

# North Atlantic Ocean Clusters

Increased opportunities through cooperation





# North Atlantic Ocean Clusters

## Increased opportunities through cooperation

August 2012

Published by  
The Iceland Ocean Cluster

Supported by



---

## Preface

The project “North Atlantic Ocean Clusters” was initiated by the Iceland Ocean Cluster and supported by Nordic Innovation, NORA, and members of the Iceland Ocean Cluster.

The purpose of this report is to map cluster activities in the North Atlantic Ocean and to lay the ground for further discussions based on the first seminar held by this project in Iceland, May 24–25, 2012.

The following have been a part of the preparation of this project and/or participate in the seminar:

Per Erik Dalen, Managing Director, AAKP, Norway

Olav Bardalen, Programme Manager NCE & Arena, Innovation Norway, Norway

Steen Sabinsky, CEO, Maritime Development Center of Europe, Denmark

Jógvan Jespersen, Managing Director, Nótaskip, Faroe Islands

Tønnes “Kaka” Berthelsen, Deputy Manager, Knapk, Greenland

Robert Wolff, Adviser, Civ., Eng. SINTEF, Norway

Leslie O’Reilly, Managing Director, Oceans Advance, Canada

Finnur Oddsson, Managing Director, Iceland Chamber of Commerce, Iceland

Marita Rasmussen, Managing Director, Vinnuhúsið, Faroe islands.

Niels Winther, Advisor, Vinnuhúsið, Faroe Islands

Thor Sigfússon, Managing Director, Iceland Ocean Cluster, Iceland

Vilhjálmur Jens Árnason, Project Managaer, Iceland Ocean Cluster, Iceland.

Elvar Knútur Valsson, Special Adviser, Ministry of Industry Energy and Tourism, Iceland

The author of this report, Vilhjalmur Jens Arnason, MBA, worked in close collaboration with Thor Sigfusson, Managing Director of the Icelandic Ocean Cluster; Eva Rún Michelsen, Administrative Manager at Iceland Ocean Cluster; and with members of the supervisory committee of the project.

We would like to thank all of those who have contributed to this report with their guidance and advice. This report is a part of a bigger initiative to gather information and encourage cooperation between countries that share access to the northern part of the North Atlantic Ocean. We welcome all suggestions on how we can improve its content and serve best the mission of this project.

---

## Executive Summary

Nations that live in close proximity to the ocean readily understand the ecological, economic, and social importance of the oceans. For the Nordic countries and countries such as Canada, Scotland, and Ireland, the ocean has always been an important part of the culture and has had a profound influence on the lives of their people. Traditionally, these nations have seen the ocean both as a source of food and valuable minerals and as a vast highway for commerce. In recent years there has been a growing interest in ocean-related matters connected to research and in the new means of harvesting ocean resources.

To capture new opportunities and move traditional industries forward, various marine/ocean clusters have been formed in the North Atlantic region, from Western Canada, Iceland, Scotland, Ireland, Norway, Denmark, Sweden, and Finland in the east. Most of these clusters are based on the national or regional dimension of networks and enjoy assistance from various organisations and institutions. Many of these clusters have shown some positive results, and yet research indicates that numerous small firms are still striving to penetrate global markets.

The main objective of this report is to map these ocean clusters and to a certain degree the marine-related industries in the different countries. The report is seen as a basis for further discussion about how to increase cooperation between the countries covered in the report.

Despite their different strengths and weaknesses, the countries of the North do show many correlations and similarities. The cultural ties between them are strong and there is a tradition of working together in many areas for mutual interest. The main message of this report is that these countries are facing similar challenges and that they are equipped with unique know-how and experience which should enable them to find common solutions. They are all relatively small, are facing large competitors, and are in an economic environment in which globalisation is making our world smaller and more competitive. To ensure that they can stay among leading nations, it is important to combine forces and, by doing so, become stronger.

---

# Table of Contents

<b>PREFACE</b>	<b>IV</b>
<b>EXECUTIVE SUMMARY</b>	<b>V</b>
<b>INTRODUCTION</b>	<b>7</b>
<b>THE CLUSTER CONCEPT</b>	<b>10</b>
<b>CLUSTERS IN THE NORTH ATLANTIC REGION</b>	<b>13</b>
Norway	14
Canada	16
Denmark	19
Finland	21
Sweden	22
Ireland	23
Iceland	26
Scotland	28
Faroe Islands	29
Greenland	29
<b>SECTORAL OVERVIEW</b>	<b>31</b>
<b>Marine Food</b>	<b>31</b>
Marine food clusters in the North Atlantic	38
Opportunities	49
<b>Marine Energy</b>	<b>51</b>
North Atlantic Marine energy clusters	52
Opportunities	61
<b>Marine Transport</b>	<b>63</b>
North Atlantic Marine Transport Clusters	65
Opportunities	73
<b>Marine Biotechnology</b>	<b>73</b>
North Atlantic Marine Biotechnology clusters	74
Opportunities	78
<b>CONCLUSION</b>	<b>79</b>
<b>REFERENCES</b>	<b>80</b>

## Introduction

**Figure 1.** Countries involved in the mapping of marine-related industries.

The main objective of this report is to map ocean clusters and, to a point, the marine-related industries in the different countries in the northern part of the North Atlantic Ocean, an area that includes the Baltic Sea, the Davis Strait, the Denmark Strait, the Norwegian Sea, and the Labrador Sea. The countries involved are the Nordic countries, Scotland, Ireland, and Canada. The report is seen as a basis for further discussion among various North Atlantic marine/ocean clusters and institutions on how to increase cooperation between the countries covered in the report. This project was supported by Nordic Innovation and NORA.

Oceans cover 71 percent of the earth's surface and support the life of nearly 50 percent of all species on earth. Fisheries and aquaculture provide 20 percent of the animal protein and five percent of total protein in the human diet. Ocean currents have a huge impact on the earth's ecosystem, climate, and weather. The ocean is key to transportation with more than 90 percent of the trade between countries being carried by ships and about half the communications between nations taking place through underwater cables. The world's oceans supply nations with energy and create a venue for recreation. Increased demand for food in the world can be met with ocean resources and it is in the ocean that we might find the cures to many diseases. Yet to a great extent this underwater world is unexplored and research on opportunities and threats associated with its resource use and abuse has been limited.

In this report the focus is both on ocean-/marine-related clusters in industries connected to transport by sea and on the exploitation of resources in the ocean and beneath the seabed. The main emphasis is on marine-related food, energy, transportation, biotechnology and research.

All the Nordic countries along with Canada, Ireland, and Scotland are endowed with substantial coastlines; it comes as no surprise, then, that ocean accessibility has had an important effect on their economies and lives. A significant part of the population in these countries lives next to the sea, a fact which often shapes the conditions and possibilities of challenges faced by coastal dwellers. Even though the distance between some of these countries is relatively short, the ocean has been perceived as being a barrier down through the centuries. In this report we will look at the ocean as something that unites these countries and as a source of shared interests and common approaches. Modern technology makes it easier than before to share ideas and thoughts with people farther away and development in transportation technique is making our world a smaller place.

There are strong cultural ties between all of these countries and collaboration among them has in general been stable and peaceful. Certain language barriers have obtained but as the number of those speaking English as a first or second language is substantial in this area, communication between these countries has been relatively problem-free.

The countries covered in this project all share common values and display striking similarities in the shape and contour of their political landscapes. They all have relatively small, open economies with a high export-dependency. Foreign trade constitutes an important part of their economic activity. All of these countries compete on markets that are dominated by much bigger nations with larger populations. Most of these countries have access to huge land and sea areas but are in general sparsely populated with an average population density of around 35 people per km<sup>2</sup> (see Table 1). The combined population of all the countries in the North Atlantic Ocean cluster project is around 70 million people; Canada has the largest population of 34 million. The composition of the population in these areas is also in some ways different from the countries in the southern part of the developed world, particularly in respect of the higher population percentage of younger people.

In the report "Innovation in the Nordic Marine Sector", the Nordic countries were encouraged to increase cooperation amongst government, research, and industry on a pan-Nordic level (Margeirsson and Edvardsen, 2009). Various projects have been initiated in the North Atlantic in the ocean/marine sector that aim to increase cooperation. The issues raised include the environment, seabed research and fisheries, among others. These projects have often consisted of 2-3 countries with some only focusing on EU countries (such as mapping the EU west coast led by Ireland). Ireland, for example, has worked with Canada in several projects. Academics specializing in ocean affairs have also had various relations across the North Atlantic. However, industry activity in this area has been limited to date.

Working within the definition of a cluster as "localised networks of specialized organisations, whose production processes are closely linked through the exchange of goods, service or knowledge" (Porter, 1998), this project examines how stronger cooperation or harmonisation among the clusters in the North Atlantic may become a vehicle for improved performance for the North Atlantic marine-/ocean-related industries. This report may assist the project in addressing questions such as the following:

- Could benchmarking among North Atlantic marine cluster and sharing of best practices strengthen ocean/marine industries and clusters?
- Could the clusters gain more from strengthening their cooperation, cooperation which has been scarce in recent decades?
- Could a stronger image of the North Atlantic as a centre of excellence in ocean-related industries assist these firms in selling their products, et cetera?
- Can countries in the North respond with cooperation when the world's political and economic centre of gravity is shifting from the West to the East, that is to countries such as China and India?

While many marine/ocean clusters in the North Atlantic have mapped the industries involved and have observed the strengths, weaknesses, and opportunities of individual countries in developing ocean/marine clusters, a project aiming to harmonize clusters and address the questions above for the North Atlantic ocean/marine sector has, to our knowledge, not been conducted. This project

**Table 1. Population and population density in the North Atlantic region**

Country	Population (1000)	Population density km2
Canada	34174	3.75
Sweden	9394	22.86
Denmark	5565	130.67
Finland	5363	17.65
Scotland	5220	65.01
Norway	4883	15.99
Ireland	4451	65.05
Iceland	318	3.17
Greenland	56	0.14
Faroe Islands	49	35.04
<b>Total/Average</b>	<b>69473</b>	<b>35.93</b>



could thus provide both innovative and timely findings on how to develop stronger networks in the ocean/marine sector.

This project aims to bring together leaders from marine clusters in these countries, to map the opportunities, to benchmark against other successful clusters, and to initiate further cooperation amongst the countries. The most important goal of the project revolves around the mapping and opening of new channels of communication and around the building of bridges between the countries. Other goals that might be looked at as beneficial for the participating countries are improving the image of the region, increasing innovation and cooperation in many areas such as education, security matters, and environmental issues, and utilising resources more efficiently. More information can also make it easier to draft a general policy for the region, while stronger awareness of opportunities in the area might encourage growth and attract interest.

## The cluster concept

In recent years the concept of industry clusters has generated substantial interest among scholars, policy makers, industry leaders, and media. The cluster concept has gained some prominence as a tool to explain and promote regional and urban economic growth and to create foundation for increased competitiveness. The word “cluster” is in many ways a mainstream word today. Finding a generally accepted definition of the word or a unified theoretical approach is, on the other hand, not an easy task. Different actors seem to have different definitions and the concept is used widely in varying contexts.

The concept is generally traced back to Alfred Marshall’s *Principles of Economics*, which was first published in 1890. According to Marshall (1890), agglomeration advantages were supposed to be linked to three sets of localization economies: a pooled market for workers; availability of specialized inputs and services; and technology spillovers.

Ohlin (1933) made an attempt to define, in a systematic manner, what would be the benefits that accrue to firms located with other spatial clusters of economic activities as agglomeration economies. He explained the agglomeration of economies through economies of scale and scope within firms, development of varied labour market, pools of specialized skills, interaction between local suppliers and customers, lower transportation cost, and shared infrastructure.

Contemporary work on industry clusters is heavily influenced by ideas of agglomeration theorists such as those that have already been mentioned. In general, these ideas focus on external economies of scale, industrial linkages, and the factors that give economic advantages to individual firms located close to other similar or related firms. However a different line of work has emerged after the late 1980s that calls for a more detailed analysis of industry agglomeration in which the economics are more embedded with social and cultural aspects. Pyke (1990) introduced the term “New Industrial Districts” to describe those districts that were characterized by smaller scale production, flexibility, specialization, and more cooperation between contracting firms to make vertically disintegrated production possible. This concept is often referred to as the flexible specialisation school in which the main emphasis is on social and cultural networks with interpersonal relations, on face-to-face encounters, and on casual and informal flow of information on culture. This knowledge sharing built on trust and informal relations is, along with industrial emphasis, good business organisation and strategy, and labour mobility, a key factor affecting business success.

With more emphasis on knowledge-based economies, the relationship between industrial agglomeration and competitiveness is to a greater extent explained by enlisting local knowledge rather than analysing external economies of scale or natural advantage. The network of actors (i.e. firms and institutions) who enjoy geographical proximity and shared cultural, linguistic and social norms and values determines the innovative performance of companies, their growth, and their competitiveness. Innovation is supposed to be best where there are high levels of interaction and face-to-face contacts. According to this idea of innovation, the cost of transmitting knowledge increases with ever increasing distance.

Michael Porter, who has been the most influential person to recently write about industry clusters, offers a broad definition of the cluster concept. He defines them as “geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated organisations (such as universities, standard agencies, trade associations) in a particular field linked by commonalities and complementarities” (Porter, 1998). Among the cluster of companies there is competition as well as cooperation. Successful cluster policy creates jobs and increases income, export growth, and innovation. It opens up new possibilities and access to global markets and global partners and can increase competence through cooperation with partners within the cluster, the official support system and the research community. This leads to better regional competitiveness and enhances productivity (Porter, 1998).

There is considerable debate regarding a number of issues associated with clusters today. One of the questions is whether regional diversity and/or specialization can promote knowledge spillovers. Other questions include: How do clusters work differently when they are working on a regional, national or cross border basis? What composes a cluster: firms or industries, or local or regional factors? Location can influence how clusters function. In some cases the existence of clusters can rely on the idea that a good deal of competitive advantage lies *outside* companies and even outside their industries, residing instead in the locations at which their business units are based. A good example of a strong internationally known regional cluster would be Silicon Valley. According to Malmberg and Maskell (2002), empirical studies have not been able to provide evidence for the proposition that proximity between co-located firms is of vital importance for exchange of information and knowledge. Porter (2000) points out that changes in technology and competition have diminished many of the traditional roles of location. The question arises also about how to define a location. Is a location a city, a region, a country or countries? The idea behind Scandinavian design for example is not built on the ability of one nation: It is built on the idea of people living in a region that is composed of a number of fairly small nations that have shared values and ideas. This region then competes with other regions in the world that have a different approach and bring different elements to the table. Being united under one umbrella makes a particular region stronger and more visible; it also makes it easier for this region to compete with bigger and more powerful regions or nations.

In general it can be stated that at the heart of every successful cluster is the willingness of its participants to demonstrate a certain flexibility and to communicate and share information. Through cooperation it is possible to increase innovation and through innovation comes production effectivity and business. In most cases difficulties are associated with players that have little experience in cooperation and that lack trust. It can take some time to build confidence and an open dialogue at a strategic level and there may be deep-seated animosities between stakeholders (known only to them). Stakeholders may also have different agendas and perspectives, may move at different speeds, and may react differently. Major companies, especially MNEs, may feel threatened and ego clashes between stakeholders can occur. These obstacles may be overcome by informal clusters in which there are strong individual players and in which there is general enthusiasm among cluster members for sharing information. But usually a formal cluster is managed by a project manager who may be a part of a special institution ranging from public non-profit associations to public agencies and companies. These managers, along with strong partners in the cluster, are often the main drivers of the cluster activities.

Bringing different clusters or cluster managers together across borders to form an alliance is not an entirely new idea: It has been done for example in the Medicon Valley Alliance where 270 private and public members from Sweden and Denmark work together. Another example is the Baltic Sea Region Program (BSR), which is a European Union initiative (2007-2013) that promotes regional development through transnational cooperation. A third example of interest is the Northern European competence network for offshore wind energy, a transnational cluster led by BIS in Germany together with 17 other partners from Germany, the United Kingdom, Denmark, The Netherlands, Norway, and Sweden. The cluster partnership is built on a range of expertise from offshore wind energy to oil and gas.

Getting those that have learned to work together and that have enjoyed the benefit of a regional cluster to enlarge the cluster circle and to start working with entities from similar clusters can be an interesting way forward; in a globalized world with increasing competition such a strategy also represents a logical step.

There is a growing consensus that, if done right, the cluster model can provide a foundation for sustainable economic growth and be the pathway to greater prosperity. It should not be difficult to have the emissaries of cooperation come together and share information, ideas and their experience and to give them the opportunity to create a common platform for the various ocean-related clusters and, by doing so, to make the region stronger.

### **Cluster cooperation**

There are a number of examples in which clusters work together on a number of issues. Among these are the European Network of Maritime clusters, the Baltic Sea Region Programme, and the Atlantic Area Programme.

### **The European Network of Maritime Clusters**

Founded in 2005, this network comprises the maritime organizations of Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Poland, Spain, Sweden, and the United Kingdom.

The objective of the network is to strengthen and promote maritime clusters in Europe. It is generally organized on a flexible basis; however, the work is more structured when it comes to matters associated with the European Union. (<http://www.european-network-of-maritime-clusters.eu/>)

### **Baltic Sea Region Programme (BSR)**

The BSR is A European Union initiative (2007–2013) which promotes regional development through transnational cooperation. Eleven countries around the Baltic Sea work together to find joint solutions to common problems.

The strategic objective of the Baltic Sea Region Programme is to make the Baltic Sea region an attractive place to invest, work, and live in.

Innovation environments, clusters, and networks are target groups of BSR. The networks have a looser structure than the clusters and are more connected to small and medium-sized enterprises. BSR has created a platform called Stardust, which has initiated five transnational pilots in the fields of clean technology & future energy, wellbeing & health, future transport, and digital business services. Stardust has received 6.5 million Euros for its projects from EU funds. (<http://www.bsrstars.se/>)

### **Atlantic Area Programme**

The Atlantic Area Program is a transnational cooperation programme in the framework of the "European Territorial Cooperation" objective, which is one of the instruments of the EU cohesion policy for the programming period 2007–2013. It is financed by the European Commission through the European Regional Development Fund (ERDF), with a total budget of 158 million Euro.

The Atlantic Area is defined as the entire territory of Ireland and the Atlantic regions of Spain, France, Portugal, and the United Kingdom. Its overall strategic objective is to achieve significant and tangible progress in transnational cooperation geared towards cohesive, sustainable and balanced territorial development of the Atlantic Area and its maritime heritage.

The programme strategy is implemented through four strategic priorities: transnational networks of entrepreneurship and innovation; protection and enhancement of marine and coastal environment; accessibility and internal links; and urban and regional sustainable development. (<http://atlanticarea.ccdr-n.pt/>)

## Clusters in the North Atlantic region

In this chapter the emphasis is on some general information on the countries in the North Atlantic Ocean cluster and some of the key players in forming cluster policy in each country.

Differences exist between the countries in the North Atlantic region in terms of cluster setup and degree of formality. Strength of industries in different countries also represents an important factor.

### Opportunities in the North

The combination of high-tech solutions, ample land, and access to resources such as oil and water is one major driving force behind the push to increase cooperation between the countries in and around the northern part of the North Atlantic.

