Icelandic marine algae.

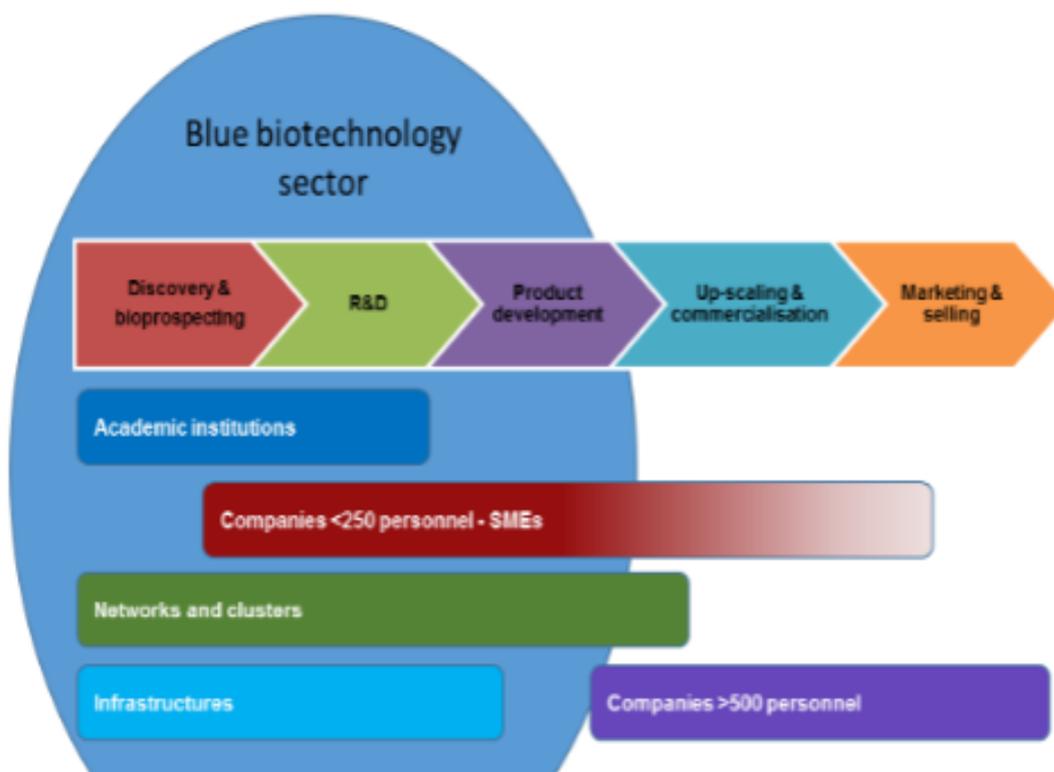
Marinnox has developed a natural method to isolate and produce the bioactive ingredients of this unique Icelandic resource and thereby ensure maximum activity of the products.

The UNA skincare products are developed and produced in Iceland.

Access to biotechnology is important when aiming at high value products and cooperation between West Nordic countries and Nordic and European facilities as well as infrastructure-sharing are necessary conditions. A small travel budget allowing visits to different infrastructures will go a long way.

## Biotechnology and its stakeholders

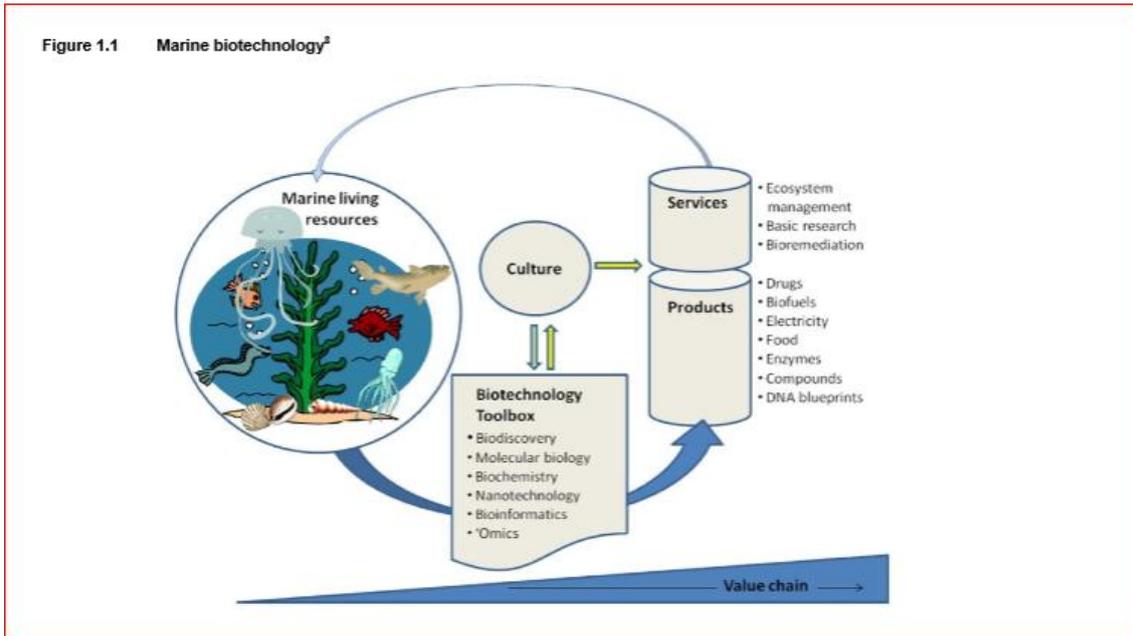
The decisive role of Biotechnology is illustrated below.