According to some scholars, changing climate and increasing population might have a significant impact on the northern countries in the coming years. One such scholar, Dr. Laurence Smith, a professor at the Department of Geography at UCLA, looks at what he calls the four forces of climate change: the anticipated worldwide toll of a growing and ageing population; dwindling natural resources at a time of mounting demand; increasing globalism and economic integration; and climate change. He predicts that global warming will open access to oil, gas, water, and other natural resources in what he calls the NORCs (northern rim countries). These countries are Canada, the state of Alaska, Greenland, Norway, Sweden, Iceland, Finland, and Russia. Changes in the environment will result in the following benefits for NORCS:

- during the summer new shipping lanes will open in the Arctic, allowing Europe to realize its 500-year-old dream of direct trade between the Atlantic and the Far East, and resulting in new opportunities for economic development in the north;
- Canada will have oil resources second only to those in Saudi Arabia. The country's population will increase by more than 30 percent, a growth rate rivaling India's and six times faster than China's;
- the NORCs will be among the few places on Earth where crop production will likely increase due to climate change;
- the NORCs will collectively constitute the fourth largest economy in the world, behind the BRIC countries (Brazil, Russia, India and China), the European Union, and the United States; and
- the NORCs' position will become extremely strong in the world because of their reserves of fresh water, which may be sold and transported to other regions.

Dr. Smith takes into account that the worldwide population will increase by 40 per cent over the next 40 years. He predicts that sparsely populated countries of Canada, Scandinavia, Russia, and the northern United States will become formidable economic powers and attract migration. The populations of Canada, Iceland, and Norway are expected to grow by 30 per cent by 2050. China will grow by just 5 per cent, according to Dr. Smith. While wreaking havoc on the environment, global warming will open access to oil, gas, water and other natural resources previously locked in the frozen North, enriching residents and attracting newcomers.

According to Smith, these resources will become available at a time when natural resources elsewhere are becoming critically depleted, making them all the more valuable.

Smith's book, *The World in 2050: Four Forces Shaping Civilization's Northern Future*, includes a list of northern cities—in Canada, the northern U.S., Scandinavia and elsewhere—that will "increase in size and prominence" as climate changes drive the Northern Rim phenomenon over the next four decades: Toronto, Montreal, Vancouver, Seattle, Calgary, Edmonton, Minneapolis-St. Paul, Ottawa, Reykjavik, Copenhagen, Oslo, Stockholm, Helsinki, St. Petersburg, and Moscow (Sullivan, 2010).

Norway, for instance, has a number of organized clusters directly connected to certain industries, such as Maritime, Culinary, Tourism, and Micro- and Nanotechnology, that are a part of the NCE and Arena programmes. In addition to these clusters, there are regional clusters that are different in size and shape. In Iceland and Canada, for example, there are one or two big multi-sector clusters along with a number of regional initiatives. In Denmark regions play a more prominent role in the formation of clusters, but there is also a national network that organises 22 innovation networks or clusters. The most active clusters in the marine sector are associated with shipping and energy; in some cases there is strong EU support. In a number of reports, clusters are often defined as groups of companies in certain regions and industries without special cluster management. Sweden and Finland have similar programs in which there is a strong emphasis on a regional approach. In the Faroe Islands and in Greenland no formal clusters exist, but there are groups of companies or networks in certain sectors that could form clusters.

## Norway

For a long time Norway has been heavily dependent on the sea. The nation has access to an ocean rich in natural resources, including oil, gas, and fish, and its fjords and sheltered waters create good conditions for aquaculture. With a long coastline and an economy that has very much been built on the export of commodities, Norway has also built up a strong shipping sector.

With its deep fjords, the coastline of mainland Norway stretches more than 25,000 km. The country's economic zone covers an area of 969,000 square kilometres. With the fishery protection zone around Spitzbergen and the fishery zone around Jan Mayen, this area may be doubled in size.

Norwegian economy and business life has changed very much since the beginning of the 20th century when the development of the hydroelectric energy sector triggered industrial growth, especially within the aluminium and ferroalloy industry and in fertilizer production. The country emerged as a major oil and gas producer in the mid-1970s, an expansion which was to transform the economy.

In recent years traditional industries—and in particular the energy demanding industries such as metal refineries—have been on the decline, while the number of companies in shipping, oil, and IT has grown. Norway, in addition to being a leading shipping nation, is one of the largest producers of crude oil and natural gas in the world today. The country is also among the ten largest fishing nations and producers of fish from aquaculture.

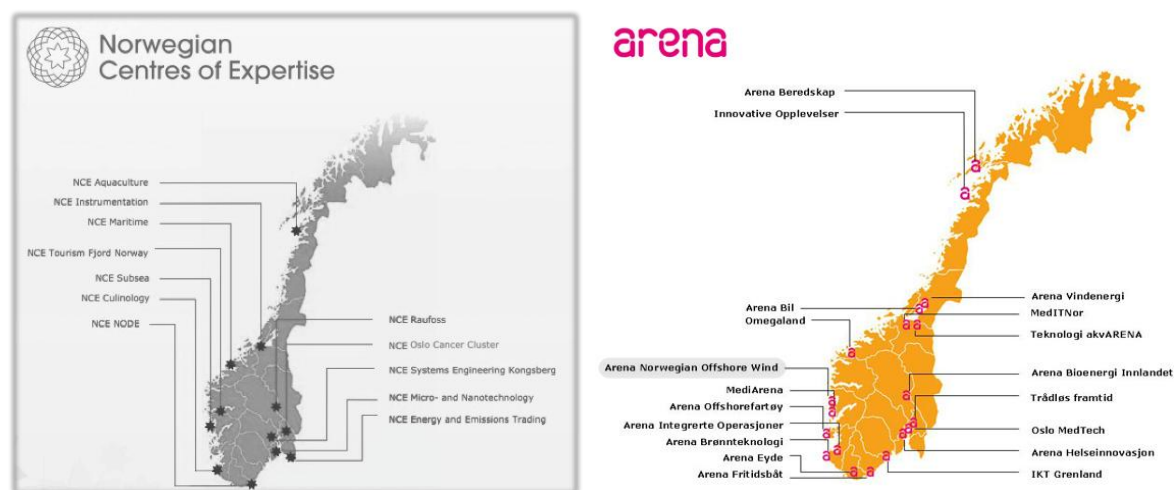


Figure 2. Innovation Norway is behind the two main cluster initiatives in Norway, The Arena Programme and the NCE clusters.

### **Cluster policy**

Innovation Norway is one of the key players in implementing Norwegian cluster policy. Wide range of tasks are performed under its aegis associated with among other things business development, entrepreneurship, regional development, tourism and internationalization. Innovation Norway is a state agency that employs more than 700 people, and has offices in all of Norway's counties and in more than 30 countries world-wide. The head office is situated in Oslo.

Innovation milieus approach is one of the organisation's main priorities. Schemes promoting network-based innovation processes in clusters, business networks and other forms of partnership between businesses, and R&D and public sector institutions all play an important role.

Innovation Norway launched the first Norwegian cluster programme, Arena, in 2002. In 2006 a second programme, The Norwegian Centres of Expertise (NCE), was implemented. Both Arena and NCE are national programmes supporting regional clusters. The NCE Programme targets the most active and growth-oriented clusters ("world-class clusters"). The Arena Programme promotes development of clusters in an earlier stage ("emerging clusters"). The cluster programmes have been well received and act as quality stamps for the clusters that have been accepted into the programmes. The external evaluations for both programmes are good.

The programmes are based on annual calls for proposals and an open competition between cluster initiatives. In 2012, Arena was involved in 23 cluster initiatives, while NCE was involved in 12. The cluster programmes are owned jointly by three national innovation agencies: the Industrial Development Corporation of Norway (SIVA), the Research Council of Norway, and Innovation Norway, with the latter acting as the main operator. The programmes are operated by management team staffed with five persons from Innovation Norway, one from The Research Council of Norway and one from SIVA.

The NCE clusters are seen as motors for industry development. According to the NCE cluster programme they must speed up creation in regional business environments through cooperation between companies, researchers, colleagues, and public authorities. In addition, they must be internationally oriented.

The NCE programme has a long-term perspective. Clusters participating in the programme are offered professional and financial support for development processes for up to ten years, but most of the clusters go through three contract periods of 3+3+3 years. After three and six years the NCE clusters are evaluated as part of the process of contract renewal. These evaluations answer three main questions: Has the cluster project been a relevant instrument to meet challenges and opportunities? Has the cluster project achieved its goals? Has the cluster project been an efficient instrument?

The Arena programme offers specialist and financial support to the long-term development of regional cluster initiatives, normally in an early stage of their development. These communities may be business clusters, or they may represent less modern relations between businesses and related knowledge and development bodies.

The object of the development processes is to strengthen the communities' ability to innovate by establishing a stronger and more dynamic form of interaction between businesses, R&D and educational bodies, and the public sector. The basis for such processes must be a clear potential for increased value creation. The process of collaboration is to be long-term and goal-oriented, even as it should be widely focused on boosting cooperation on innovation, the international perspective, access to expertise, new ventures, and so forth.

The Arena programme normally supports main projects over a 3 year period. Clusters with a good progress and performance and with a potential for further development may be supported for 2 more years. Funding for the Arena cluster's amounted to 37 million NOK in 2011. This means that each project gets around 1,5- 2 million NOK annually. This public funding must be matched with an equal sum by the cluster partners.

According to the organizers of the Arena and NCE programmes, there are a number of key elements that are of importance such as the triple Helix relationship which they emphasise.

Funding and facilitating is also important, with facilitating being perceived to be a key success factor. The facilitators are cluster managers who are getting support from others. An involvement of key companies who support the cluster and assist the facilitator is important as well. Crash courses for cluster managers are organised as a part of the training programme, along with seminars and study tours. Great emphasis is also placed on steering groups, for which cluster governance seminars are held.

Sometimes loosely connected networks develop into clusters. The Omegaland cluster, which revolves around the omega industry, started out with an initiative from a regional university and had a strong background in R&D activities. NCE Aquaculture started with an initiative taken from Innovation Norway inviting a small group of business leaders in the Nordland region to discuss the idea of a more systematic collaboration. Now the network is not only in the region but there are strong links with companies along the coast.

Cluster development can vary from one cluster to the next. In a sense each cluster has its own special approach, however creating stronger relationships within the cluster is important. Education providers in the region, as well as those associated with R&D, are also called in to be a part of the cluster. One easy way to initiate collaboration is to motivate people to talk with one another. Business leaders often have loose relationships with one another; consequently, the trust-building process between these parties can often pose a number of challenges.

## Canada

Canada has followed the pattern of many other developed nations in its transformation in recent decades from an agricultural economy to an industry-based and service-based economy. Retail, business, education, and high technology have evolved and are now among the most highly valued industries. Manufacturing and other industries related to natural resources are still crucial to the Canadian economy however. A list of key Canadian industries includes transportation equipment, chemicals, processed and unprocessed minerals, food products, wood and paper products, fish products, petroleum, and natural gas.

Boasting the longest coastline in the world, approximately 250,000 km long, Canada is very much an ocean nation. Eight of its ten provinces and three of its territories all border on salt water. Canada's Exclusive Economic Zone encompasses some 3 million square kilometres<sup>1</sup>.

A part of the service industries in Canada is linked to marine activities in sectors as diverse as offshore energy, fisheries, marine transportation, and ocean sciences.

In 2009, the overall ocean economy was estimated to be worth more than \$1.5 trillion CAD. Approximately one-third of Canada's Gross National Product (GNP) is generated by activities that in

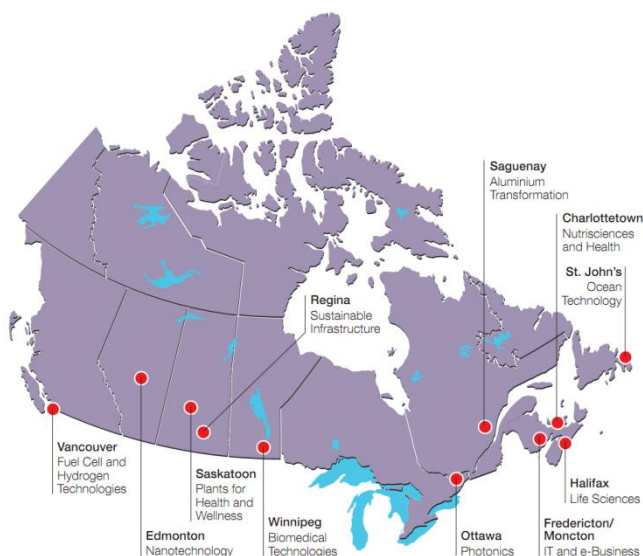


Figure 3. NRC clusters in Canada

<sup>1</sup> Assuming the full extent allowed should Canada ratify the United Nations Convention on the Law of the Sea (UNCLOS).



one way or another use the coastline either directly or as a transportation route. Up to 350,000 part-time and full-time jobs are related to these industries, especially in coastal communities. Furthermore, approximately 7 million Canadians live in coastal communities, many of which were established to access marine resources or to be used as marine transportation centres.

### **Canadian cluster approach**

Acquiring a general overview of how clusters are organised in Canada is reasonably difficult. There are a number of anchor organizations that are different from region to region. They vary between private firms, a publicly regulated utility, a joint venture formed by public utilities, and public research institutions. All of these actors play a similar role in focusing resources on exploiting the commercial potential of new knowledge and technology. In most cases the antecedent conditions for cluster formation are laid down by the presence of a strong research base.

A leading cluster organization, the National Research Council (NRC) is the Government of Canada's premier organization for research and development. A key aspect of the organisation's strategy is to bring together government, academia, and the private sector to improve innovation, skills, and learning. Since 2001, NRC cluster initiatives have enjoyed strong support from the Government of Canada with total funding contribution reaching over \$550 million. Though NRC has established a substantial presence in 11 technology clusters across the country, encouraging collaboration across regions and internationally is still seen as the institutions mandate. As part of NRC's clustering initiatives in these communities, the organization's research institutes act as hubs, offering cluster players federally funded labs and equipment, incubation space and business development mentoring. The cluster initiatives are for the most part run by the NRC; however, the provincial governments are in most cases active supporters through provincial strategies and investments.

### **OceansAdvance Inc.**

There are a number of clusters in Canada whose focus is, to some extent, on marine-related opportunities. One of the biggest clusters associated with ocean activities in Canada is OceansAdvance. Based in St. Johns, the cluster focuses on activities in Newfoundland and Labrador where approximately 25 percent of GDP is connected to ocean-related economic activities. With funding cost-shared among ACOA (the Atlantic Canada Opportunities Agency), the provincial government's former Department of Innovation, Trade and Rural Development and NRC-IRAP, and with project support from Industry Canada, OceansAdvance was established as an industry-led ocean technology cluster organization in 2005.

OceansAdvance is a cross-sector cluster in which the emphasis is on service and technology. The cluster members, who are composed of private companies, institutions, and R&D entities, are active in aquaculture, defence and security, education and training, fisheries, marine transportation, ocean observation, and offshore energy.

The mission of the OceansAdvance cluster is to foster and promote the growth and development of the ocean technology cluster in the province by aligning industry, academia, research, and government. There are around 50 companies in the ocean technology industry in the province. Since 2006, sales revenues of these companies have increased by 126 percent or 31 percent annually. Sales during this period have gone from CAD 225 million to CAD 509 million, and exports have increased by 300 percent. OceansAdvance has established a target of achieving \$1 billion in annual revenues by 2015. One of key elements in achieving this goal is the support of educational institutions, research institutes, and numerous R&D labs that provide specialized education, training, and research.

Further information about the OceansAdvance Inc. Can be found at the clusters website: <http://www.oceansadvance.net>

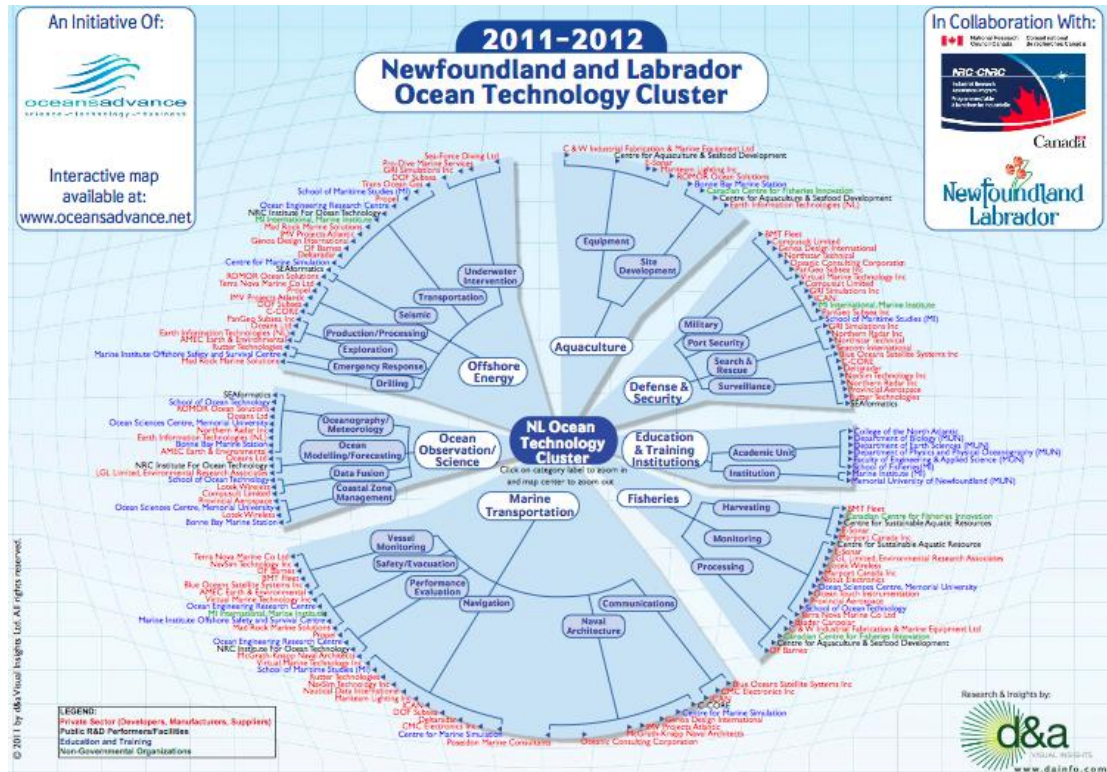


Figure 4. OceansAdvance is governed by a Board of Directors whose members come largely from the private sector.

Other cluster initiatives

Other clusters in Canada that build on marine-related activities are life science technology clusters in Halifax and on Prince Edward Island where the focus is on marine biosciences. A cluster with 29 contributing members and made up of stakeholders from the institutional, research, business and governmental sectors is the Marine Resource, Science and Technology cluster called **Technopole Maritime du Québec**. It is situated in Rimouski, the regional capital of the Lower St Lawrence.

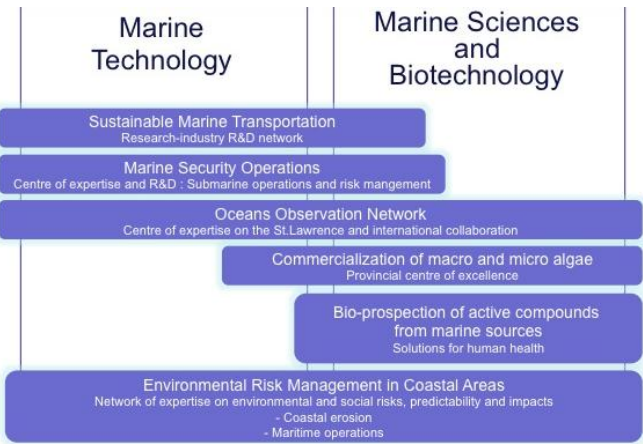


Figure 5. Main focus areas of Technopole Maritime du Québec

The main objective of Technopole Maritime du Québec (TMQ) is to position itself as a leader in Quebec and Canada in the marine biotechnology and maritime technology sectors, in order to create wealth through growth and new investments by businesses, institutions, and organizations.

Incorporated in 1995 to assist in the pursuit of aerospace and defence industry growth and development opportunities, **the Aerospace and Defence Industries Association of Nova Scotia (ADIANS)** also merits mentioning here. ADIANS acts as a facilitator that links companies to one another, to government, to agencies, and to the larger aerospace companies seeking suppliers, partners, and collaborators. ADIANS supports a growing and diversified aerospace and defence industry base, employing approximately 6,000 skilled and experienced workers, generating

approximately \$600 Million in revenues, and operating in both the defence and commercial aerospace markets.

ADIANS is also focused on emerging sectors such as marine security and ocean and space technologies and works to create a cluster of advanced technology companies that align with Nova Scotia’s interest in driving a stronger innovation culture. ADIANS also acts as an advocate for the industry with the Federal and provincial governments.

Further information about **the Aerospace and Defence Industries Association of Nova Scotia (ADIANS)** can be found at the clusters website: <http://www.adians.ca>

In addition to these clusters, there is a cluster of OCEAN industries in British Columbia, but because the focus here is on activities associated with the Pacific Ocean, the cluster does not fall under the scope of this report.

## Denmark

With a population of 5.5 million and a surface area of 43,000 square kilometres, Denmark is mostly surrounded by water and has a coastline of more than 7,000 kilometres. Denmark’s status and image as a naval nation has made significant contributions through the years to the country’s advanced industrial economy within marine and offshore industry. Danish offshore and energy industry is strong and growing, even as Danish equipment, products, and know-how enjoy respect in international markets. Although the country is not a major fishing nation, fisheries are important for certain regions and the country is a major player (no 6 in the world) when it comes to producing high value products and exporting fishery products.

Around 115,000 individuals are directly or indirectly employed in the Danish marine cluster. This figure accounts for approximately six per cent of the private workforce in the country. Shipping is the biggest sector with approximately 69,000 employees. Denmark counts itself among the world’s largest shipping nations; not surprisingly, the industry is one of the country’s largest export revenue creators. Denmark is also among world leaders in clean-tech development, with 3.1 percent of its GDP coming from renewable energy technology and energy efficiency.

<b>Industry</b>	<b>Direct</b>	<b>Indirect</b>	<b>Total</b>
Shipping	50000	19000	69000
Shipbuilding	1000	2000	3000
Equipment manufacture.	23000	10000	33000
Offshore exploitation	2000	2500	4500
Fishing	4000	1500	5500
<b>Total</b>	<b>80000</b>	<b>35000</b>	<b>115000</b>
<b>Share of total Danish employment.</b>	2,9	1,3	4,2

(Source: Clasen & Clausen, 2011)

### Danish cluster programmes

Denmark was among the first countries to implement cluster policies in a systematic way and there is strong tradition in Denmark for using the cluster method. The cluster concept was first introduced by the Danish government in the early 1990s when some broadly defined mega-clusters were identified. Though these clusters had positive effects, the general perception at the time was that the definition of clusters was too broad and that it therefore had negative effects in terms of focus and a reduced effectivity of cluster policy. From 1999–2002, the Ministry of Industry and Trade introduced a narrower concept of cluster activities. By using mapping and analysis, 29 clusters of competence were identified. It was felt that the selection process was favouring some industries above others and that this approach could increase the risk of overlooking future growth opportunities in new and developing industries. The emphasis then shifted after 2001 to implementing general framework conditions and strengthening cooperation between businesses and knowledge institutions on local and regional levels by introducing, for example, regional growth centres. To a certain degree a heavier emphasis was also placed on analysis and on studies on clusters and cluster activities with governmental support. After 2007 there were major changes when the number of counties and municipalities was reduced to reform governance structure and improve public service. From 1970 to

2007, Denmark was divided into 14 counties and 275 municipalities; in 2007 this was changed to 5 large regions and 98 municipalities. The regions are responsible for regional development and growth. When it comes to cluster activity they have supported certain initiatives, but the most active institutions have been nationally-oriented professional and educational organizations. There is a certain regionally-based specialization, such as the fishing industry, which is important for the Nordjylland area, however shipping is more concentrated in Copenhagen, which is one of the busiest ports in Scandinavia.

In the beginning of 2010, the Danish Ministry of Science, Technology and Innovation established Netmatch as a unifying platform and support function for the innovation networks/clusters in Denmark.

One of the leading cluster organisations is Innovation Network, a forum where companies and knowledge institutions share experience and develop new ideas within a specialist or technologically delimited field.

There are 22 nationwide innovation networks and two strategic platforms working within the programme. Following is a list of sectors that the network has been focusing on:

- Information and Communication Technology
- Experience Economy and Tourism
- Production, New Materials and Design
- Health/Medico
- Energy
- Offshore Center Danmark
- Food, Primary Sector
- Food Network - Fødevarersektorens Innovationsnetværk
- Environment
- Construction
- Transport
- Service



Figure 6. The five Danish regions

Each network has pools for innovation projects where companies and researchers work together to solve concrete challenges. The innovation networks also carry out idea generation processes and matchmaking activities, and they hold theme meetings and specialist events. The Ministry of Science, Technology and Innovation finances up to half of the innovation network activities.

Another noteworthy initiative is "REG X". Its work supports the development of the Danish clusters through three specific efforts: competence building, knowledge sharing, and networking.

REG X's aim is to be one of the world's leading centres for cluster development. This goal will be achieved by collaborating with leading Danish and foreign experts and knowledge institutions and by being in close contact with the Danish cluster actors.

REG X currently has 6 employees, 3 student assistants, and a PhD student. To ensure that the right competencies are enlisted in the realisation of REG X goals, the initiative also draws on a global network of partners.

REG X is located at University of Southern Denmark in Kolding. Funding is provided by the Danish Enterprise and Construction Authority, the Region of Southern Denmark, the Bitten and Mads Clausen Foundation (Danfoss), and the European Social Fund.

## ***Finland***

Even though Finland is probably best known for being the country of a thousand lakes, the Finnish nation has strong links with the sea and approximately 70 percent of the population lives in close proximity to the ocean. The country's coastline spans approximately 1,250 kilometres facing the Gulf of Finland (south), the Baltic Sea (southwest), and the Gulf of Bothnia (west). The rugged coastline is deeply indented with bays and inlets. The offshore region is studded with islands.

Virtually all of Finland is north of 60 degrees north latitude, making it the northernmost country on the European continent. Increased activity in the arctic region is therefore of great interest for Finnish companies offering expertise in many sectors, such as offshore industries and shipbuilding, building of infrastructure, machinery and equipment, logistics, knowledge of Arctic conditions, and environmental know-how.

The relative weight of the marine sector in Finland is not very substantial compared to the economy as a whole. According to a report published in 2006 about employment trends in all sectors relating to the sea or using sea resources, the maritime sector contributed to the creation of nearly 122,000 jobs (Wihlborg, 2006). Coastal tourism was the largest sector with 73,000 jobs. Of the more traditional marine industries, marine equipment and shipping and shipbuilding were by far the biggest sectors with around 35,000 employees. Finland has numerous companies on a world scale, both in ship engines and cargo handling equipment. The country also has leading companies in special fields of marine technology and ranks among top countries as a builder of cruise and passenger ships and in terms of the export shares of these ships compared to other countries.

### **Finnish cluster approach**

A number of initiatives have been introduced to enhance the competitiveness of Finnish firms. The Centre of Expertise Programme (OSKE), in laying the ground for diverse innovation activities in which high-level research is combined with technological, design and business competence, is the most influential institution apropos of cluster programmes..

The Programme offers networks and services for companies, universities, universities of applied sciences, and research institutions. The Centre has acted as the key instrument of growth-oriented regional development in Finland, development which is based on competition between regions and which enhances the level of specialisation and attractiveness of each region. Launched in 2007, the Expertise Programme has undergone a renewal: 13 competence clusters have been established that currently comprise 21 centres of expertise and six affiliate members across the country. The objective of these clusters is to strengthen regional partnerships in innovation activity, while at the same time creating more effective development entities at both national and international level. The Programme is a fixed-term special programme coordinated by the Ministry of Employment and the Economy, in compliance with the Act on Regional Development. It targets local, regional and national resources for utilisation by top-level expertise. The programme supports regional strengths, the specialisation of regions, and cooperation between Centres of Expertise.

The Centre of Expertise Programme reinforces innovation hubs that can be desirable partners for international networks. Through the programme, companies can receive competitive advantages through the meetings between different regions and sectors.

At the core of the programme are project planning, company activation, strengthening partnerships, and boosting competence. The collaboration leads to new companies, new business, growth companies, new business models, and new services. It allows for opportunities in the new global economy to be identified and seized more quickly.

The Centre of Expertise Programme is implemented by the following 13 national competence clusters:

Cleantech  
Digibusiness  
Energy Technology  
Food Development  
Forest Industry Future  
HealthBio  
Health and Well-being  
Intelligent Machines  
Living Business  
Maritime  
Nanotechnology  
Tourism and Experience Management  
Ubiquitous Computing

Each cluster comprises of four to seven regional centres of expertise. A competence cluster forms a network and cooperation forum for its centres of expertise, which is managed with a view to fulfilling shared objectives. Each cluster is appointed a programme director to coordinate the cluster's national and international operations.

## ***Sweden***

Sweden's geographical location and its major dependence on foreign trade give shipping a dominant role in the transport of the country's international trade. It is estimated that around 90 percent of all exports and imports are conveyed via cargo vessels or ferries.

According to figures from the Swedish Shipowner's Association and the Swedish Maritime Administration, approximately 14,000 people are employed in the core of the maritime cluster (shipping) and a further 70,000 are employed in other maritime sectors. In addition to these, Swedish maritime activities also contribute to the employment of 133,500 people through supply chain linkages. In all, it is estimated that 220,000 individuals are employed, either directly or indirectly in the maritime activities. In addition, there are 5,000 employers in the fishery sector.

Centred on its southwest coast, Sweden has a relatively small but modern fishing industry. Most of the fishing is concentrated in the waters of the Baltic, the Skagerrak, and the Kattegat. The catch is made up largely of cod, herring, and mackerel.

The largest ports of the country are in Göteborg (the largest), Stockholm, and Helsingborg. Approximately 160,000 of the 220,000 employed in shipping are located in the areas around these ports.

### **Swedish cluster activity**

A global survey of cluster initiatives in 2006 identified 102 Swedish cluster initiatives (Ketels, 2009), while the European Cluster Observatory ([www.clusterobservatory.eu](http://www.clusterobservatory.eu)) listed 64 Swedish cluster initiatives in 2008. The vast majority of these efforts have some form of government involvement and often the public sector has been a key driver in their creation. The regions and professional organisations are also often involved in the cluster initiatives and financial support from EU is quite common.

The 2004 national strategy for innovation (Regeringskansliet, 2004) introduced the cluster terminology in the context of a major economic policy strategy. Among other things, the strategy led to six sector-specific industrial strategies for the leading sectors of the Swedish economy, developed in public-private dialogue. These include individual government agencies such as NUTEK (The Swedish Development Agency), VINNOVA (The Swedish Governmental Agency for Innovation Systems), Knowledge Foundation (KK-Stiftelsen), and ISA (Invest in Sweden Agency).

The flagship project for the Swedish cluster policy is Vinnväxt, a programme run by VINNOVA since 2001. In 2003, the first three regional clusters were selected in a competitive process for a ten-year programme with up to 10 MSEK funding available per year, together with parallel process support. In 2004, five more clusters were selected and another four emerging clusters were accepted to the programme in 2008.

Another important institution in terms of cluster policies in Sweden is the Regional cluster programme organised by Tillväxtverket. The programme's goal is to strengthen regional systems of innovation through support of cluster initiatives. Success is measured by the capacity of activities to increase national and economic growth and to strengthen ability to compete in international markets. The programme targets business-driven clusters where companies lead but acquire support from educational institutions and public bodies. Traditionally the support has been more in instances where the clusters are mature, but recently there has been a change in the direction of supporting early-stage clusters. There is also an increased emphasis on linking different industries and similar mature clusters.

### ***Ireland***

With its unique location, Ireland enjoys an ocean territory ten times the country's landmass. Around 80 percent of the population lives in coastal communities along the Irish coastline of 7,500 km, longer than that of most European countries. However little attention has been given to opportunities associated with resources in the sea in Ireland. Currently ocean-related activities contribute to approximately 1.2 percent of the country's GDP. The Irish government would like to change this and in 2011 it took the first steps by collecting views about how to approach ocean matters in new ways and by introducing a forward-thinking programme called "Our Ocean Wealth—Towards an Integrated Marine Plan for Ireland".

The ocean economy is primarily a service economy dominated by shipping and transport firms. Fishery and aquaculture sectors in the country have however been on a small scale. There is a growing interest in Ireland in the use of ocean resources that emphasizes knowledge-intensive industries and research.

Table 3. Direct Turnover, Direct and Indirect Gross Value Added and Employment by Category from 2003–2007						
	Turnover (€ millions)		Direct Employment		Direct GVA	
	2003	2007	2003	2007	2003	2007
<b>Established Markets</b>						
<b>Shipping &amp; Maritime Transport</b>	584	889	2,005	2,194	102	328
<b>Water-based Tourism &amp; Leisure</b>	566	944	5,271	5,836	306	453
<b>Cruise Liners</b>	35	45	0	0	23	30
<b>Other Marine Services</b>	121	140	779	569	51	62
<b>Sea-Fisheries</b>	210	251	2,142	2,200	118	100
<b>Aquaculture</b>	102	106	1,394	1,061	42	42
<b>Seafood Processing</b>	366	396	2,802	2,090	94	88
<b>Oil &amp; Gas</b>	137	197	439	790	78	137
<b>Marine Manufacturing**</b>	116	265	907	1,600	45	110
<b>Established Market Sub-Total</b>	<b>2,237</b>	<b>3,233</b>	<b>15,739</b>	<b>16,340</b>	<b>859</b>	<b>1,350</b>
<b>Emerging Markets</b>						
<b>High Tech Marine Products &amp; Services*</b>	N/A	44	N/A	350	N/A	27
<b>Marine Commerce</b>	N/A	100	N/A	65	N/A	47
<b>Marine Biotechnology &amp; Bioproducts</b>	9	18	175	185	6	8
<b>Marine Renewable Energy</b>	0	6	10	101	0	4
<b>Emerging Markets Sub-Total</b>	<b>9</b>	<b>168</b>	<b>185</b>	<b>701</b>	<b>6</b>	<b>86</b>
<b>Total</b>	<b>2,246</b>	<b>3,401</b>	<b>15,924</b>	<b>17,041</b>	<b>865</b>	<b>1,436</b>

(Source: Morissey, Hynes, Cuddy & O'Donoghue, 2010)

In 2007 the Irish Marine sector employed approximately 17,000 individuals. Ireland's total Gross Domestic Product (GDP) in 2007 was €189.7 billion (Morissey, Hynes, Cuddy and O'Donoghue, 2010). The sector is categorized into three distinct groups of activities: Marine Services, which accounts for nearly two thirds of the total annual turnover; Marine Resources (e.g. fishing, aquaculture), which accounts for more than a quarter of the total annual turnover; and Marine Manufacturing companies, which generate €166 million in combined annual turnover.

In addition to the three commercial marine sectors, there is a fourth category of activity that focuses on marine research, education and training. But Ireland has a long tradition of marine science and innovation. The Irish Government has in recent years funded the largest civilian seabed mapping project in the world in which physical, chemical and biological features have been mapped to build up expertise and knowledge that enable companies and researchers to develop a range of new products and services.

Ireland's enterprise development policies have resulted in a switch from a reliance on primarily food-based and traditional manufacturing industries to a focus on high-tech and internationally traded service sectors. In 2008, Ireland was the European base for corporations such as Intel, Microsoft, HP, Apple, Pfizer, Google, and Amazon. Almost 1,000 overseas companies have invested in Ireland and are involved in a wide range of activities in sectors as diverse as engineering, information communications technologies, pharmaceuticals, medical technologies, and financial and international services (Knowledge and enterprise clusters in Ireland, 2008).



Indigenous enterprises are making their mark in high-tech areas such as software and medical devices and in internationally traded services. Through a National Development Plan 2007–2013, the Irish Government is investing heavily in developing Ireland’s capabilities in the areas of ICT, biotechnology, nanotechnology, and sustainable energies (Knowledge and enterprise clusters in Ireland, 2008).

#### **Cluster policy**

According to CSC (Center for Strategy and Competitiveness) in Europe, there are ten so-called “star clusters” in Ireland. The rating is based on cluster size, specialization, ability to attract interest from other regions, and focus, which indicates the proportion of a regions’ overall employment. The largest clusters in Ireland are associated with tourism and business services; together they have around 60,000 employees. Other smaller clusters include the processed food and transportation and logistics clusters, each with 40,000 employees.

In general the formulation of enterprise development policies relevant to networks and clusters in Ireland is the responsibility of the Department of Enterprise, Trade and Employment. The Department can draw upon the advice of Forfás, the national policy and advisory board for enterprise, trade, science, technology and innovation, in the design of new enterprise development policies (Knowledge and enterprise clusters in Ireland, 2008).

There are a number of agencies under the aegis of the Department which are responsible for policy implementation. These include IDA Ireland (the Industrial Development Agency for inward investment), Enterprise Ireland, Science Foundation Ireland, FÁS, Shannon Development, and the network of County and City Enterprise Boards. In addition, two other bodies should be mentioned, Skillnets and InterTradeIreland (Knowledge and enterprise clusters in Ireland, 2008).

The concepts of clusters and networks have been used by Irish policy makers for several years. In 1992 a report was published by the Industrial Policy Review Group recommending the promotion of industrial clusters with a focus on niches of national competitive advantage. A number of enterprise development support programmes also highlighted the advantages of clusters as being desirable or necessary to improve productivity (Knowledge and enterprise clusters in Ireland, 2008).

There are a number of government-funded initiatives that seek to promote the establishment of clusters, having both a policy push and bottom-up approach to cluster formation. Additionally, a number of clusters have been formed as a result of Ireland’s foreign direct investment policies. The country has benefited both from its focus on a number of high growth sectors such as IT and bio/pharma and its exploitation of “first-mover advantages”, by which the enticement to the country of the sub-suppliers of a major company in a target sector is made easier by first attracting the major company (Knowledge and enterprise clusters in Ireland, 2008).

The closer integration of the two economies on the island into a rapidly evolving All-Island economy has been reinforced by the development of an increasing number of mutually beneficial Collaborative Business Networks in areas such as software, digital media, and healthcare (Biomed Ireland). This development is being carried out both on an All-Island basis and regionally through initiatives such as the North West Science & Technology Partnership (NWSTP) — all of which have received facilitation and project funding from InterTradeIreland, an organisation encouraging economical cooperation between Ireland and Northern Ireland (Knowledge and enterprise clusters in Ireland, 2008).