Small and medium sizes enterprises (SMEs) are an important aspect of the blue biotechnology value chain as they play a key role bridging the gap between public sector research & development (R&D) activities and commercialisation of products, mainly by large private, often multinational companies.

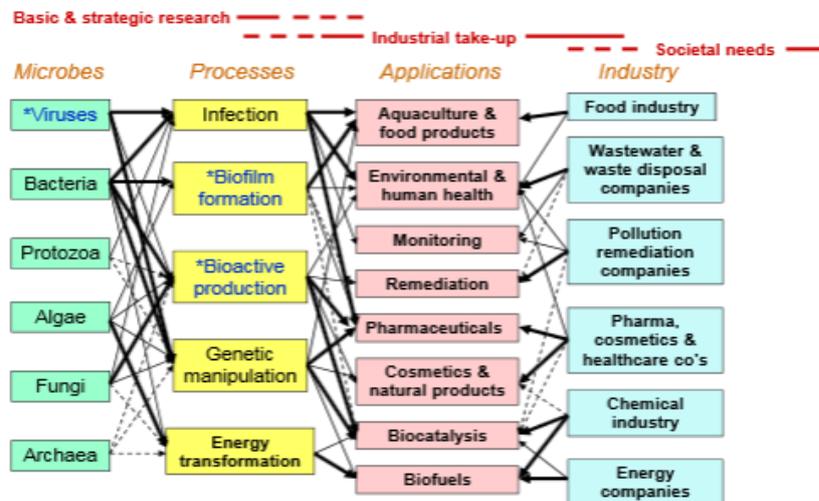
The role of SMEs is the identification, validation and de-risking of industrial opportunities from marine bio-resources. SMEs tend to be placed at the initial product development stage of the value chain, essentially the high-risk cash-burn phase where the screened products, often lodged in 'bio banks' are transformed into bankable potential products for up-scaling and commercialisation. Due to the risks involved, financing – often but not always from venture capital – is unpredictable and fickle. As a consequence, these SMEs are very vulnerable; for example there has been a 17% drop in venture capital investments since 2008. The SMEs and the commercials are emerging as one of the weakest links in the chain. Access to seed money is vital.

Figure 1.1 Marine biotechnology<sup>8</sup>



The figure below illustrates one particular part of the ‘field’ of marine biotechnology and provides examples of the types of tools and technologies utilised in this part and the resulting products and services.

Figure 2.2 The web of linkages from marine bioresources to industrial use<sup>12</sup>



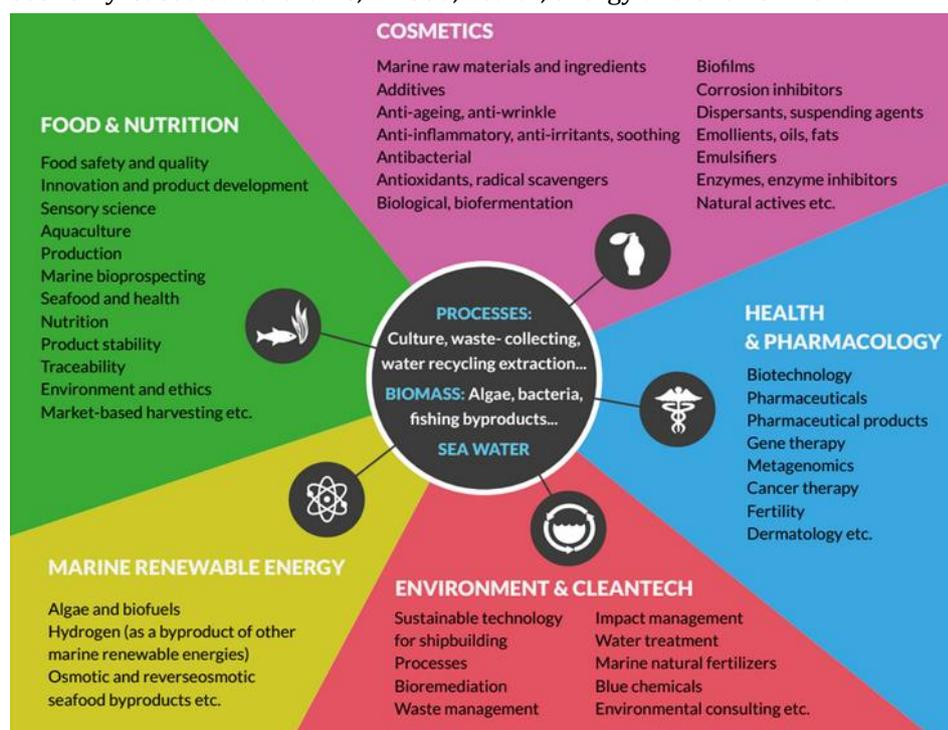
The main risks at this level of bioprospecting (see Figure 2.2 above) are that too many novel organisms and molecules will be found, creating a bottleneck in screening, selecting and identifying

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<sup>34</sup> [http://ec.europa.eu/maritimeaffairs/documentation/studies/documents/study-blue-biotechnology\\_en.pdf](http://ec.europa.eu/maritimeaffairs/documentation/studies/documents/study-blue-biotechnology_en.pdf)

## A new global approach in the marine bioresources industry to foster SMEs' business opportunities and facilitate access to funding

The BioMarine International Clusters Association (BICA) is to be the champion for marine bio-resources and their sustainable and innovative utilization in all trans-sectors applications. BICA will federate national and regional marine and bio marine clusters, advocate policies that enable the realization of the marine biotechnology's promise for providing breakthrough products to feed the world, clean the environment, and improve health and nutrition. BICA is unique in that it is a conjugation of a strong international business opportunity and an intensely networked set of marine bio-clusters. BICA will structure the bio marine industry and foster economic development by the creation of international business opportunities and partnerships. BICA wishes to meet the needs of industry, science and the civil society by creating and organizing economic value from blue bio-economy-based value-chains, in food, health, energy and environment.



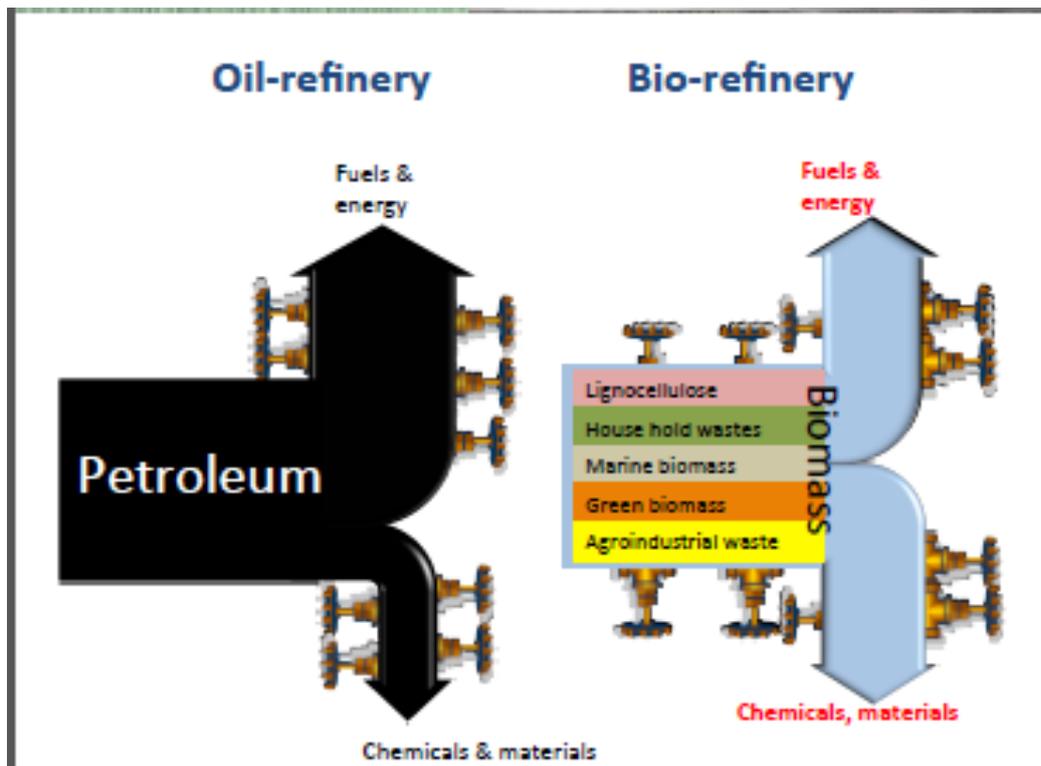
## Substituting renewables for fossils in chemical industry

Biomass is one of the standard raw materials for chemical production. Historical examples include ethyl alcohol from biomass, soap from fat, and acetic acid from tree distillation. Chemical industry is currently largely but not exclusively based on mineral oil, e.g. about 25% of the acetic acid (about 6.5 Mt per year) is currently produced from recycling, including biomass. However, as a chemical reagent, biological sources of acetic acid are of interest but generally uncompetitive. There are numerous examples within the cosmetics and pharmaceutical worlds of products based on raw marine biomass raw materials.

At the conference "Arctic Bio-economy Focus on West-Nordic Countries", 11 November 2014, Dr Lene Lange, professor, Department of Biotechnology and Chemistry, Aalborg University,

Denmark, held a presentation on “Bio-economy in the Nordic countries, strategy, opportunities and needs”<sup>35</sup>, which reviewed the potential of substituting renewable biomass for fossils. The figures below are from that presentation.

The task, according to the Danish National Bio-economy Panel, of which Lene Lange is a member, is to diminish the dependency on fossil resources, increase resource efficiency, create new jobs also in coastal and rural areas, increase technology, export and competitiveness, improve re-circulation of micronutrients (P), strengthen sustainable agriculture, forestry and aquatics and contribute to environmental services.