#### **SmartOcean Innovation Exchange**

Launched in 2010, the **SmartOcean** cluster is built on existing partnerships established between specialist research institutes and innovative SMEs and MNCs involved in the **SmartBay**, **SmartCoast** and **Smart Catchment** Projects (funded by the Marine Institute and EPA). As part of the implementation of the Sea Change Marine Technology Programme, the Marine Institute has led a loosely coordinated clustering initiative, bringing together partners whose skills, expertise, products, and services are not traditionally associated with the seas and oceans with good results.

The aim the Smart Ocean Initiative is to harness Ireland’s natural marine resources and specialist expertise in Marine Science and ICT to establish Ireland as a leader in the development of high value

products and services for the global marine sector. This includes the delivery of next generation technology products and services for marine sectors including aquaculture, environmental monitoring, shipping and security, and marine renewable energy. Its goal is also to excite the investment community and the public about the potential of new technologies and opportunities now opening in the emerging and established marine sectors.

The vision of the SmartOcean initiative is to make Ireland, by 2020, "a recognized leader in the development, testing, commercialization and delivery to market of the next generation of innovative technologies addressing evolving global markets in marine renewable energy, environmental monitoring and water technologies." (SmartOcean Ireland, n.d.)

There are around 50 indigenous and multinational companies based in Ireland and engaged in the development and provision of High Tech Marine products and services to the Global Marine Sector. These include the provision of remote sensing systems, data management and visualisation tools, modelling, simulation, forecasting and engineering design that supporting operational management. (SmartOcean Ireland, n.d.)

In the context of these companies and the vast array of ocean-related opportunities SmartOcean was established. The programme is a part of the Advanced Technology programme organized by the Marine Institute, an agency responsible for Marine Research, Technology Development and Innovation (RTDI). The Institute provides research funding and scientific, technical and advisory services that support the fisheries, aquaculture and seafood sectors.

For further information on SmartOcean Innovation Exchange, visit: <http://smartocean.org>

## ***Iceland***

At around 103,000 km<sup>2</sup> in size, with a 5000 km long coastline, Iceland is the 18th largest island in the world. The livelihood of the nation living on this island positioned almost midway between Europe and America is very much influenced by the sea. Iceland's ocean economic zone spans 750, 000 km<sup>2</sup> and encompasses a wealth of natural resources; the three main resources are fisheries, renewable energy and water. The ocean currents from the south affect the climate, making it temperate relative to how far to the north the country is located. The ocean is the most important transportation route for the country. The Icelandic continental shelf is being explored for oil and gas but research is in an early phase.

The fisheries sector has been seen as one of the cornerstones of the Icelandic economy, and yet, with 1.5 percent of the global marine harvest, the island economy is one of the most seafood dependent economies in the world. The share of seafood in the export of goods from Iceland is around 42 percent and the per capita catch is nearly four thousand kilo of fish per person each year. A strong technology industry has been built up around the fishing industry, creating jobs and export revenues. Shipping of fishery products and food is also emerging as a strong independent industry. According to national accounts, the direct contribution from fisheries and fish processing to the GDP has been around 7–10 percent over the past few years and presently five percent of the workforce or 8,600 people are directly employed in fisheries and fish processing (Statistics Iceland, 2011). According to research done by the Iceland Ocean Cluster, the contribution of fishery and fish processing and of connected industries is closer to 26 percent of GDP and the number of employees is closer to 15–20 percent of the workforce or 25,000–35,000 jobs.

### **Iceland's cluster approach**

In Iceland the idea of clusters has been used in relation to industrial development. Icelandic governance and professional development associations in the countryside have worked with cluster ideology to strengthen the position of the countryside and reinforce development by enhancing cooperation among the government, municipalities, and research and university societies. Among these projects is the Ocean Cluster in the Westfjords, which aims to increase cooperation among companies in fisheries in the region. The Federation of Iceland Industries, in cooperation with other parties, has worked on this ideology in relation to fisheries, health technology, and biotechnology.

Another cluster, the Icelandic Geothermal Cluster, has been strategically working on the mapping and development of cluster cooperation for the past few years. The development of most of these clusters is still not far along and remains quite informal. According to research conducted by Michael Porter in 2006 on the competitiveness of Iceland, there are two clusters which could be considered as mature: the geothermal cluster and the marine products cluster (Porter, 2006).

**The Iceland Ocean cluster**

The Iceland Ocean Cluster is a cooperative project among over 50 Icelandic companies in ocean-related business. The project began with a mapping of all the activities related to the ocean around Iceland from traditional fishing and fish processing, R&D and biotechnology to high-tech production, transportation, financing, and repair and maintenance services. Its mission is also the mapping of foreign operations related to the Iceland Ocean Cluster. Foreign operations here mean complex operations of the ocean cluster abroad, that is seafood-factories, marketing companies, specialized transport companies and fishing companies, to mention a few.

An attempt was made to compile information on all the major sectors within the marine cluster, to assess their scope, to explore opportunities and challenges, and to see what is being done in many other places to assess whether or not there are still opportunities to develop and promote activities related to the ocean. Mapping such as this can be of great value for the whole ocean cluster and can lead to systematic development. One of the main benefits of mapping the ocean cluster is that it shows relationships among different activities, thereby revealing possibilities and opportunities for further cooperation.



**Figure 7.** The Iceland Ocean Cluster consists of 11 smaller clusters.

Sigfusson and Arnason (2012) assessed the direct and indirect contribution of the Iceland Ocean Cluster to Iceland’s GDP, the Cluster’s induced impact, and the independent export operations that have grown in the Cluster (see Table 4).

The total contribution to the GDP is approximately 26 percent. It should be noted that this assessment is subject to considerable uncertainty, with the greatest uncertainty involving the induced impact and the added value that other export operations of the Cluster create. For further comparison, mention may be made of the fact that investigations into the economic impact of ocean clusters in countries such as Ireland, the UK, Canada, and New Zealand indicate that the economic impact of ocean clusters in these countries is between 1.5–5 percent (Morrissey et al., 2011).

**Table 4. Direct and indirect contribution of the Iceland Ocean Cluster to Iceland's GDP**

<b>Fisheries industry:</b>	<b>% of GDP</b>
Direct contribution	10.20%
Indirect contribution	7.30%
Induced impact	7.00%
Other export operations of the Cluster:	1.50%
<b>Total</b>	<b>26.00%</b>

As Sigfusson and Arnason (2012) suggest, the cluster

“viewed as a whole, is therefore economically more dynamic, more efficient and more flexible than the simple sum of the companies that form it. One reason for this is the development of human resources and technology within the Cluster which all the companies have access to through market trading, collaboration and co-operation. Thus it is possible, within the Cluster, to achieve a significant economy of size and range. The Cluster, therefore, operates to some extent as a very large and diverse company without the administrative disadvantages that generally characterise such companies.”

To date, the Icelandic Ocean Cluster has clearly been undergoing a growth and development phase. This is evident from the fact that a large and growing aspect of the Ocean Cluster is the independent export of goods by Cluster companies. Examinations indicate that Icelandic companies that have grown out of the Icelandic Ocean Cluster and are engaged in their own exports have returned ISK 38bn in export value in 2010. For comparison, it may be mentioned that the export value of seafood products during that year was approximately ISK 220bn.

## **Scotland**

The marine and coastal environment has always played an important role in Scotland's culture, history, and landscape. Scotland's territorial seas (from the coast to 12 nautical miles) cover an area greater than the Scottish mainland and islands combined. The inshore and offshore waters together make up 13 percent of all European seas. The country has a highly indented coastline with about 800 islands lying to the west and north. As a result, Scotland's coastline is now some 11,800 km long. It almost entirely surrounds the country.

The oil and gas sector is very important to the economy. The vast majority of the UK's oil production and over half of its gas production comes from fields based in the continental shelf around Scotland. Renewable energy in Scotland is also based on strong foundations; it is home to a quarter of the European offshore wind and tidal resources and 10 per cent of the European wave resource. Renewable energy is currently estimated to account for at least 3,000 jobs in the country, and it has been estimated that over the next decade there is potential for at least 16,000 new jobs. The oil and gas sector is a major source of employment on both sides of the border; for example, 45% of jobs associated with the UK oil and gas industry – a total of 196,000 jobs – are in Scotland. The skills and knowledge developed in Scotland since the development of the North Sea are a huge asset for the country.

Shipbuilding, ship repair and ship management services are also vital to the Scottish economy. Not surprisingly, the country is a major centre for these activities with almost one third of the UK market. In many rural communities fisheries and aquaculture are of importance. The aquaculture sector has been growing steadily and Scotland is now the third biggest producer of farmed Atlantic salmon in the

world. According to figures from Scottish Enterprise, there are more than 450 companies involved in this part of the marine industry employing over 22,000 people. Annual turnover is in excess of £2 billion and over 85 percent of companies export their goods or services.

### **Scotland's cluster approach**

Scottish Enterprise is the main institution in Scotland that encourages and implements cluster strategies. In many ways it might be said that Scotland pioneered the implementation of cluster thinking in the UK to better exploit its development potential in a number of industrial sectors (Rosiello, 2004). There is a tradition when it comes to clustering in the country as industries such as the textile industry in the Borders, the shipbuilding industry on the Clyde, and the financial industry in Edinburgh have always clustered. These historical clusters were formed due to the attraction of economic and logistical benefits. The adoption of the cluster approach in recent times is based on Michael Porter's work as a consultant for SE in the second half of the nineties and the launch of SE's cluster strategy in 1999. At the time five industrial sectors were identified as those where Scotland could achieve a competitive advantage based on the characteristics of local skills and productive factors, demand conditions, sectoral structure, and the dynamics of national and international competition: biotechnology, microelectronics, tourism, food and energy. Later, the scope of the strategy was expanded to include other sectors.

Some Scottish institutions and companies are part of the UK Marine Industries Alliance, a de facto cluster organization covering the whole of UK.

### ***Faroe Islands***

The Faroe Islands are an archipelago of 18 islands situated halfway between Iceland and Scotland. The country has a land area of 1,396 km<sup>2</sup> and a sea area spanning 274 000 km<sup>2</sup>. The Ocean resources are a major source of income for the Faroe Islands with the fishing industry representing approximately 95 percent of exports. Fish farming is also becoming an important economic activity as well. Safeguarding the marine environment and using its resources sustainably is of vital interest for the well-being of the Faroese people. Over 20 percent or around 5,000 of the Faroese workforce is employed in fisheries, fish processing, aquaculture or shipping.

There is an ongoing search for oil and gas wells on in the Atlantic Margin near Faroese Islands, a search which has spurred some hopes of sustained economic growth in the future.

Though there are no official industry clusters in the Faroe Islands, it might be of interest to establish such a cluster in the region or to connect companies with more established clusters in nearby regions.

### ***Greenland***

At 2,166,086 km<sup>2</sup>, Greenland is the world's largest island, and the 13th largest country in the world. Located between the Arctic and Atlantic Oceans, east of the Canadian Arctic Archipelago, most of the surface land is covered in ice.

With a coastline 44,087 km long, Greenland, like the Faroe Islands, is very dependent on fisheries and seafood exports. In fact, approximately 90 percent of export earnings come from seafood. Traditionally the shrimp fishing industry has been the leading source of income. The country depends heavily on shipping both for the export and import of goods and also because the towns and settlements of the country are not connected by roads. Passengers and goods are therefore transported by sea or by air.

There might be a number of opportunities in Greenland that call for increased activity in the region. Signs of oil and gas have for instance been found in mud off the coast of Greenland. According to the U.S. Geological survey, Greenland's oil and gas resources may total 50 billion barrels—a figure that outstrips the U.S.'s proven crude reserves. There might also be some opportunities in the energy

sector associated with the construction of new hydropower plants. And the country has started to mine in what appears to be a startlingly diverse resource industry: rubies, sapphires, zinc, copper, gold, platinum, pig iron, and extremely rich reserves of rare earths. All of these activities call for increased transportation of goods and equipment.

Though Greenland has no official industry clusters, it might be of interest to establish such a cluster in the region or to connect companies with more established cluster in nearby regions.

## Sectoral overview

The focus of this section is on different marine sectors. The first part deals with marine food, the second part with marine energy, the third with marine transport, and the fourth part with marine biotechnology. It would have been possible to have a different division between the sectors (e.g. by making a distinction between aquaculture and fisheries), but the authors of this report have chosen to focus on these industries as evolving around marine-related food. Because there are so many companies servicing the different industry sectors, it would also have been possible to have a special service sector overview, but we have chosen to align the different service sectors with the associated industries. We have therefore put shipping and shipbuilding under one umbrella and linked those that are producing food processing equipment and those in fisheries and aquaculture.

Every subsection of the sectoral overview starts with some analysis of the industry. This is then followed by some information on the status of the industry in individual countries in the North Atlantic Marine cluster and some information on the clusters that serve the sectors. We often found it difficult to find information on formal clusters and in some cases the clusters were non-existent in the countries under review. All information about potential clusters that are missing in this report are well received and can be sent to [vja@sjavarklasinn.is](mailto:vja@sjavarklasinn.is).

### Marine Food

Several factors determine the dietary habits of people. The major factors that are expected to drive change in global food demand over the next couple of decades is increasing population combined with increasing prosperity and rising income levels in developing countries. The demographic changes in recent decades in the world are unprecedented. In the last half century the world's population more than doubled to reach 6 billion in late 1999. And, in late 2011, it surpassed 7 billion. Lower mortality rates, longer life expectancy, and large youth populations in countries where fertility remains high all contributed, and still contribute, to the rapid population growth.

Cereals are by far the world's most important sources of food, both for direct human consumption and indirectly as inputs to livestock production. The average global per capita consumption of cereals is at around 153 kilograms per person. One of the fastest growing food items in the world in recent years has been poultry, but consumption has gone up by around 210 percent since 1970. During the same period, consumption of fish has grown by 53 percent and pig meat by 58 percent. The increase in the consumption of lamb has been slower at around seven percent and there has been a slight decrease in the consumption of beef during the period or around 11 percent.

A substantial difference exists between the dietary habits of those living in the developed countries and those in the developing world and between those living in rural areas and those in urban areas. In developing countries food consumption is changing. One of the reasons for this change is that people are moving from rural to urban areas. In general, people living in urban areas have access to a greater variety of food and they tend to have a more balanced diet because they consume meat, fish, eggs as well as green leafy vegetables. The diet of those who live in rural areas is generally less varied, with limited intake of protein, fat and micronutrients, although often with a high intake of vegetables. In the developed world the consumption of meat, dairy, and fish has increased

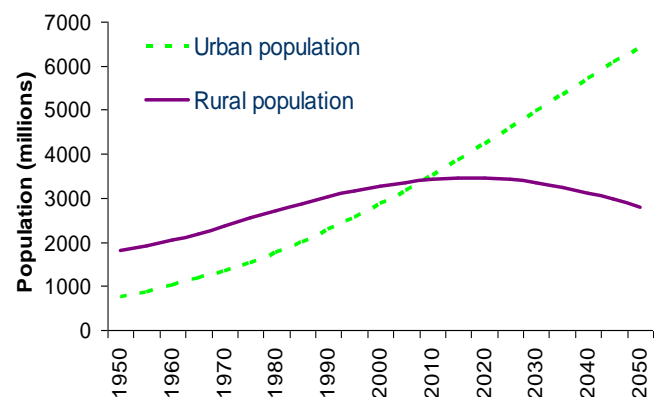


Figure 8. Development of urban and rural population in the world 1950–2050 (United Nations, 2008)

substantially over the last 50 years. In the EU countries for example, meat consumption is twice the world average with the average consumption at around 52 kilograms. The average consumption for dairy products is three times higher. Consumption of fish is 30 percent above the global average at 22–24 kilograms. By contrast, many people in the developing world do not consume sufficient proteins, a dietary lack which has adverse effects on human health and potential. Changes in age composition and lifestyle in the developed world are going to have some effects where the substitutions made by consumers may lead to greater consumption of processed high-value products, or where consumers may upgrade food consumption to newer and more foreign varieties that are perceived to be of better quality. The average family in high-income countries spend 16 percent of their expenditures on food, while low-income countries spend 55 percent (ERS 1997). Wealthier countries are therefore less responsive to changes in income and food prices.

According to future prospects, world population is expected to hit 9.3 billion by the middle of this century (United Nations, 2011a). The growth will mostly take place in less developed countries and will be predominately among the poorest populations in urban areas.

**Table 5. Population Growth in thousands for 2010 and projected for 2050 in five continents**

	<b>Africa</b>	<b>Asia</b>	<b>Europe</b>	<b>Latin America</b>	<b>North America</b>
<b>2010</b>	1,022,234	4,164,252	738,199	590,082	344,529
<b>2050</b>	2,191,599	5,142,220	719,257	750,956	446,862

*(Source: United Nations, 2011)*

The composition of food demand will undergo a greater change in the coming years in developing countries compared with developed countries. While global food demand is expected to increase with income, the food share of the total budget is expected to decline as income increases (Regmi, Deepabk, Seale & Bernstein, 2001). Rising income levels generally result in a more diverse diet. It is assumed that cereal consumption, which today accounts for a large part of the total food budget in low per capita income countries, will see a moderate growth or decrease and as per capita income rises, consumers in these countries will shift some of their consumption to higher value livestock products.

It is projected that this development towards increased population growth and wealth will lead to increased demand for proteins from animal products by more than 50 percent by 2030 compared to that of 2000. The Food and Agriculture Organisation of the United Nations (FAO) has estimated that it would be necessary to increase agricultural output by some 60 percent to feed this growing population.

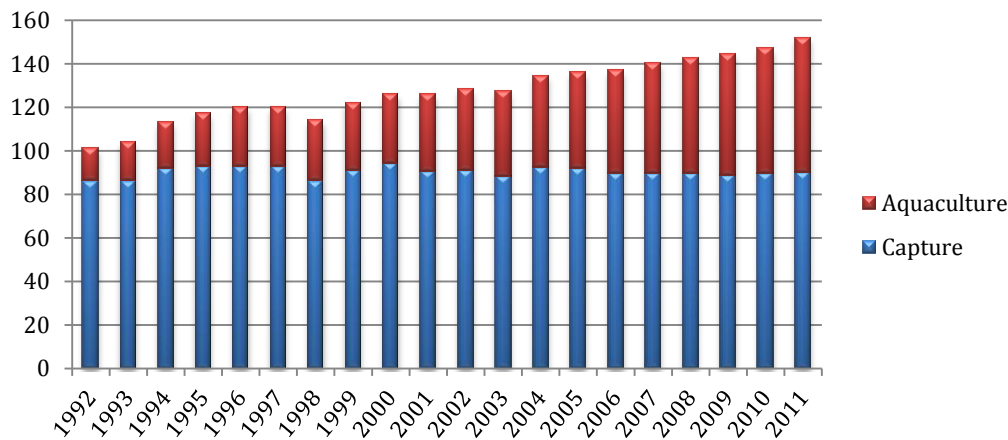
The increasing global demand for animal products may lead to constraints on the environment. Expansion of about 10–20 percent in cropland and grassland is expected, a development which may lead to loss of terrestrial biodiversity, especially in some developing countries. Globally, 30 percent of total human-induced biodiversity loss is related to livestock production. In addition, growing agricultural production could lead to an increase in greenhouse gas and nitrogen emissions. Current global livestock production is responsible for 12 percent of global greenhouse gas emissions.

In 2011, total fish supply in the world was estimated at 152 million tonnes, the highest level ever. This supply volume will lead to a new record in total export and import values, which will in turn push total exports up by 11 percent in comparison to 2010 to almost USD 120 billion in 2011.