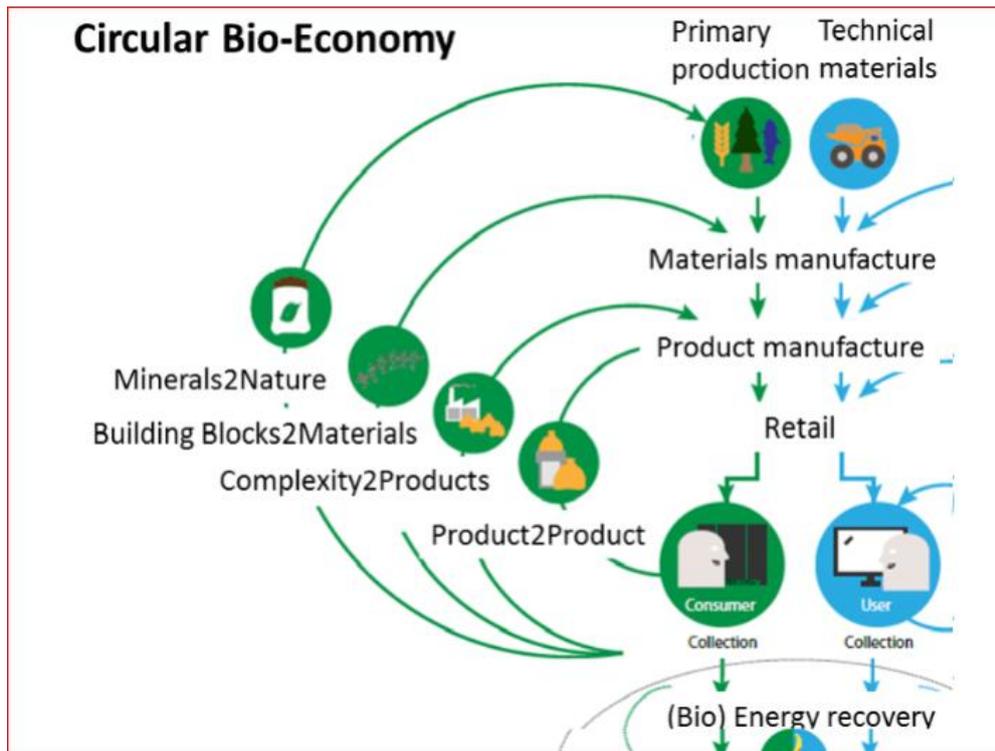


**Message: complexity is value!**  
 You can make more products and more value from new biomass than from fossilized biomass (= crude oil)  
 -because complexity is intact!

Grass

Plant cell wall structure and proteins

<sup>35</sup> [http://www.matis.is/media/utgafa/erindi/Arctic-Bio-economy-Potentials-Lene\\_Lange.pdf](http://www.matis.is/media/utgafa/erindi/Arctic-Bio-economy-Potentials-Lene_Lange.pdf)



## Blue Biorefinery Value Cascade

### Macro-Algae/Kelp!



- Product2Product: food!
- Complexity2Product: fucoidan; proteins
- Building blocks2Materials: sugars for production
- Minerals2Nature: Phosphate back to soil

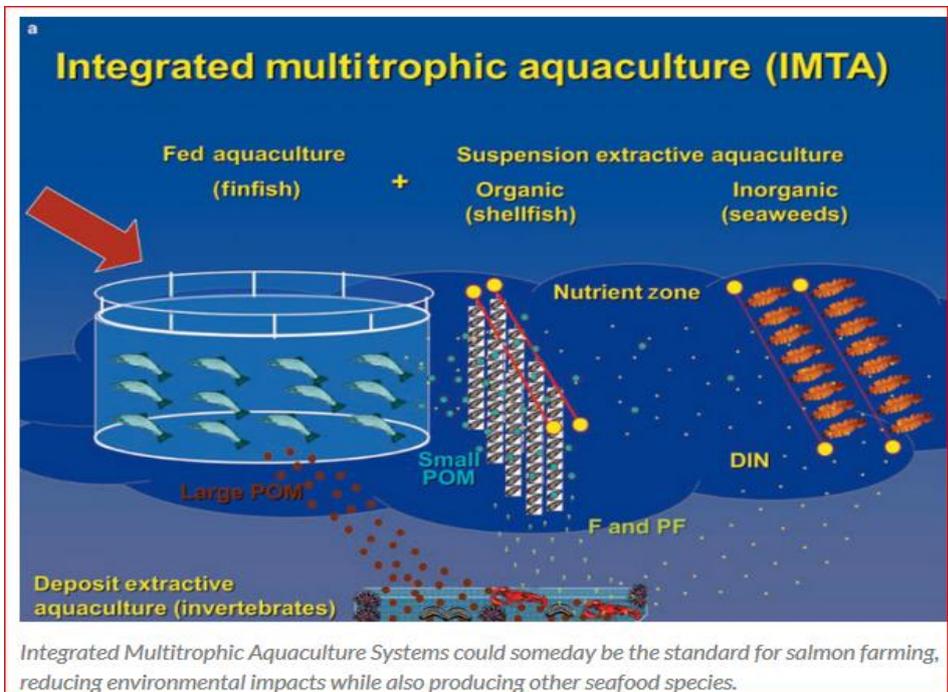
### Nordic Algae Network

The project's aim is to help the participants to a leading position in the field of utilizing algae for energy purposes and for commercial exploitation of high value compounds from algae. An additional aim is to increase the synergy and facilitating collaboration between the

participants involved in the project thereby increasing their ability to compete in this new Field.<sup>36</sup>



Figure 6. Microalgae are used to produce electricity, biofuel, soil fertility, and food.  
Source: <http://www.algaeaqua.com/Welcome.html>



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<sup>36</sup> <http://www.nordicinnovation.org/nordicalgae>

<sup>37</sup> <https://salmonfarmscience.files.wordpress.com/2013/04/imta-system.png>

## Potential of Macroalgae cultivation in the West Nordic Countries

Macroalgae cultivation is found to be highly potential in the ocean area surrounding the Faroe Islands, mainly due to nutrient (nitrate) levels and relatively stable temperatures. Of ten macroalgae species that were assessed for cultivation potential in the Faroe Islands, five were assessed to have a high potential.<sup>38</sup>

In the same survey there are also conclusions on macroalgae cultivation in Greenland.

Ocean Rainforest Sp/F is a limited company located in the Faroe Islands engaged in the production of marine biomass from macroalgae in open ocean cultivation facilities. Ocean Rainforest has 1200 meter of seaweed seed lines in the Faroe Islands, where continuous current and stable sea temperature provide perfect conditions for seaweed farming. Ocean Rainforest aims to become a leading supplier of sustainable cultivated macro algae in open ocean environments.

Ocean Rainforest is developing a method for cultivating seaweeds in the open ocean - thus moving this maritime resource away from a hunter-gathering style of procurement and into the realm of true aquaculture.

The mission of Ocean Rainforest is to provide a stable source of marine biomass for food, feed, cosmetic, pharmaceutical, nutraceutical and energy products. The scale will be in excess of 100,000 tonnes of wet weight per annum. Ocean Rainforest has designed a seaweed facility that is suited for the harsh conditions of the open ocean, which has been operating since March 2010.

At present there is no legislative framework in the Faroe Islands for licensing areas for farming of macroalgae. Ocean Rainforest operates under an exploratory licence held by the largest salmon farming company in the islands.

## Harvesting macroalgae in Iceland

Seaweed Iceland<sup>39</sup> is a small family-owned business located in Grindavík, on the southern coast of Iceland. High quality seaweed is harvested and sold in selected specialty stores and online. The seaweed is harvested in a sustainable manner and enough plants for re-growth are left. Once the harvest is completed, the seaweed is air dried at low temperatures (below 28 degrees celcius) in a closed drying facility. The electricity to do so comes from a geothermal plant 10 kilometres away and is completely renewable. Moisture is controlled throughout the drying process, and dried products are then stored at low temperatures in a climate-controlled facility. Several food products are sold on the internet under the brands of Kombu, Wakame and Dulse.

## Norwegian harvesting of macroalgae

The Norwegian seaweed industry is almost completely reliant on natural beds of *Ascophyllum nodosum* and *Laminaria hyperborea*. *L. hyperborea* accounts for about 90% of the national harvest. Mechanical harvesting provides almost all of Norway's national seaweed output. Manual harvesting of other species, such as *Ulva* ssp. is carried out at very low levels, mainly for the provision of high quality raw material to restaurant or grocery stores.

Seaweed farming is under development, but generates very little biomass.

The alginate industry is by far the most important sector, consuming the vast majority of the seaweed processed in Norway (domestic and imported).

The rest is used directly as food, fodder, bio stimulants and cosmetics in aquaculture and the health sector.

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<sup>38</sup> Wegeberg et al.,2013. Integreret akvakultur i Grønland og på Færøerne. Videnskabelig rapport fra DCE – Nationalt center for Miljø nr.82.  
<http://dce2.au.dk/pub/SR82.pdf>

<sup>39</sup> <http://www.seaweed.is/>

In Norway, regulations for harvesting seaweed apply to seabed algae such as *Laminaria hyperborea*.

Harvest of foreshore algae, such as *Ascophyllum nodosum*, is not regulated, but is managed by private owner rights, because the species grows in the tidal zone.

Environmental protection laws and other regulations can restrict areas for harvesting. Regulations for farming seaweed are under preparation<sup>40</sup>.

## Pharmaceuticals and cosmetics

Algae, fish and shellfish are used for medical human healthcare (dietary supplements) and cosmetics e.g. (41, 42, 43)

One example is the extraction of chondroitin sulphate from the soft bones shark. This active material is valuable to the pharmaceutical industry, due to its effects against rheumatic diseases in humans and animals (44) and may have anti-cancer effects (45, 46).

Focus in Europe has so far been on plant-lignocelluloses waste. This has low protein content while marine bio waste has high protein content. Europe and the world have a significant protein deficit in terms of meat production while the West Nordic region has a very interesting option to produce animal feed from upgraded bio residues and waste.

Mayer et al. (2013) give a review of Marine Pharmacology in 2009–2011: Marine Compounds with Anti-bacterial, Anti-diabetic, Anti-fungal, Anti-inflammatory, Anti-Protozoal, Anti-tuberculosis, and Antiviral Activities; affecting the Immune and Nervous Systems, and other Miscellaneous Mechanisms of Action<sup>47</sup>.



## Other marine organisms with potential for blue growth

These could for example be the tunicates. The fact that marine resources are still largely unexplored has inspired many scientists to intensify their efforts by using novel technologies to overcome the inherent problems in discovering compounds, which may have potential for further development as pharmaceuticals or as functional products such as cosmetics, nutritional supplements and functional foods (48). Extracts of the tunicate *E. turbinata* were shown to have anti-tumour effects in 1969, but isolation of the active compound was not achieved until 1990 (49)

The picture shows the colony of the marine tunicate *Ecteinascidia turbinata* which is at the basis of a commercially available anti-cancer agent (Yondelis®) with sales at €30 million in 2008, rising to €45 million in 2009<sup>50</sup>.