The largest part of the fish supply comes from capture fisheries, the volume from which has been fairly stable in recent years at about 88–92 million tonnes. Of this figure, 80 million is from marine waters and around 10 million from inland waters. Total global production of fish, crustaceans, and molluscs has increased in recent years, mostly because of strong growth in aquaculture, which is the fastest growing animal food-producing sector. Although growth rates are slowing, the annual growth

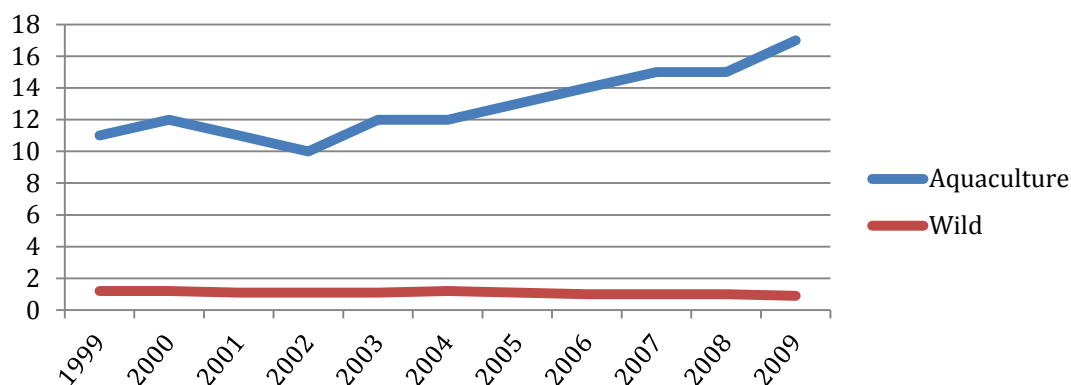


rate in aquaculture has been approximately 6 percent. The estimated production in 2011 indicates 62 million tonnes.



**Figure 9.** World fisheries and aquaculture from 1992–2010 in million tons (FAO)

Around 84 percent of the total fishery production was destined for human consumption and approximately half of that production was live or in fresh form but half of the world's fish production underwent some form of processing. In 2011 it is estimated that 49 percent of fish and fishery products for direct human consumption will come from aquaculture.



**Figure 10.** Production of seaweed from wild and aquaculture Million MT 1999–2009 (FAO)

According to figures from 2009, the production of seaweeds and other aquatic plants was 18.2 million tonnes, 17.3 million tonnes of which came from aquaculture. These plants are mostly used as raw material for industry and as food items, especially in Asia. The value of aquaculturally produced aquatic plants in 2009 was USD 4.8 billion. There was an increase in aquaculture production from 2000 to 2009 of 6 million tonnes, while production of wild seaweed and aquatic plants decreased from 1.2 million tonnes in 2000 to around 900 tonnes in 2009. The vast majority of aquaculturally produced seaweed—99.8 percent of total production in quantity and 99.5 percent in value—is grown in Asia. The largest producers in wild seaweed are China and Chile, both capturing a share of around 30 percent each in quantity. Japan and Norway follow, each with a respective share of 10 and 13 percent. These are followed by countries such as Ireland, Iceland, and Canada who claim a substantially smaller share of 2–3 percent.

Production of fish and fish products takes place for the most part in the developing countries, viz. 81 percent of total production and 93 percent of aquaculture production takes place in these countries. The ten largest countries in Asia in terms of production are responsible for approximately 62 percent of the total world production. The ten largest countries in Europe are responsible for 9 percent of world production, while the combined share of the ten largest countries in North and South America is 15 percent. The share taken by the North Atlantic Ocean cluster, with its combined production of 8.2 million tonnes, is around 6 percent.

**Table 6. Fisheries production by capture and aquaculture, 2009. Comparison between 10 largest countries in Asia, America, Europe, and the North Atlantic Ocean cluster**

Asia				America			
	Total	Capture	Aquaculture		Total	Capture	Aquaculture
1. China	49699466	14919596	34779870	1. Peru	6958769	6914452	44317
2. India	7845161	4053241	3791920	2. USA	4702125	4222052	480073
3. Indonesia	6832789	5099355	1733434	3. Chile	4246677	3453786	792891
4. Viet Nam	4799300	2243100	2556200	4. Mexico	1768063	1611106	156957
5. Japan	4633927	3847017	786910	5. Brazil	1241048	825412	415636
6. Myanmar	3545036	2766940	778096	6. Canada	1093247	939078	151169
7. Philippines	3339851	2602454	737397	7. Argentina	862543	859933	2610
8. Thailand	3137682	1741662	1396020	8. Ecuador	696763	478402	218361
9. Bangladesh	2885864	1821579	1064285	9. Venezuela	310423	295585	14838
10. Korea	2329675	1856615	473060	10. Panama	228509	222110	6399
Total	89048751	40951559	48097192	Total	22108167	19821916	2283251

Europe				North Atlantic Ocean cluster			
	Total	Capture	Aquaculture		Total	Capture	Aquaculture
1. Russian F.	3942700	3836129	11657	1. Norway	3486277	2524427	961840
2. Norway	3486277	2524427	961840	2. Iceland	1147034	1141869	5165
3. Spain	1171435	904959	266476	3. Canada	1093247	939078	151169
4. Iceland	1147034	1141869	5165	4. Denmark	811881	777752	34129
5. Denmark	811881	777752	34129	5. Scotland	460000	300000	160000
6. UK	770086	590993	179093	6. Faroe Isl.	390100	330805	59295
7. France	645098	411215	233883	7. Ireland	316295	269083	47212
8. Turkey	622679	463917	158762	8. Sweden	211953	203413	8540
9. Netherl.	437703	382142	55561	9. Greenland	197878	197878	0
10. Italy	415316	253001	162315	10. Finland	168219	154592	13627
Total	13450209	11286404	2068881	Total	8282884	6838897	1440977

(Source: FAO, pages 24–26, 2010)

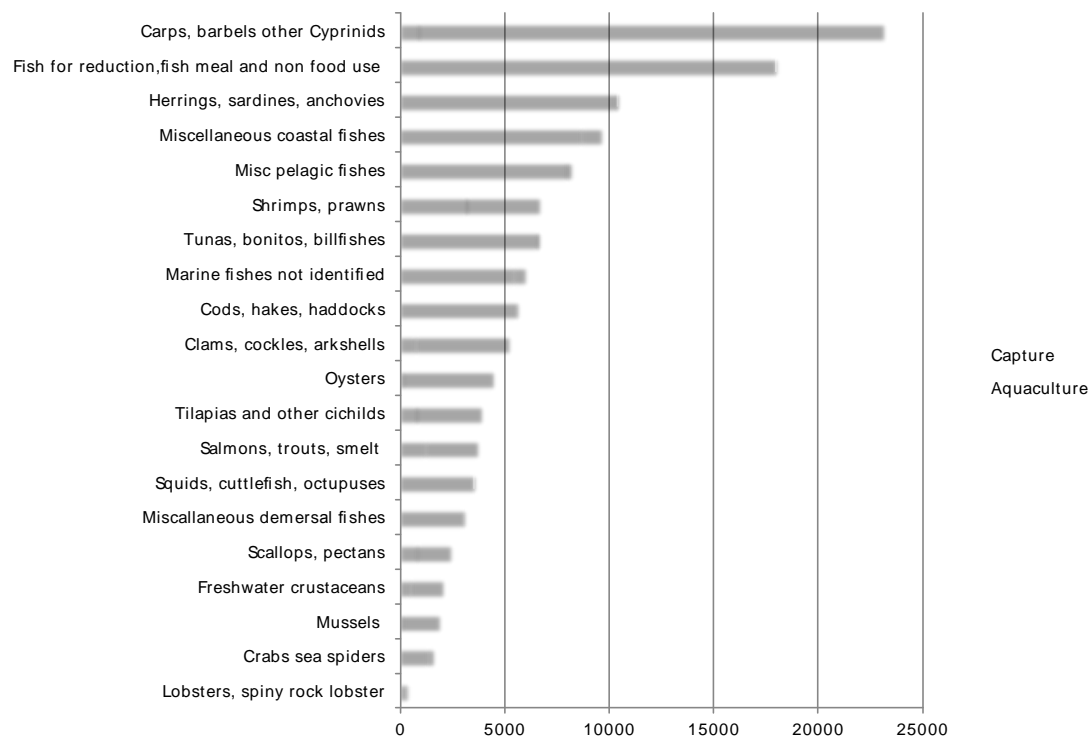
It is interesting to compare the share of aquaculture and capture among the ten largest countries in Asia with the ten largest in Europe. In the former, the share of capture is 46 percent; in the latter, the share is 84 percent.

China is the world leader in fish production with approximately 50 million tonnes, 35 million of which derive from aquaculture. It produces 62.5 percent of the world's fish aquaculture in terms of quantity and 51 percent in terms of value. The country is also the number one exporter of fish but its imports are also growing. This trend can be explained by increasing domestic consumption and also as a result of outsourcing. Chinese processors import raw material from abroad, re-process it, and then

export them as products. The second largest fish producer in the world is India with a total production of 7.8 million tonnes. The largest single producer in Europe is Russia with 3.9 million tonnes, followed by Norway with approximately 3.5 million tonnes.

There are more than 5000 species accessed in wild fisheries and 400 species used in aquaculture. The largest group of cultured species in terms of quantity and value are carps, barbells, and other cyprinids, In 2009 the production of this species was 23 million tonnes with an estimated value of USD 30 billion. The second largest group that are captured in terms of quantity would be herrings, sardines, and anchovies; production in 2009 was 10.3 million tonnes. Anchovies are the single largest species with 6.9 million tonnes. In terms of value, shrimps and prawns are the second largest group with an estimated value of USD 25 billion. At a single level species, white leg shrimp generates the highest value of any species in the world with USD 9.2 billion. Atlantic salmon comes second with USD 6.4 billion.

Shrimp is mostly produced in the developing countries. Accounting for 15 percent of the total value of internationally traded fishery products, it is the largest single commodity in value terms. A large part of these products finds its way to international markets and ends up on the tables of consumers in the US, Europe or Japan. The domestic market for these products is however getting stronger and a growing share of this production is consumed locally.



**Figure 11.** World - Main species capture and aquaculture in 1000 T (Source FAO, 2009)

The share of salmon in world trade has been growing steadily to the current 12 percent. This is mostly due to salmon aquaculture in Northern Europe and in North and South America. Norway has seen a constant growth in recent years, but Chile, another salmon-farming nation, is slowly recovering from a disease outbreak in the industry. In addition, there has been a growing supply in recent years from wild-caught salmon from the USA and Russia.

The increasing supply of salmon might be a cause for concern for some of those involved in salmon farming. In recent years salmon farmers have seen record prices for their products, but in early 2011 the prices dropped considerably and the outlook for 2012

**Table 7. Main producers of farmed Atlantic Salmon 2008–2011**

'000 Mt	2008	2009	2010	2011
Norway	743	867	935	980
Chile	389	203	115	160
UK/Scotland	129	145	142	146
Canada	104	115	121	124
Faroe Islands	38	51	45	48
Other	54	50	50	50
<b>Total</b>	<b>1,457</b>	<b>1,431</b>	<b>1,408</b>	<b>1,508</b>

(Source: Groundfish forum)

is bleak. At the same time the overall demand for fishmeal has gone up, but feed costs constitute approximately 50 percent of production costs in salmon farming. The production of fishmeal has decreased from an average of around 6 million tonnes to less than 5 million tonnes, mostly because producers in Northern Europe are increasing the share of production for direct human consumption rather than for reduction. This change of production process has led to higher prices of fishmeal.

Groundfish species represent around 11 percent of world fish exports, Cod being the most expensive specie. Supply of groundfish has gone down in recent years and was around 5.7 million tonnes in 2009. In comparison the total supply in 1992 was 9 million tonnes. Currently some groundfish stocks are recovering because of better management, but others are still suffering because of overfishing. The North Atlantic cod stocks are only at half their former levels. The Grand Banks cod fisheries off Newfoundland are slowly recovering after it was shut in 1993 following a collapse in stocks.

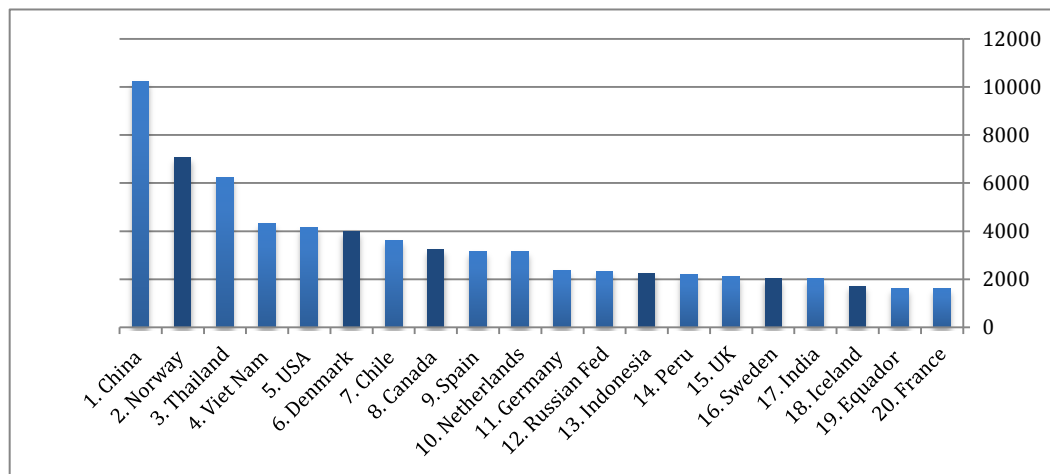
Some farmed whitefish such as tilapia and pangasius compete with captured groundfish and offer a cheaper alternative. In Europe, Nile perch is however more popular than tilapia, making the Nile perch the second most important freshwater species.

**Table 8. Largest producers of Groundfish – North Atlantic**

	Atlantic cod	Haddock	Saithe	Redfish
<b>Norway</b>	331	152	226	8
<b>Russia</b>	312	139	12	30
<b>Iceland</b>	180	55	55	70
<b>Eu &amp; Greenland</b>	160	60	60	20
<b>Faroe Islands</b>	28	9	60	7
<b>US / Canada</b>	28	30	12	19
<b>Total</b>	<b>1039</b>	<b>445</b>	<b>425</b>	<b>154</b>

(Source: Groundfish Forum)

A large part of fishery products—around 38.5% (live weight equivalent)—enters international markets. In general, developing countries are the main suppliers to world markets with close to 50 percent of all exports. The developed countries are also more visible among the twenty largest exporters. Among the largest group of exporters are Norway, USA, Denmark Canada, Spain,

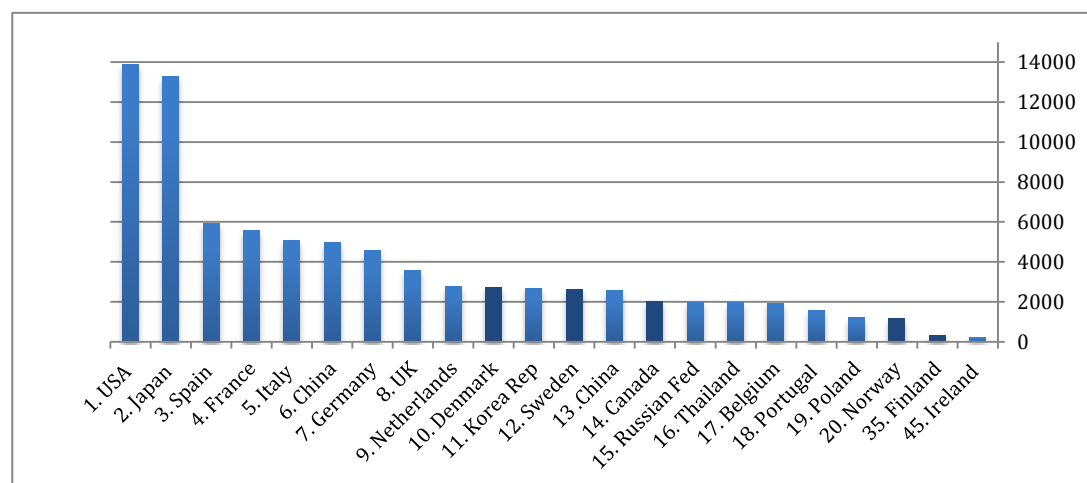


**Figure 12.** Ranking of the twenty largest exporters of fisheries products in 2009. Countries associated with the North Atlantic Ocean cluster in dark blue colour. (Source FAO – USD 1 000)

Netherlands, and Germany. As mentioned above, China is the single largest exporter with approximately 11 percent of world export. The combined share of the Nordic countries is around 16 percent and the North Atlantic Ocean Cluster's share is approximately 20 percent.

Developed countries are responsible for 76 percent of fisheries products imports, which was valued at USD 110 billion in 2010. These countries supply their processing sector and their own domestic consumption. The largest importers of fisheries products are the European Union with approximately 40 percent, followed by the USA with around 14 percent and Japan with 13 percent. The combined share of the North Atlantic Ocean cluster in world imports is approximately 9 percent.

The largest importers within the EU are Spain, France, Italy, and Germany. In 2010 around 60 percent of fish consumed in the EU was imported. There has been a constant increase in the import of fish to EU countries for the last twenty years. During this period consumption has gone up from around 8 million tonnes to 10.5 million tonnes, while production has gone from 8 million tonnes to 5.5 million



**Figure 13.** Ranking of the twenty largest importers of fisheries products 2009. Countries associated with the North Atlantic Ocean cluster in dark blue colour (Source FAO – USD 1 000)

tonnes. In 2009, the EU imported 4.3 million tonnes more fish and fishery products than it exported, but the imports were worth around €15.5 billion (European Pocketbook 2007).

Japan and China might reveal future opportunities in importing seafood, though it must be said that these countries are trying to reduce their catch in the interest of conservation. Conservation notwithstanding, there is a strong tradition in consuming fishery products in both countries and in China the number of customers who can buy more expensive commodities is growing.

Global seafood consumption was 16.7 kilograms per capita in 2010 and was estimated to be 17.8 kilograms in 2011. This figure has grown steadily over the past four decades from an average of 11.5 kilograms in the 1970s to 12.5 kilograms in the 1980s to 14.4 kilograms in the 1990s. Fish protein competes with other sources of protein. The share of fish protein in human consumption of all proteins in the world is 6.2 percent and 15.7 percent if only animal protein is taken into account.

The worldwide salmon consumption can be divided into five major markets: the European Union fresh and frozen market, the Japanese fresh and frozen market, the US fresh and frozen market, canned salmon markets, and other markets.

Though Europeans eat more fish than many of those living in developing economies, consumption of fish protein is still low with only 10 percent of proteins consumed coming from fish. This is only half of what is the recommended amount of fish intake according to WHO guidelines and consumption of fatty fish is related to a decrease in the prevalence of cardiovascular disease. In developed countries, they recommend, from the perspective of public health that individuals should consume more fish, fruit, and vegetables. Lean fish muscle provides 18–25 percent protein by weight, the equivalent of beef or poultry, but is much lower in calories. In fish one gram of protein contains from four to ten calories, as contrasted with 10–20 calories per protein gram for lean meats and up to 30 for fatty meats. High consumption of red meat on the other hand is related to increased risk of cancer, according to the World Cancer Research. Furthermore, a high intake of saturated fatty acids, which are mostly related to animal products, may increase the risk of cardiovascular disease. A diet low in meat and dairy and high in fish would potentially increase human health and life expectancy and reduce health costs.