<sup>40</sup> [http://www.netalgae.eu/uploadedfiles/Norwegian\\_seaweed\\_industry\\_WP12.pdf](http://www.netalgae.eu/uploadedfiles/Norwegian_seaweed_industry_WP12.pdf)

<sup>41</sup> <http://www.livestrong.com/article/427863-the-benefits-of-fish-oil-for-the-hair-and-skin/>

<sup>42</sup> <http://www.cosmeticsdesign.com/Formulation-Science/Omega-3-shown-to-provide-protection-against-sun-damage-and-skin-cancer>

<sup>43</sup> <http://www.akerbiomarine.com/news.cfm?path=200.169&id=3-1566>

<sup>44</sup> <http://nordicway.org/2014/08/bio-economy-products-represent-enormous-value/#.VFSw54dxv4Y>

<sup>45</sup> <http://www.kemi-online.dk/files/side22-23dak6-02.pdf>

<sup>46</sup> <http://www.matis.is/media/utgafa/erindi/Patermann---Copy.pdf>

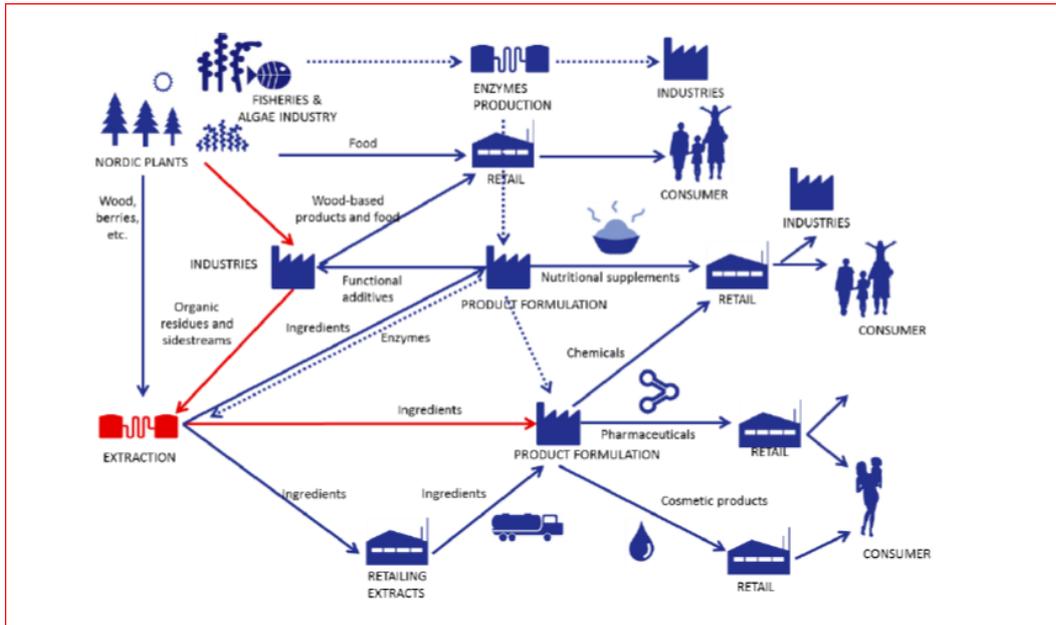
<sup>47</sup> <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3736438/>

<sup>48</sup> [https://www.marine.ie/NR/rdonlyres/C076682C-2B32-437C-A781-B2EACBAA6B62/0/ESFMBmarine\\_biotechnology\\_paper15LR.pdf](https://www.marine.ie/NR/rdonlyres/C076682C-2B32-437C-A781-B2EACBAA6B62/0/ESFMBmarine_biotechnology_paper15LR.pdf)

<sup>49</sup> <http://techmedia.swiflet.com/tm/dak/25/13/>

<sup>50</sup> [https://www.marine.ie/NR/rdonlyres/C076682C-2B32-437C-A781-B2EACBAA6B62/0/ESFMBmarine\\_biotechnology\\_paper15LR.pdf](https://www.marine.ie/NR/rdonlyres/C076682C-2B32-437C-A781-B2EACBAA6B62/0/ESFMBmarine_biotechnology_paper15LR.pdf)





### Organisation of bio-panels and stakeholder involvement

The West Nordic countries have agreed to cooperate with the Nordic Bio-Economy Panel. This is the most efficient way of pushing forward with issues of importance in the region. Nordic cooperation like NORA will be activated to support the process. These decisions should be communicated efficiently to the governments in the area. The process should start immediately with a clear action plan with deadlines and road maps. Funding can be regional (NORA & Northern Periphery Programme) or structural and Horizon 2020 funding. There should be awareness of neighbourhood policies in the EU and infrastructure sharing. A small travel budget allowing visits to different infrastructures will go a long way.

It is necessary to investigate the complexity of funding and de-risking, and stress sustainability in the widest sense. The following steps are proposed in investigating the blue elements of the bio-economy.