In recent years, consumers have become more aware of the benefits of consuming fish oil, a growth in awareness reflected in the 34 percent increase in fish oil production in the first half of 2011.

### **Marine food clusters in the North Atlantic**

Apropos of fisheries, fish processing, and aquaculture, a number of similarities exist between the countries in the North Atlantic Ocean cluster. The fishing, processing, and exporting of cod has in most of the countries been of great importance. Herring is either caught or consumed in most cluster countries and in some cases it is exported from between regions for further processing. Capelin has been caught in large quantities by Iceland, Norway, and Canada. Some of it goes into fishmeal used by the aquaculture sector in Norway, Scotland, and the Faroe Islands. While cod was the source of much friction between the countries in the North Atlantic, it is mackerel on its journey further north that is the cause of some current disputes.

The production of salmon is dominating the aquaculture sector in most of the cluster countries and rainbow trout is farmed in all of the countries.

### **Norway**

The seafood industry in Norway is still one of the country's major industries. It is the second largest export industry with approximately 6 percent of export value stemming from fisheries. In recent years, the total annual fish catch has ranged from 2.3 million tonnes to 2.7 million tonnes. Cod is the most important species in value, with annual catches at around 240–340 thousand tonnes. While herring is the largest group of fish in terms of quantity, Atlantic cod is the largest group in terms of value.

The Norwegian seafood industry employs more than 20,000 employees directly, in addition to another estimated 20,000 in related activities. There are approximately 12,000 fishermen in Norway. The number of personnel employed on fishing boats has more than halved during the last 20 years and the fishing fleet has been reduced by 50 percent over the last ten years. At the same time production of fish and seafood products has increased. The largest counties in terms of fish landings are More and Romsdal; together they take approximately 20 percent of total landings. The county is home to Aalesund harbour, Norway's largest port for fish. Norway's second largest county is Nordland, with around an 18 percent share of total landings.

Because of natural limitations in wild fish stocks, the main growth in the seafood business has been in the aquaculture sector, with export sales from this sector now exceeding the sales from the traditional fisheries. In 2010, the Norwegian aquaculture industry generated EUR 4,1 billion in export revenue.

Almost 5,000 people work directly in Norwegian fish farming. Approximately 1000 of these employees work in the Hordland county, which has the largest number of sites in seawater.

Norway is among world leaders in terms of fisheries and aquaculture. The country is the world's second largest seafood exporter and among the ten biggest producers of fishery products. It is also the biggest producer of farmed Atlantic salmon in the world and is a leader in Atlantic cod fisheries.

**Table 9. Norway - Quantity of catch by fish species in 2010, live weight**

Species	Tonnes
Total pelagic	1,796,783
Capelin	273,782
Atlantic Mackerel	233,957
Herring	923,741
Blue whiting	194,318
Other	170,985
Total Groundfish	693,434
Haddock	124,696
Saithe	228,114
Atlantic Cod	283,481
Cother	57,143
Total Flatfish	35,000
Total Crustac. and molluscs	150,100
Deep water prawn	24,474
Other	125,656
Total	2,679,156

(Source: Statistics Norway, 2012)

### Cluster Activity

Some of industry clusters in Norway associated with fisheries, processing and aquaculture are dealt with in the rest of this subsection.

### NCE Aquaculture

The NCE Aquaculture cluster is based in Bodø along the coast of Nordland and has been active in developing the aquaculture sector in Norway since the 1970s. Their focus is on the value creation and innovation associated with commercial production of farmed fish and seafood for the global market. These are areas of importance for the further development of Norwegian aquaculture and include the production of fry and edible fish, processing, feed production, technology, health and environment, finance, and research and training.

The NCE Aquaculture partnership is formalized through business agreements between 20–25 companies and institutions. Activities are organised around five prioritised working areas. The core of this is innovative cooperation in practice and the further development of the relations and the cluster dynamic that have already been developed. The work is focused on projects and activities across companies and the industry, and on those which unify and strengthen the cluster as a whole. The cluster has given priority to projects within:

- market and reputation;
- production, fish welfare, environment and technology;
- competence and recruitment;
- external conditions; and
- networking and sharing of knowledge between companies.

The cluster companies' ambition is to increase a total value creation of NOK 5 billion and generate 600 new jobs in the region by 2017. These goals can be obtained by developing existing activities and intensifying the breeding of new species.

One other objective which is of importance for NCE Aquaculture cluster is to establish a common and nationally coordinated R&D strategy. The realisation of such a goal will contribute to the more efficient use of resources, faster problem solving, and shorter development periods before commercialisation.

For further information, log on to the cluster's website: <http://www.nceaquaculture.com>

### **Technology akvARENA**

Technology akvARENA applied for an ARENA cluster status in 2007 and worked in accordance with the Arena programme setup from 2008–2012. In the beginning of 2012, the cluster started to work independently and in strong collaboration with regional organisations in Trondheim, where the cluster is based.

Technology akvARENA aims to contribute to the development of a world-leading knowledge community for suppliers to the fish farming industry. Collaboration between suppliers, fish farming companies, and the knowledge providers, together with an ideal coastal climate for fish farming, provide akvARENA with a solid foundation for success. Fish farming is a young industry that has already achieved results. But there is still great scope for development opportunities vis-à-vis technology and better and more efficient operations.

akvARENA initiates and organizes

- innovation projects with a focus on sustainable technology;
- workshops; and
- national and international study trips.

The cluster akvARENA approaches both large and small players, i.e. suppliers, fish farming companies, and knowledge providers. The common feature here is that the companies can achieve more through collaboration than they could by themselves. There are around 50 members active in the cluster, including several leading technology suppliers, fish farming companies, and internationally recognised knowledge providers.

For further information, log on to the cluster's website: <http://www.akvarena.no>

### **Arena Ocean of Opportunities**

Arena Ocean of Opportunities is located in Stavanger and commenced work under the Arena umbrella in 2011. Cluster participants are both large and small, local and global in fish farming, suppliers of services, and fish feed. The focus is on the future of aquaculture, sustainability of fish consumption, and human health and food quality. The cluster's main goal is to double the production of salmon in the South West Area in Norway from 50,000 metric tonnes to 100,000 tonnes. Other goals include:

- increasing the efficiency of logistics from feed to finished product;
- ensuring better survival of salmonids in seawater from the current level of 74 percent to 90 percent; and
- increasing knowledge on how the residual raw materials from the farming activities can be retrieved.



In the next three years cluster will focus on projects to develop the world's most sustainable fish farming, but also to work systematically to gain better knowledge about the importance for human health and food quality. The results of cluster activities should contribute to the streamlining of the supply chain, higher quality, and better, long-term profitability for cluster firms..

For further information, log on to the cluster website: <http://arenaoceanofopportunities.no>

### **Omegaland**

Omegaland was supported by the Arena programme from 2009-2011 and facilitated by Aalesund Kunnskapspark, which still acts as the facilitator for the cluster.

Omegaland's objective is to develop the great potential of Omega-3 products. Through collaboration, innovation, and commercialization, the industry cluster, which is situated on the northwestern coast of Norway, aims to strengthen its position as a world leader in the processing of marine oils for human consumption and health products.

A huge potential exists for the production and the product development of Omega-3 dietary supplements, functional food, and medicines. The cluster currently accounts for 40 percent of the Omega-3 production worldwide. Norwegian companies are included in the value chain and the suppliers are well known for high quality products.

Common challenges for the further development of Norway's Omega-3 environments include: increased access to raw materials; securing the raw material sources; recruitment of a competent workforce; and increased expertise and focus on knowledge. This leads to a strengthening of the capacity and quality within R&D. A partnership has already been established with Møreforskning (research institute) and Aalesund University College.

Over 20 companies and institutions have been active in the Omegaland cluster and to add to this number of participants is a part of the cluster's mission.

### **NCE Culinology**

The NCE Culinology cluster was established in 2007. Its main goal is to strengthen the knowledge platform and capacity for innovation in the field of gastronomy and culinary differentiation for the benefit of Norwegian food production. The cluster is situated in Stavanger in the Rogaland region and has deep historic roots in the production of agricultural-based food and seafood. In addition to a strong production side, the district has a vigorous network in which approximately 100 partners from industry, R&D institutions, and public authorities are working in close collaboration to develop the industry.

The guiding principle throughout the entire project period is clarity in the building up and dissemination of knowledge. This is being achieved by means of four main activities:

- basic knowledge;
- coordination/innovation-oriented R&D projects;
- innovation practice; and
- other common, cluster-strategic activities.

NCE Culinology functions as a professional catalyst and is measured on its ability to increase the level of innovation and upgrade the professional and market-oriented skills within and between operators in the food and meal industry cluster. The objective is to further develop the quality of raw material production, specialize processing, and increase value creation per investment factor.

Food producers and suppliers are exposed to increasingly tough international competition, both in Norway and abroad in terms of pricing, quality and character. Furthermore, the quality requirements for raw materials, traceability, ingredients, product characteristics, production conditions, profiling

and market orientation are becoming increasingly demanding. This exposure not only applies to skills within the typical culinary market segments, but also within the more volume-oriented grocery trade. It is becoming increasingly clear that the culinary dimension and the need to differentiate products are critical success factors at corporate level.

The vision for NCE Culinology is to raise the production environment in Rogaland and Norwegian food production to the top level in the European food quality markets in the next 10 to 15 years.

For further information, log on to the cluster website: <http://www.culinology.no>

### Denmark

Denmark is a large exporter of food with 17 percent of its total exports in this sector. The country has an established tradition in fisheries and aquaculture. The industry is important in numerous communities; however, in sales of goods from Denmark, products related to fisheries and aquaculture do not have a significant impact on the Danish economy. About four percent of export value stems from these industries. In 2010, almost 1.1 million tonnes of fish, valued at 3.4 billion DKr, was landed on Danish shores. A portion of these landings were from other EU vessels or from third-world country vessels. Danish vessels were responsible for 700,000 tonnes worth of the 2010 load—almost 2.4 billion DKr

Species	Value DKr
Atlantic Cod	303,011
Norway Lobster	237,035
Atlantic Mackerel	169,110
Plaice	155,637
Herring	141,459
Industry	823,816
Total	2,388,597

(Source: Ministry of Food, Agriculture and fisheries, n.d.)

Danish fisheries can be divided into consumer fisheries and industrial fisheries. In 2010 industrial fisheries of Danish vessels was 533,000 tonnes worth or 823 million DKr, but the value of fish for consumption was almost 1.6 billion DKr—a quantity of around 167,000 tonnes. Denmark is among leading fishing nations in Europe and is active in fish trading. The country is the sixth largest exporter of seafood in the world and the tenth largest importer.

Cod is the most valuable and important catch for the Danish fleet, but Norway lobster, mackerel, herring and plaice are all also of great importance.

The majority of activities associated with the fishing industry take place in the Northern Jutland and Western Jutland regions. The main volume of fish is landed in the ports of Hanstholm, Skagen, Hirtshals, Thyborøn, Bornholm, and Grenå. More than 60 percent of the fish processing takes place in the Northern Jutland region.

Regarding aquaculture, the main product is rainbow trout from freshwater ponds and mariculture units; this trout also produces roe, an important by-product. Eel is farmed in re-circulated freshwater tank systems; mussels and oysters are produced in minor quantities; and turbot fry is exported for further on-growing. A new species in Danish aquaculture is pike-perch, which has successfully been farmed during the last few years. Production of food fish is expanding rapidly, as is the export of fry for grow-out in other countries.

The total annual aquaculture production in Denmark was around 44,000 tonnes in 2011, or 3.3 percent of the country's total fish production, worth 20 percent of the total value of fish produced. 90 percent of fish production goes for export. The Danish freshwater fish production takes place in about 230 fish farms, primarily in Jutland. There are 18 marine fish farms, which produced approximately 10,000 tonnes of fish, mostly rainbow trout, in 2010. More than 800 people are directly employed in production (with just above 600 full-time employees), the majority of which are engaged in traditional fish farming. In addition, a significant number of people are employed in associated industries such as processing and smoking.

One of the main strengths of the Danish fishing industry is a strong processing sector that is close to the major buyers of seafood within the borders of the EU common market. In recent years, Danish

fish processing companies and aquaculture producers have invested in established companies in Poland, Letland, Romania, Bulgarian, Vietnam, China, and Ghana.

**Cluster activity**  
**FISKEVIDEN.DK**

Fiskeviden is situated in Hirtshals and is associated with the national cluster FoodNetwork. The cluster serves the fishing industry in North Jutland and is a part of the business development strategy in the region for food from the fishery sector.

FISKEVIDEN.DK's vision and mission is to enhance growth and innovation in the North Jutland fishing sector and to strengthen technological, organizational, and financial ability in order to maintain and further strengthen the competitive position of the area.

Studies are being carried out on the industry and preliminary results have led to a large number of development projects and cooperation across sectors. Among cluster activities are training courses, themed meetings, and other activities at the request of the companies.

The main institutions behind the project are the North Sea Science Park (Nordsøen Forskerpark), IFM–Aalborg Universitet, and the Centre for Fødevareteknologi.

FISKEVIDEN.DK is a part of the cornerstone programme of Region North Jutland to continue the development of the North Jutland food industry.

For further information, log on to the cluster website: <http://fiskeviden.dk>

**Konsumfisk**

Konsumfisk is a cluster cooperation between the three west coast ports of Thyborøn, Thorsminde, and Hvide Sande and two fisherman's organizations, Fiskeriforening, Sydvestjysk Fiskeriforening and Fiskernes Fremtid A/S–Hvide Sande, and Danske Fiskeauktioner A/S ("Danish Fish Auctions"). The main goal of the cluster is to attract fresh fish to the region, fish which is then sold through Danish Fish Auctions A/S, one of Europe's most modern fish auction systems located in all three west coast ports. The sales of fish are handled over an Internet-based system (PEFA), attracting an impressive number of buyers every day both locally and over the Internet. These buyers are sitting at home in their businesses around Denmark and in Europe.

The two fishermen organisations together represent the employment of more than 400 commercial fishermen. But the fishing cluster activities as a whole generate more than 1000 jobs and are an essential component for the survival of west coast communities.

For further information log on to the website: <http://www.konsumfisk.dk/>

**AquaCircle**

AquaCircle is a Danish knowledge cluster for the continuous development of recirculation technology in aquaculture. It was established in 2006 and is based in Brøndby.

Companies, institutions, fish farmers, organisations, and other stakeholders with an interest in recirculation technologies within the aquaculture formed the cluster, which currently has around 40 members. Funding comes from the Danish Ministry of Food and the EU Commission through the European Fisheries Fund.

The cluster aims to create information on recirculating aquaculture systems intended for authorities, financial institutes, science communities, fish farmers, industries, educational sectors, consumers, and to the general public. Internally among its members, AquaCircle strives to act as a greenhouse, that is it strives to stimulate the creation and to support the growth of groups; to facilitate companies and people to cooperate with multiple and cross-sectoral approaches; to solve problems and to test ideas;

and to create innovative solutions to be implemented for the benefit of the sector and to enhance the use of recirculating aquaculture systems.

To secure the need for qualified scientists and employees to the Aquaculture sector, AquaCircle assists and supports in building up relevant training and education on all levels.

For further information, log on to the cluster website: <http://www.aquacircle.org>

### **FoodNetwork**

FoodNetwork is a part of the Innovation Networks Denmark programme. This is an extensive network with a large number of Danish Universities, research institutions, technological service institutions, schools, and innovation and development parks.

FoodNetworks main goal is to create growth within the food industry by linking different bodies and through projects and activities. Its role is also to increase visibility of relevant partners in the industry and to support both new and more mature clusters. Part of the cluster activities is associated with the seafood sector where it works in collaboration with the Fiskeviden.dk cluster in Hirtshals.

For further information, log on to the cluster website: [www.foodnetwork.dk](http://www.foodnetwork.dk)

### **Foodbest**

Foodbest (best = business, education, science and technology) is a new initiative whose aim is to boost the European food sector. The Foodbest consortium is organised by a pan-European consortium that comprises Denmark/Sweden (the new bi-national DK/S Foodbest organization – supported by industry, academia and public authorities), the Netherlands, France, the UK, and Italy. The organizing partners of Foodbest are all leading European food clusters/countries with the presence of world-class universities and powerful and innovative food companies.

One way to boost the food sector is by creating knowledge-intensive jobs and to build the sector on innovation and higher added value production and services. Foodbest's goal is to raise €150 million per year for innovation from 2014 on. The ambition is to raise a part of this amount by developing the best "KIC", "knowledge and innovation community", a consortium that will be among the most dynamic and exposed food communities in the world.

The Foodbest project partners, coordinated by the participating regions, work together to promote the importance of a Food KIC and to create a strong candidacy for a potential Food KIC consortium.

The cluster's vision is to be the best facilitator for turning global challenges into business opportunities in the food sector. Its mission is to facilitate the development of healthy, sustainable and appealing food for a growing world population in a competitive and sustainable way.

The cluster set out to

- increase the number of start-ups, patents, license agreements, entrepreneurial candidates, and training courses; and to
- increase added value in food production, stimulating interdisciplinary collaborations and innovation models, as well as public private partnerships across Europe and globally.

The regional contact for Denmark/Sweden is the Foodbest DK/S secretariat.

Foodbest DK/S is supported by relevant Danish and Swedish universities, regional authorities, and a number of international companies, such as Arla, Danisco, Chr. Hansen, Novozymes, Lantmännen, IBM Denmark, Foss, and Danish Crown. Foodbest DK/S is funded by the EU Regional Development Fund through the Interreg IVA programme Øresund-Kattegat-Skagerak.

## Sweden

It has been estimated that the Swedish fishing, aquaculture and processing industry employs a total of around 5,000 people and has an annual turnover of around SEK 5 billion. Cod and the pelagic species are the most important species and are responsible for three-quarters of the total catch value. In 2010, Swedish catches from marine fisheries reached almost 212,000 tonnes (live weight).

The Baltic Sea is the most important fishing area, with 72 percent of the total national catches, with the remaining volume coming from the North Sea (14 percent) and from the Kattegat and Skagerrak area (14 percent). The most active fishing ports are on the western seaboard where most of the fishing fleet capacity—around 86 percent of the gross tonnage—is concentrated. The main port in terms of fleet capacity is Fiskeback. Other ports include Rörö and Fotö. Several Danish ports such as Skagen and Hanstholm are important for landing Swedish catches.

The processing industry is dominated by several large companies mostly situated on the west coast. Sweden is a large importer of fish and is the 12th largest importer of fish in the world, with annual imports of fish of between 400–500 thousand tonnes.

Swedish aquaculture is growing, though it still remains on a relatively small scale. In 2010, Sweden produced around 9,000 tonnes. The largest species produced is rainbow trout with around 85 percent of the share of production for human consumption.

### Cluster activity

The authors of this report were not able to find any cluster associated with fisheries or aquaculture in Sweden.

## Canada

There is a strong tradition in fisheries and fish processing in Canada. Though the industry has experienced a crisis of sorts in recent years, Canada is still the eighth-largest exporter of fish in the world, with the industry directly contributing C\$2 billion a year to the nation's GDP. Seafood is today the largest food commodity exported by Canada. The United States is the main destination for Canadian seafood exports, with 63 percent of exports in 2010 (C\$2.4B). The share of exports to Europe has increased from nine percent in 2002 to 14 percent in 2010.

In 2009 commercial fisheries landings were 924,756 tonnes, at total worth of C\$1.7 billion. In the same year, the commercial fishing industry employed approximately 70,000 people in Canada and was the economic mainstay of approximately 1,500 communities in rural and coastal Canada for that year. Nova Scotia, Newfoundland, and New Brunswick are the largest provinces.

The top four species in terms of quantity in 2009 were herring at 166,000 tonnes, shrimp at 141,000 tonnes, snow crab at 97,000 tonnes, and hake at 69,000 tonnes. In terms of value, the top four species were lobster at C\$495M, snow crab at C\$311M, shrimp at C\$225M, and scallop at C\$88M.

Aquaculture production in 2009 was 155,000 tonnes, which represented 14 percent of total marine production. Output value was C\$800 million, representing 33 percent of total marine value. It has been estimated that the industry provides 14,500 jobs. During the past 20 years Canada has been able to quadruple aquaculture production and the country now ranks as the 20th in the world in terms of the value of the production.

With 65 percent of the total production and 75 percent of the total aquaculture value, salmon is Canada's most widely produced species. It is perhaps no surprise, then, that Canada is the fourth largest producer of salmon in the world.

### Cluster activity

The authors of this report were not able to locate any cluster associated with marine food. A number of companies in the fisheries and aquaculture sector work with the OceansAdvance programme. The main focus is on harvesting, monitoring, and processing.

## **Iceland**

The Icelandic economy is heavily dependent on fisheries. Direct contribution of fisheries and fish processing to the GDP has been around seven to ten percent; however, direct and indirect contribution has been estimated at around 25 percent of the GDP. In many smaller coastal communities, fisheries and fish processing companies constitute the most important source of livelihood. The employment opportunities in such communities are often more limited because of less economic diversification.

In 2010 the total catch in Icelandic waters was close to 1.1 million tonnes of fish products worth ISK 220 billion or €1.3 billion in export value. The share of seafood in the export of goods from Iceland is around 39 percent. Cod is the most important species with approximately 33 percent share in total fish exports. The combined value of herring, haddock and redfish is similar to the export value of cod, each with around eight to nine percent of export value.

The fishing industry directly employs 8,600 people or five percent of the total workforce, with fishing employing 2.4 percent and fish processing 1.7 percent of the workforce. Indirect employment has been estimated at 25,000–30,000 people or 15–20 percent of jobs in the country.

The importance of the fisheries sector for the Icelandic economy increases the emphasis on profitability and efficiency within the sector. There is a high demand for improved technology, both in processing and harvesting; the use of fully automated processing with latest computer technology is widespread in the industry. Improvements and innovations in transportation and logistics have also increased efficiency. The availability of air cargo capacity has greatly increased, supporting a huge rise in the export of chilled fish products and new methods in shipping the products by sea.

Several auxiliary companies have developed as offspring of the fishing industry, providing support services and products. Some of these businesses have started to export their innovations and expertise globally. Companies marketing fishing technology, fish processing machinery, and those involved in marketing of seafood products have thus become valuable for the economy as exporters.

Icelandic fish products are supplied to all major international markets. The majority of the exports or around 66 percent goes to the EU countries with the UK constituting the biggest single market. Today the spectrum of products supplied by Icelandic companies is much broader than ever before, ranging from catch-fresh raw materials to highly processed convenience products. Traditional processing techniques, such as salting, have to some extent been replaced by fresh and frozen products.

The aquaculture sector has remained relatively small and has shown many difficulties associated with unstable natural environment. Production in 2010 was around 5,000 tonnes worth 4 billion ISK. Arctic char is the most important species with a 47 percent share in total production. Cod is the second largest species with a 35 percent share, followed by Salmon with a 14 percent share.

It is estimated that production in coming years will increase substantially, especially in salmon farming, and that production in the next five to seven years will be around 25,000 tonnes.

### **Cluster activity**

A number of companies in fisheries and fish processing and companies belonging to the service sector participate in the activities of the Iceland Ocean cluster. There are already a number of initiatives that the cluster is focusing on, among them a project called Codland. The idea is to establish a processing cluster with headquarters in Grindavik, a town in the southwest of Iceland. The challenge is to increase cooperation among companies in the region and encourage full utilization of the raw material, both with a view to increasing the capacity of entrepreneur companies in the field and creating value.

## **Scotland**

According to the Scottish Government a total of 358,000 tonnes of fish were landed by Scottish fishing vessels in 2011, a volume worth around £500 million. This represents a 15 percent increase in

worth in comparison to the previous year. During this period there were 2096 active fishing vessels, three percent fewer than in 2010, while the number of fishermen employed in Scottish vessels dropped by four percent to 5005 at the end of 2011. The wider seafood processing sector employs 12,000 people and is extremely important to coastal communities. The industry comprises 230 companies, enjoying an annual turnover of £700 million.

A total of £184 million worth of pelagic fish—includes mackerel and herring—was landed in 2011, a 44 percent increase on the previous year. Fishermen also landed £164 million worth of shellfish, six percent more than in 2010, while the value of whitefish landings such as in cod and haddock was stable at £152 million.

The provisional figures for 2011 showed that mackerel remained the most valuable species to the Scottish fleet at £163 million, with prawns the second most valuable at £83 million. The value of whitefish landings—led by cod, haddock and monkfish—was generally stable year-on-year, while a modest reduction in fleet size reflects trends towards greater productivity and higher landings value per vessel.

Peterhead in the northeast of Scotland is the UK's largest fishing port. Around 120,000 tonnes of fish are landed in the port annually.

In terms of aquaculture, Scotland occupies a comparatively good position as the largest current producer of farmed Atlantic salmon in the EU and the third largest globally, accounting for over one-third by value of the country's food exports. In 2010, production was 154,164 tonnes with an estimated value of £539.6 million at farm gate prices, which equated to over one-third by value of Scotland's food exports.

Scottish shellfish production is also expanding quickly with much of aquaculture production focused on the West and North of the country. Farmed blue mussel is the biggest species at 7,199 tonnes annually and worth £6.7 million.

#### **Cluster activity**

The authors were not able to locate any specific cluster associated with fisheries and aquaculture in Scotland, but there is a food and drink cluster based in Edinburgh serving the seafood sector to a certain degree. The Scotland Food & Drink cluster was established in 2007 and is a not-for-profit organization. The role of the cluster is to guide food and drink companies of all sizes towards increased profitability.

The cluster's mission is to grow the industry to a value of £12.5 billion by 2017; its vision is to build Scotland's international reputation as 'A Land of Food and Drink'.

Scotland Food & Drink is supported by the Scottish Government and works with a number of partner organisations in order to deliver events and initiatives to the benefit of both members and the food and drink industry as a whole. Among these partners are the Scottish Salmon Producers' Organisation, Sea Fish Industry Authority, and Seafood Scotland.

For further information, log on to the cluster's website: <http://www.scotlandfoodanddrink.org>

#### ***Ireland***

The waters around Ireland's 7,500km coastline are rich in aquatic life and form a good environment for seafood. Total sales of Irish seafood on both domestic and export markets, excluding direct landings for Irish vessels into foreign ports, amounted to €730 million in 2008, which represented 345,000 Tonnes. Exports of Irish seafood for 2010 are estimated at €365 million, making up approximately 50 percent of total Irish seafood sales. The main European Irish seafood markets are France, Spain, UK, Germany, and Italy.

An estimated 75 percent of Irish seafood exports are sold in EU markets, with France as the main market for Irish seafood, followed by Spain and the UK. Markets outside the EU are also of vital

importance, especially for the country's pelagic fleet, which fishes mainly mackerel, herring, and blue whiting. Nigeria and Russia are among the main markets for these species. The sales of pelagic species account for €149.4m with the value of whitefish at €46m

There are approximately 2,000 vessels in the Irish fishing fleet, i.e. approximately two percent of the EU fishing fleet. The top fishing ports are Killybegs, Castletownbere, Dingle, Dunmore East, and Kilmore Qua. The Irish seafood industry generates an estimated 11,600 jobs, supporting the economic viability of remote, rural and coastal communities. At production level, it is estimated that 4,987 people are employed in fisheries, 1,936 in aquaculture, 3,507 in seafood processing, and 1,185 in ancillary services.

Ireland has the 7th largest aquaculture sector in the EU, producing 48,350 tons of aquaculture in 2007. With an estimated value of €131 million, the Irish aquaculture industry continues to contribute considerably to the seafood sector. Salmon is the most important species with a total worth of €54.7m. Cultivation of mussels, oysters, and scallops is also very important; 2011 saw a value of shellfish sales of €158.6 million.

#### **Cluster activity**

The authors were not able to find any formal industry cluster for fisheries and aquaculture in Ireland, but a key institution in encouraging innovation and cooperation is Bord Iascaigh Mhara or the Irish Sea Fisheries Board. Their website is <http://www.bim.ie>.

### ***Finland***

Unlike other Nordic countries, Finland has had few fishermen, and the fishing industry has remained small. Finland's coastal waters offer poor fishing grounds because of their low salt content (caused by the heavy flow from the country's many rivers). The Finnish fishing industry's share in the country's GDP accounts for only 0.04 percent.

The poverty of Finland's waters explained why relatively few Finns were fishermen despite considerable government aid. In 2008, for example, only 2,200 fishermen were in full-time employment, while another 5,000 were in part-time work; both full-time and part-time fishermen used a fleet of about 530 boats. That same year, the fish catch totalled some 111,000 tons, of which roughly two-thirds were salt-water fish, and one-third were fresh-water fish. Baltic herring was the most valuable catch, followed by salmon. A share of the catch came from Soviet and Swedish waters, to which Finland had gained access under bilateral agreements.

Finland has a strong tradition in the consumption and processing of fish. The country has been unable to meet domestic demand and has had to import about 300,000 tonnes of fish each year, including large amounts of fish offal that was used as feed on fur farms.

Nowadays the value of the production of aquaculture is larger than that of professional fishing. In total, there were 515 aquaculture stations and production units in the register of aquaculture in 2009.

#### **Cluster activity**

The authors were not able to find any formal industry cluster for fisheries and aquaculture in Finland.



### Faroe Islands

The Faroese economy is heavily dependent on the fishing and fish farming industry. Of the export of goods 97 percent of the value derives from fish products. A large variety of fish stocks are utilized. The most important fish for the Faroese fleet are groundfish species such as cod, haddock, saithe, redfish, and Greenland halibut. Deep-water stocks in blue ling and pelagic fisheries producing mackerel, herring, and blue whiting are also important. The total catch in 2011 was 355,000 tonnes. Approximately 3,500 people are directly employed in fisheries, fish processing, and aquaculture.

Species	Quantity
Atlantic Cod	28,800
Haddock	5,600
Saithe	33,200
Mackerel	122,000
Other	165,300
<b>Total</b>	<b>355,000</b>

(Source: Statistics Faroe Islands, 2012)

Clean, temperate waters and strong currents around the Faroe Islands provide ideal conditions for fish farming and a strong aquaculture sector has emerged. The farming of Atlantic salmon and rainbow trout is an important and growing part of the total Faroese fish production. Total production of these fish in 2011 was 50,000 MT with almost all of the production from salmon. Great emphasis has been placed on marketing salmon from the Faroe Islands, by the Faroe Fish Farmers Association, resulting in higher prices on international markets.

### Greenland

Fishing and processing of seafood products is the Greenland's primary industry. Approximately 25 percent of the population is employed in the industry and seafood has a 90 percent share in the export of goods.

According to catch statistics of various types of fishes in 2010, the total catch was almost 100,000 tonnes. Prawns were the largest item with an estimated catch of 54,200 tonnes; Greenland halibut came second with almost 23,000 tonnes; and cod was the third largest species with 9,400 tonnes. Fishing of other species was substantially less.

#### Opportunities

For the time being it is difficult to see any substantial growth in fisheries in the near future that would meet the increasing world demand for food. According to reports from the Food and Agriculture Organisation of the United Nations (FAO) (2009), 52 percent of the world's fish stocks are fully exploited and 28 percent are overexploited or depleted. Pace the FAO, it would be wise to avoid too much generalisation regarding matters of overfishing however. In some areas the industry has followed stringent management practices that have rather created opportunities for increasing the catch.

This turnaround applies to some of the countries in the North Atlantic where some fish stocks are growing and where the industry should enjoy the benefits of being responsible in their approach. For example, stock levels of Atlantic cod in the Barent Sea north of Norway—the world's largest Atlantic cod fishery—are at their highest levels since modern records began in 1946 (Mitchell, 2011).

People are being advised to eat more fish because of the health benefits associated with fish consumption. And yet the industry is experiencing difficulties in meeting increased demand. It has to be taken into account that the harvesting of food from the wild is very rare in today's mass market economy: it is therefore questionable whether this industry should not be earning higher prices.

Table 12. Total Fishing in Greenlandic Waters by Greenlandic Vessels in 2010

Species	Quantity
Atlantic Cod	9,400
Snow crab	2,800
Greenland halibut	22,900
Northern prawn	54,200
Lumpfish	8,600
Other	1,800
<b>Total</b>	<b>99,700</b>

Source: Statistics Greenland, 2012)

Earning higher prices in combination with a high-intensity marketing effort on the part of the industry might be the solution.

There might also be opportunities for reducing waste from fisheries and decreasing the high levels of unwanted and often unreported by-catch and discards. According to the FAO, it is estimated that 7.3 million tonnes of fish (usually dead or dying) is discarded annually by marine fisheries throughout the world. Opportunities could be found by implementing new fisheries management schemes and developing means of catching species that are smaller and lower in the food chain. These opportunities could be exploited through new and better fishing methods and through new and more accurate fishing gear.

One answer to the problems associated with the growing demand for animal products is aquaculture. In recent years there has been some discussion about the negative impact of aquaculture. Fish farms have been blamed for coastal pollution and the genetic contamination of wild stocks. Production of certain species also requires large quantities wild catch as feed, a requirement that may put pressure on some wild stocks. For example, salmon can consume more wild fish in weight than they themselves weigh. Criticisms of aquaculture notwithstanding, the industry as a whole has a lower impact on the environment than cattle, pig or poultry farming does. Fish process energy more efficiently than mammals do: whereas herbivorous fish only require 13 kilograms of grain for every kilogram of protein, cows need the equivalent of 61 kilograms of grain for each kilogram of protein and pigs need 38 kilograms for each kilogram of protein. In addition, aquaculture emits less phosphorus, nitrogen and greenhouse gases than livestock farms do (Hall, Delaporte, Phillips, Beveridge & O'Keefe, 2011).

To ensure as little impact on the environment as possible from aquaculture, further innovation and technological advances have been a major priority of the industry. Great progress has also been made in tackling coastal pollution through better feed management and the use of complimentary species in cages. In addition, enhanced fish cage design has reduced the volume of fish escapes.

One part of the solution to limiting environmental impact from the industry might also be to switch to the increased production of herbivorous fish, which live on grain and not on fishmeal, or to the increased production of seaweed, muscles oysters, and molluscs, which would only require a moderate increase in the use of space and agricultural land used in the production of feed (The Protein Puzzle. The consumption and production of meat, dairy and fish in the European Union—PBL Netherlands Environmental Assessment Agency).

### **Other projects**

Cooperation in relation to ecolabelling – Harmonization of standards.

Cooperation on how to increase safety at sea.

Employee exchange programme.

## Marine Energy



**Figure 14.** Satellite image showing wind farms in Denmark, UK, Ireland, Norway, and Finland.

The ocean environment contains vast energy resources in the form of both non-renewable energy such as oil and gas and renewable energy such as wave energy, ocean current energy, and offshore solar or wind energy. From its inception, the marine energy sector has been dominated by oil and gas. One reason for this is that it has been difficult to develop technology that makes renewable energy viable in comparison to non-renewable energy sources. The renewable energy sector is still relatively small, but it is growing at a fast rate. Most of the expenditure in the sector has been on wind farms with some development in harvesting embryonic wave and tidal activity.

Offshore oil and gas is probably the world's largest marine industry in terms of the value of its output (i.e. the amount of oil and gas produced). According to a global market report from 2005 however, its size was estimated at only around €700bn in 2004. Although some small oil and gas fields remain, most of the shallow water producing regions are now in decline, a development which is causing major oil and gas companies to move to deeper water.

Population and income growth are the two most powerful driving forces behind the demand for energy. Since 1900, the world's population has more than quadrupled, real income has grown by a factor of 25, and primary energy consumption has increased by a factor of 22.5. World primary energy consumption grew by 45 percent over the past 20 years and is likely to grow by a further 39 percent over the next 20 years. Global energy consumption growth is estimated to average 1.7 percent per annum from 2010 to 2030, with growth decelerating gently beyond 2020.

Over the last 20 years, the world's population has increased by 1.6 billion people, and it is projected to rise by 1.4 billion over the next 20 years. The world's real income has risen by 87 percent over the past 20 years, with a likely rise of 100 percent over the next 20 years. At a global level, the most fundamental relationship in energy economics remains robust: more people with more income means that the production and consumption of energy will rise.

### Future trends

The next 20 years are likely to see continued global integration and the rapid growth of low and medium income economies. Energy consumption per capita in the same timespan is likely to grow at about the same rate as in the years 1970–1990 (i.e. 0.7 percent per annum).

But energy efficiency—measured very broadly as energy per unit of GDP—continues to improve globally, and at an accelerating rate. For the period 2010–2030, this accelerating improvement is true for the global average and for almost all of the key countries and regions. It is important because it restrains the overall growth of primary energy. Underpinning this trend are energy efficiency gains and a long-term structural shift away from industry and toward less energy intensive activities—first in rich and then in newly industrialized economies.

Prices, economic development (the rise and decline of the industrial sector), and energy policies (the promotion of energy efficiency) all play important roles in changing technology and the energy required to support continued economic growth (BP statistical review, 2011).

Energy consumption growth is driven by demand, the generation of power and the power industry in the developing world. China will be the world's biggest economy by 2030, and the question has often been raised whether energy growth can and will be sufficient to support high economic growth in China, or indeed in the wider group of industrializing countries.

The global fuel mix continues to diversify—and for the first time, non-fossil fuels will be major sources of supply growth. The contribution of fossil fuels to primary energy growth is projected to fall from 83 percent (1990–2010) to 64 percent (2010–2030), while the contribution of renewable fuels to energy growth is projected to increase from 5 percent (1990–2010) to 18 percent (2010–2030).

Offshore wind is one of the fastest growing markets, especially in the EU where investment in offshore wind is a core part of its energy strategy. To meet this trend, current plans leading up to 2020 will see between 20–40 terawatts of offshore wind power being developed, an equivalent of up to 10,000 wind turbines. With the annual market growth in Europe for offshore wind in the next 10 years expected to be approximately 25 percent, this means that there will be a need for the installation of 1,000 megawatts in 2010, a figure which will increase to 8,000 megawatts in 2020.

#### **North Atlantic Marine energy clusters**

Many of the countries belonging to the North Atlantic Marine Cluster are world leaders in activities associated with the energy sector. These countries have been able to develop a unique knowledge base and are experienced in using different means of harvesting energy.

#### **Denmark**

Denmark was the first country to discover oil in the North Sea and is the only oil-exporting country in the EU today. In 2008, the value of the Danish oil and gas production was estimated at €9 billion. Around 600 companies are involved in the Danish oil and gas sector, which includes oil companies, suppliers, specialists, researchers, and educational establishments. The country is also leading in green technology and since the world's first offshore wind farm was erected in Denmark in 1991 in the southern part of the country, a significant industry has emerged that is involved in renewable energy. Operators, producers, sub-suppliers of products and services, together with a range of research and educational institutions are all involved in a highly active and focused way in this sector.