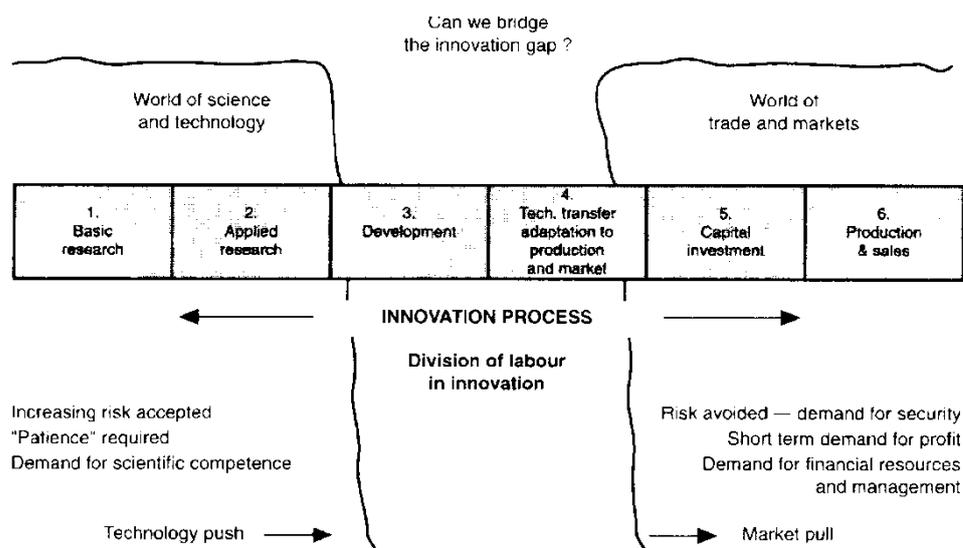
1. Action Plan. Time line in the investigation
2. Bio refining activities:
  - a) Animal feed, Aquaculture
  - b) Micro- and macro algae.
  - c) Residue streams from fisheries, very protein rich high value
3. Establishment of a Centre of Excellence. Interdisciplinary; communication through virtual use of IT.
  - a) Research Priorities to avoid duplication.
4. Establish stakeholder panels with industry. Importance of informing others. Learn from the technology platforms in Europe. Beware of old hierarchies (old bio-economy). Find success stories, they have societal consequences.

Creating an Arctic centre of excellence will build on the work of the “Arctic Bio-economy” project (2012-2014) as well as the ongoing “Arctic Bio-economy II - Biotech” project (2015-2016). It will use the new opportunities identified by the West Nordic countries and extend the scope for the Arctic region for value creation and job opportunities based on bio-economy<sup>49</sup>.

## 8. Removing obstacles for Blue Growth

Innovation and development in the traditional fisheries, aquaculture and land-based processing is very much driven by the markets.

Moving from traditional blue economy to adding value by using larger parts of the residue streams opens up a brave new world of possibilities. Here is real innovation possible, but the process is hit by the innovation gap, as illustrated below.<sup>52</sup>



This figure is around 20 years old. More advanced models have been developed; see particularly the Nordic Innovation publication 2014:01.<sup>53</sup>

In the Nordic Innovation publication I. Rönnlund identifies the following obstacles in Nordic Bio-economy:

**Remarkable need of capital and lack of financing**

Bio-economy related businesses are resource- and investment intensive

**Bio-economy as a sector is not familiar to the financiers**

**Lack of references and track record**

**Unclear market outlook**, regulation biases the markets, and unstable operating environment

**Long and slow regulatory procedures**, innovations are not recognized by existing laws

**Difficulties in commercialization** of bio-based products and services

Innovations are often technology driven, instead of being market driven

The lack of piloting and demonstration possibilities

**Access to markets is lacking** and market knowledge is limited. Lead markets do not exist.

Questionable access to raw materials

The existing infrastructure does not support new innovations

Crosscutting nature of bio-economy presents challenges

Too little experience of open innovation and cooperation

**Lack of actors** in the value chains and ecosystems

**Diversified beneficiaries** in bio-economy business ecosystems are not clear

<sup>52</sup> From Icelandic National Research Council, RANNIS

<sup>53</sup>[http://www.nordicinnovation.org/Global/\\_Publications/Reports/2014/2014\\_01%20Innovation%20in%20Nordic%20Bio-economy\\_final.pdf](http://www.nordicinnovation.org/Global/_Publications/Reports/2014/2014_01%20Innovation%20in%20Nordic%20Bio-economy_final.pdf)

There is a lot of expectation in the Nordic countries, in the EU and around the world to the potential for growth in bio-based economy. It is seen as a central element for the EU to regain growth and economic recovery in a new industrial policy<sup>54</sup>. A number of EU member states have launched programmes to support bio-economy, in some countries termed “Green Growth, “Green economy” or just “Industrial Biotechnology”<sup>55</sup>.

The Nordic countries outside the EU have also launched programmes and as we have seen in this report the West Nordic countries and territories have moved in the same direction in programmes financed by the Nordic Council of ministers.

In the blue bio-economy in the North East Atlantic one of the major preconditions is a “detailed action plan based on the principle of distribution and division of work, talents and resources”. This should form a basis for building up the bio-economy, inclusive opening up markets for bio-based products and services<sup>35</sup>.

Exchanging information and best practices, building up bio-based value chains, including bio-refining, and most importantly, securing an uninterrupted supply of biomass is most important.

In summary cooperation between the coastal states in the NE-Atlantic and securing that the residual biomass from fisheries, aquaculture and food production is available for further processing, is essential.

There is a strong tradition for cooperation between the North East Atlantic coastal states, but at present cooperation is at a long time low, because of lack of agreement on allocation between the coastal states of the three major straddling pelagic stocks. This has led to boycott and international dispute.

With respect to securing the residual biomass from fisheries and aquaculture most administrations are sitting on the fence. In fisheries there are examples of business cases around heads, fish offal and entrails, but they are few and most of the residual biomass is still dumped at sea.

There is at the moment a lively debate about how to get the marine biomass, now dumped at sea, onshore for production. The industry points out that the prices paid for biomass do not cover the expenses. Other parts of society feel that it will be necessary to legislate to get the biomass, in a sense a total discard ban on all parts of the fish.

The factory trawlers in the Barents Sea from Norway and the Faroe Islands produce fillets on board and dump the residual 55-65 % of the fish biomass into the Sea. Russian vessels in the Barents Sea utilise the biomass 100%. There are examples of installing fish-meal plants on board on the vessels and bringing frozen products on shore for processing, but they are few. In Iceland there has been a movement away from factory trawlers in the bottom fisheries to fresh fish trawlers, thus making the residual biomass accessible for further processing.

The West Nordic region suffers from a series of disadvantages related to its remoteness from major markets and trade routes. Even direct transport connections linking the four NORA members are limited. External connections to Greenland and the Faroes are extremely limited and mostly pass through Denmark. There is untapped potential for stronger links between the western parts of NORA and Atlantic Canada and the eastern parts of NORA and the United Kingdom. This would facilitate access to larger markets. The lack of critical mass makes it hard to develop and diversify the transport network, especially in Greenland and the Faroes, but an improved and more diversified transport infrastructure is crucial to overcome the problem of remoteness and improve the region’s competitiveness<sup>56</sup>.

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<sup>54</sup> Recommendations of the EU in the Recovery report on Europe 2012. 10<sup>th</sup> October 2012 (From Pateman 2014)

<sup>55</sup> Pateman 2014.

<sup>56</sup> OECD Territorial Reviews: NORA Region 2011. <http://www.nora.fo/en/thenoraregion/oecdterritorialreviewofthenoraregion/>

## **Policy initiatives to pave the way for blue bio-economy in the Arctic and North East Atlantic**

It is obvious that to attain economies of scale with respect to the volumes of fish biomass accessible for processing and value adding, cooperation between the West Nordic countries is necessary. The amounts available in each of the four countries are insufficient for a sound economy of a meal/oil factory using current technology, and therefore transport to a central factory or the development of technology that is economical at a smaller scale is required. This may involve new products beside fishmeal and oil.

There are problems here. The four countries are not necessarily interested in the processing of fish landed by their fleet outside their own area and there are problems in logistics, for example transporting residue biomass from Greenland to other West Nordic countries.

With respect to using macroalgae there may be environmental problems with harvesting algae and when it comes to farming algae the competition for space with other farming, especially salmon farming in the Faroe Islands and Norway, is an unsolved problem.

With respect to developing technology, SMEs are seen as central and therefore most importantly there have to be policy initiatives to make it possible for SMEs to develop the initial product development stages of the value chain, before up-scaling and commercialisation, by making seed money and venture capital available.

## Appendix List of abbreviations

ABNJ Areas beyond National Jurisdiction  
CBD Convention on Biological Diversity  
CFCA Community Fisheries Control Agency  
CFP Common Fisheries Policy  
CITES Convention on International Trade in Endangered Species of Wild Fauna and Flora  
EAF Ecosystem Approach to Fisheries  
EEZ Exclusive Economic Zone  
ENGOS Environmental Non-governmental Organisations  
ESCAP UN Economic Commission for Asia and the Pacific  
EU European Union  
F Instantaneous Rate of Fishing Mortality. On an exponential scale  $F=0.5$  means that  $1-\text{EXP}(-0.5) = 39\%$  are removed.  
FAO Food and Agriculture Organization of the United Nations. FAO COFI  
GDP Gross Domestic Product  
GGs Green Growth Strategy (OECD)  
ICCAT International Commission for the Conservation of Atlantic Tunas  
ICES International Council for the Exploration of the Sea  
IUCN International Union for Conservation of Nature  
IUCN CEM FEG Fisheries Expert Group  
IUU Illegal, unreported and unregulated fishing  
MPA Marine protected area  
MCS Monitoring Control and Surveillance  
MSFD EU Marine Strategy Framework Directive  
MSY Maximum sustainable yield  
NAFO Northwest Atlantic Fisheries Organization  
NAMMCO North Atlantic Marine Mammal Commission  
NASCO North Atlantic Salmon Conservation Organization  
NEAFC North East Atlantic Fisheries Commission  
NGO Non-governmental organisation  
NORA (Nordic Atlantic Cooperation)  
NPP Northern Periphery Programme  
OECD Organisation for Economic Co-operation and Development. OECD COFI  
OSPAR Oslo-Paris-Convention; Convention for the Protection of the Marine Environment of the North East Atlantic  
PA Precautionary approach  
RAC Regional advisory council  
RFB Regional Fishery Body  
RFMO Regional Fisheries Management Organisation  
SOFIA-Report The state of world fisheries and aquaculture FAO  
TAC Total allowable catch  
TRIPS Agreement on Trade-Related Aspects of Intellectual Property Rights  
UNCED United Nations Conference on Environment and Development  
UNCHE UN Conference on Human Environment  
UNCLOS United Nations Convention on the Law of the Seas  
UNECA United Nations Economic Commission for Africa  
UNEP United Nations Environment Programme  
UNFSA United Nations Straddling Fish Stocks Agreement (UN 1995 Fish Stock Agreement)  
UNGA United Nations General Assembly  
UNICPOLOS or ICP United Nations open-ended Informal Consultative process