Denmark is among world leaders in harvesting renewable energy and the country has hundreds of onshore facilities and several offshore wind parks. According to the Energistyrelsen, the state energy regulator, the share of installed offshore megawatts jumped from 423 megawatts in 2008 to 868 megawatts in 2010. The total installed capacity at land and at sea equalled 3.8 gigawatts last year, representing 25 percent of the country's electricity demand. The Danish government is aiming to have wind energy represent 50 percent of electricity consumption by 2020, and to phase out fossil fuel use by 2050.

#### **Cluster activity**

##### **Offshore Center Danmark**

Offshore Center Danmark has been in existence since 2003. In 2006 the cluster became a regional technology centre, with the task of making the region around the offshore town of Esbjerg ready to make use of its highly specialised knowledge with a view to bringing about growth and jobs. Eight thousand of Denmark's thirteen thousand jobs in the offshore sector are located in Esbjerg Municipality. Offshore Center Danmark was accredited with national innovation centre status in 2008. Today the main task for the centre is to support and strengthen the Danish offshore industry's efforts to remain perpetually competitive.

240 member companies and institutions are participating in the cluster project. Focus areas are oil and gas, offshore wind, the offshore maritime area, and wave energy.

Offshore Center Denmark has organized more than 50 conferences, hosted workshops within offshore-related subjects, and coordinated more than 40 industry development projects. The centre works through initiatives and activities that develop knowledge and promote the cooperation among all the players in the Danish offshore sector: Industries, consultants, educational institutions and the authorities.

For further information, log on to the cluster website: <http://www.offshorecenter.dk>

#### **Innovation Network for Renewable Energy VE–Net**

The network began its life in 2006 as a high-tech network in the energy sector. In 2010 it became a part of the innovation network programme, which emphasises the establishment of new innovative projects.

Innovation Network VE–Net is a nationwide network in which participants from all energy areas and energy systems can meet.

Participants in the network are research and scientific institutions, industry associations, and companies, all of whom are involved in the interaction between and across energy systems and energy technologies. The aim of such interaction is to strengthen the opportunities for increased use of renewable energy and technologies in all parts of the Danish energy forum.

The Danish energy market is characterized by many small energy-producing plants equipped with various technologies. The actors of the VE-Net will focus on future solutions and the technology needed to achieve these solutions by linking the various technologies together.

Innovation Network VE-Net will contribute to a strategic restructuring of the Danish energy sector from being a consumer-controlled production environment to a production-driven consumption environment.

For further information, log on to the network website: <http://www.ve-net.eu>

### **Norway**

Over last 40 years Norway has become an important supplier of oil and gas. There are 70 fields in production on the Norwegian continental shelf with production in 2011 reaching 2.0 million barrels of oil per day. Norway is ranked as the seventh largest oil exporter and the fourteenth largest oil producer in the world. The country produces 100 billion standard cubic metres of gas in 2011, making it the world's second largest gas exporter, and the world's sixth largest gas producer.

Norway provides much of Western Europe's crude oil and gas requirements. Exports of petroleum products in 2010 amounted to almost NOK 500 billion, accounting for approximately 47 percent of total exports. In addition, offshore exploration and production have stimulated onshore economic activities and vast amounts of capital have been invested in exploration, field development, transport infrastructure, and onshore facilities. The activities associated with the petroleum resources have created a growing service and supply industry, with a turnover of approximately NOK 248 billion in 2009. Some of these suppliers have gained a strong international position. This part of the industry has increased its international sales more than fivefold in the last 15 years.

The total number of employees in oil and gas-related activities amounts to approximately 75,000. Only 35 percent of the employees in the oil industry work offshore. The largest percentage of those employed in the sector—around 45,000 people—work in the Stavanger area. Stavanger houses all major international operators, approximately 280 oil service companies, and all the main suppliers along with Norway's official administrative centre for the petroleum industry.

Norway has a rather high renewable energy share compared to other countries. This is mainly due to extensive production of hydropower. The main obstacle to further increasing the renewable share is

that energy used for transport purposes is mainly based on fossil fuels: transport consumption constitutes about one quarter of total energy consumption

## Norwegian clusters

### Offshore Oil and Gas clusters

#### NCE Subsea

The NCE Subsea cluster was established in 2007 and is based in Bergen. The cluster's aim is to work towards the internationalization of the subsea industry in the Bergen region. Around 100 companies and organizations now count themselves as cluster members.

The Bergen area in Norway constitutes a cluster in subsea technology. Focusing on the markets for maintenance, modification and operation, as well as innovative products, the cluster provides a full spectrum of products and services for the industry.

The subsea industry in the Bergen area has both a higher rate of employment and economic growth than other comparable industries. Most of Statoil's activities related to installation and the operation and maintenance of subsea equipment on the Norwegian Continental Shelf are handled from the Bergen area. Three of the world's leading suppliers of subsea production systems also run their installation and maintenance activities from the region. This has led to the establishment of a great number of subcontractors and the development of a unique level of expertise.

In 2008, the subsea industry in the region employed more than 4600 people and had a turnover of NOK 11.6 billion. More than 100 companies and organizations are now a part of the NCE subsea cluster

The cluster offers financial and technical support to encourage innovation. Projects with NCE Subsea involvement of have received more than NOK 470 million in project funding.

For further information, log on to the cluster's website: <http://www.ncesubsea.no>

#### NCE NODE

NODE, or Norwegian Offshore & Drilling Engineering, was established in 2005 as a cluster project for the supplier industry in southern Norway and is based in Kristiansand. Its vision is to assist in assuring that the oil and gas industry in southern Norway will maintain its position as a global leader, regardless of outside competition.

Several of the companies have gained a unique market position in each of their segments. The companies deliver everything from complete platform solutions to high-technology equipment for use on platforms and ships. Their client list includes both national and international rig owners as well as oil and shipping companies.

At the end of 2010, fifty-one companies were participating in the programme. Their total turnover was around NOK 40 billion.

For further information, log on to the cluster's website: <http://www.nodeproject.no>

#### Arena Centre for smart and safe wells

The target of Arena Centre for smart and safe wells (CSSW) is to develop solutions and technologies that enable the better exploitation of oil reserves. The network has a well-defined strategy: focusing on the close collaboration between the E&P companies and the related cluster of service and vendor companies.

Finding new and accessible oil fields and reservoirs is a task that is fast becoming more and more difficult, while costs related to well construction and production are on the increase. At the same

time, the optimization of production from mature fields and new but small fields is becoming increasingly more important. The main drivers for achieving this optimization are proper planning, know-how, and new technology.

Both small and large companies within CSSW work in close cooperation with the industry and come from a variety of technology companies, R&D institutions, academia, and public institutions.

The centre has three focus areas:

- research;
- testing and verification; and
- educational development.

The aim of CSSW is to be a driving force for the development of new technology within the drilling and well segment of the oil and gas industry and to be a strong, organised arena for technology and innovation, marketed through meetings, conferences, international network, bulletins, and website.

For further information, log on to

[http://ekstranett.innovasjon Norge.no/templates/Page\\_Meta\\_\\_\\_\\_57732.aspx](http://ekstranett.innovasjon Norge.no/templates/Page_Meta____57732.aspx)

### **Arena Preparedness & Protection**

The partners within Arena Oil Spill Solutions aim to be an active development group: their objective is to develop world-leading solutions within the field of oil-spill preparedness. Norwegian authorities have implemented some of the strongest measures in relation to oil-spill preparedness for coastal zones in the world. In order to comply with these demands, considerable improvements are required vis-à-vis technology, overall solutions, competence, and organization.

The cluster consists of private companies with products and services relevant for oil spill preparedness, R&D institutions, investment companies, and companies with specialized expertise. The Norwegian Coastal Administration (NCA) is a cooperating partner. NCA is the Norwegian national agency for coastal management and marine safety and communication. The key companies within the cluster are situated in the region of Lofoten, Vesterålen, and Southern Troms. While some are experienced exporters, others have concentrated on the home market.

The commercial objective of the cluster is to establish a competitive network of suppliers that offer integrated solutions to a demanding national and international market. The oil industry and public authorities are the most important customer and attracting customers into the process is important to keep up with existing standards.

Participants' main goal is to represent a complete industrial cluster within oil spill preparedness. The cluster also strives to represent a motive power for development for each partner in order to succeed commercially. It intends to do so by focusing on innovation in the individual company, interaction apropos of common important initiatives, and introducing the cluster on the international market. Innovation and implementation of new solutions are important to the cluster. It also has a strong focus on equipment, technology, and services, as well as the organization and management of operations.

The cluster project is financed by the partners themselves, the national Arenaprogramme, and Innovation Norway.

For further information, log on to the cluster's website: <http://www.arenaberedskap.no/>

### **Arena Integrated Operations**

Arena Integrated Operations use ICT solutions based on real time data to integrate work processes across professions and between organizations. With the help of smart real time solutions, operations can be managed independently of distance, for example between offshore platforms offshore and

onshore operation centres. By using video and visualization tools, an expert can solve a drilling problem in real time from anywhere in the world.

The cluster focus is on creating opportunities through the innovation of new technology and new forms of collaboration. Its aim is to establish an industry environment in which the cluster is the world leader in integrated operations and real time management of reservoirs. The cluster's main objective, then, is to contribute to the added value within the industry through increased profitability and competitiveness among cluster participants.

For further information, log on to the cluster's website:

[http://ekstranett.innovasjon Norge.no/templates/Page\\_Meta\\_\\_\\_57738.aspx](http://ekstranett.innovasjon Norge.no/templates/Page_Meta___57738.aspx)

### **Arena Offshore Support Vessel—offshore technology and operations**

Owned by Haugaland Kunnskapspark (Haugaland Knowledge Park) in Haugesund, Arena Offshore Support Vessel was started in January 2009 and was supported by Arena until 2011. Out of the 120 companies that form the NOK 33 billion petromaritime cluster, 20 active companies are active in the programme.

Advanced technology within offshore operations is the core expertise of the offshore cluster in Haugaland and Sunnhordaland. The cluster aims to be an international leader within complex offshore operations, both on board and from ships. The cluster currently comprises 120 companies that are developing technology and operational solutions for the performance of complex operations on board and from offshore vessels. The aim of the project is to provide increased competitive power and value creation within this maritime cluster.

Future oil prospecting and drilling in the Arctic and the northern regions provide new challenges. They will take place in deeper water, in tougher climatic conditions, and through operations that are more remote from the mainland. This especially applies to activities from ship to seabed. Haugaland and Sunnhordland are regions with a strong knowledge base. The majority of Norway's shipping companies, shipyards, and suppliers are all closely integrated with the oil and gas value chain.

To improve recruitment and competence development, the cluster has entered into collaboration with Stord/Haugesund University College. Closer cooperation between the cluster participants, the maritime industry, and other R&D environments is also given considerable emphasis.

For further information about the Arena programme, log on to the cluster's website: <http://arenaprogrammet.no/>

### **Offshore renewable energy**

#### **Arena NOW (Norwegian Offshore Wind)**

The broad and innovative scope of the energy-related industrial and research environment in Norway's Hordaland and Rogaland counties has led to the development of a business cluster that focuses on a key element of the future of energy production—wind.

Arena Norwegian Offshore Wind (NOW) comprises companies representing the entire offshore wind value chain in conducting environmental studies, project development, engineering, supply of infrastructure, installation, and operations of wind farms.

The cluster's aim is to offer both services and products with particular emphasis on marine and offshore operations, where the Norwegian industry holds a strong position resulting from 40 years of accumulated experience from the North Sea oil and gas activity.

Though Arena NOW is still a young cluster, it already features over 50 companies, several of which are involved in developmental projects in the United Kingdom, Germany, the Baltic States, the United States, and Benelux. This participation includes the entire range of expertise from the fields of



engineering, procurement, production, and installation (EPCI-contracts). Through Arena NOW, measures are being taken to increase the innovation rate and capacity in the cluster via increased interaction between companies, research institutions and authorities.

One important project that will contribute to the continuing development of the cluster's overall skills and cooperation will be a pilot installation of a complete Norwegian produced offshore wind turbine facility in 2012.

For further information, log on to the cluster's website: <http://www.arenanow.no>

### Arena Wind Energy

Arena Wind Energy is a cluster where innovative industrial companies, power companies, and strong R&D communities come together to provide the foundation for a strong international position in the supply of offshore wind from mid-Norway.

Over 40 industrial companies and power producers are located in the region; in close cooperation with the R&D segment, these have been key in the mobilization of the cluster. The driving force for both established businesses as well as newcomers is a strategic partnership that puts Arena Wind Energy a strong position in preparation for the EU's large-scale development of offshore wind farms leading up to 2020.

Cluster cooperation is the result of a long history of success in mid-Norway. Since the 1980s, regional power companies have had a fruitful cooperation with the Gas Technology Centre NTNU-SINTEF in developing expertise and experience in wind energy. Expertise gained from the oil and gas sector is used to further the development of substructures for offshore turbines.

Cluster partnership will continue to be developed through joint projects, networking, and the ongoing internationalization process. Already, a strong alliance has been established between Arena Wind energy, the wind cluster Arena NOW on the west coast, and research centres in offshore wind

For further information, log on to the cluster's website: <http://www.windcluster.no>

### Canada

As the fourth largest contributor to Canada's GDP, the energy sector is one of the cornerstones of the country's economy. In 2011, it contributed 6.5 percent or C\$81.7 billion of overall GDP.

Canada is a major producer of oil: its oil industry produces over 2.6 million barrels of oil per day with a national industry value of C\$120 billion a year. The country is the seventh largest producer of crude oil in the world, and the third-largest producer of natural gas. The industry domestically employs 550,000 people (direct & indirect).

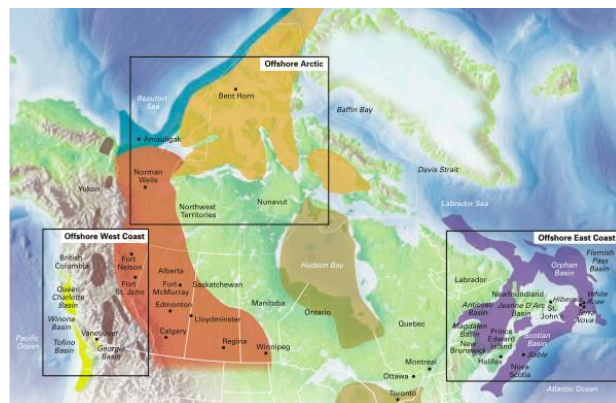


Figure 15. Canada's sedimentary basins. Source: Industry Canada, n.d.

A supply and service industry has been developed over the years, offering specialized skills and equipment and new approaches to worker training, safety management, government industry collaboration, public consultation, environmental protection, and scientific research.

Large amounts of crude oil and natural gas are located in sedimentary basins beneath the ocean floors off Canada's shores. The offshore industry has focused primarily on the East Coast due to the wealth of resources there and the region's close proximity to the large export market in the United States. On the West Coast, the government of British Columbia and the federal government are

consulting stakeholders in preparation for the possibility of renewed offshore petroleum exploration and potential development. Canada is ranked third in the world in crude oil reserves, after Saudi Arabia and Venezuela

The oil and gas industry has invested billions of dollars in seismic surveys and drilling to explore the petroleum potential off Canada's coasts. Additional billions have been spent for production and transportation facilities. The offshore petroleum industry has also made a substantial contribution to knowledge of the seas and resources off Canada's coasts.

### **Cluster activity**

#### **OceansAdvance**

A part of the OceansAdvance programme focuses on offshore energy in both the oil and gas sector and in renewable energy. Subsectors include transportation, seismic survey, production/processing, exploration, emergency response and drilling.

#### **The Ocean Renewable Energy Group (OREG)**

OREG was established in 2004 and has a member count of 50 at the beginning of 2012. The Group's mission is to align industry, academia, and government to ensure Canada's world leadership in providing ocean energy solutions to a world market.

OREG aims both to support the ocean energy developments in Canada's rivers, Atlantic and Pacific Oceans and to encourage the realisation of Canada's ocean energy resources, technologies, and project capabilities.

For further information, log on to the Group's website: <http://oreg.ca>

### **Scotland**

Scotland is home to more than 2000 companies in the energy sector; together they are operating in over 100 markets. Key energy sectors in Scotland today include:

- Oil and Gas
- Marine (wave and tidal)
- Offshore wind
- Onshore wind
- Fuel cells
- Solar power
- Bioenergy

Today the experience and expertise built up by Scotland's oil and gas industry is assisting the energy sector's diversification into renewable energy. Years of oil and gas production have created a strong supply chain, extensive skills base, a renowned academic sector, and an investment environment that is conducive to growth.

The Scottish North Sea continues to offer long-term prospects: reserves of oil currently stand at around two billion tonnes—as much as has been produced in the last 25 years. Scotland's gas fields contain a maximum remaining reserve of 1330 billion cubic metres.

Scotland's natural energy strengths are:

- 25 percent of Europe's wind resources
- 70 onshore wind farms with a current capacity of 1.8 GW
- Around 25 GW potential offshore wind capacity
- Around 7.5 GW potential tidal energy capacity
- Around 14 GW potential wave energy capacity

The industry is supported by an established network of energy centres of excellence that are leading providers of research and development opportunities.

For further information, log on to <http://www.sdi.co.uk/sectors/energy/strengths.aspx>

The UK government has spent substantial time and financial resources on marine power, both in the form of wave and tidal power. Scotland's energy sector is heavily involved in this development. In 2011, the then UK Minister for Energy and Climate Change Chris Huhne announced £20 million in funding to take marine energy into the mainstream and to the next level of development. It is estimated that wave and tidal power will have the potential to meet 15–20 percent of the UK's electricity needs by 2050 and could be worth a potential £15 billion to the economy.

Britain aims to be a world leader in marine power technology by utilizing decades of expertise in offshore industries. One developer already moving ahead with a utility-scale wave energy device is Ocean Power Technologies in Scotland. The company has installed a 150 kilowatt device designed to be deployed in arrays, 33 miles off Invergordon. The ocean trials have yielded peaks of over 400 kilowatts and an average power of 45 kilowatts in wave heights as low as 2 meters.

Scotland has ambitious plans when it comes to implementing and harvesting renewable energy resources. By 2020, it aims to meet 100 percent of energy demand by renewable energy. Currently 30 percent of energy comes from renewables, both from wave and tidal devices and from offshore energy sights.

#### **Cluster activity**

There are a number of initiatives in the energy sector in Scotland that are called clusters. One such cluster, the West Coast Cluster, focuses on offshore renewables development sites; another, the Northern Marine Energy Cluster, also focuses on development sites. There are also a number of energy centres of excellence such as the University of Aberdeen Oil and Gas Centre, the Scottish European Green Energy Centre (SEGEC), the European Marine Energy Centre (EMEC), and the BioMara project in which researchers are looking at the economic, social and technological aspects of generating bio fuel from algae.

#### ***Ireland***

The oil and gas industry in Ireland is made up of two subsectors: oil and gas exploration and the extraction and production of gas. Ireland has been a producer of gas since the discovery of gas reserves in Kinsale, Co. Cork, in 1971. The turnover generated by oil and gas exploration and production is currently around €197 million. The oil and gas exploration and production subsector employs approximately 790 individuals. Companies involved in the extraction and production of gas in Ireland are based in Cork and Dublin. However, the companies that provide services to the gas production companies are located across the country. It is estimated that Ireland's offshore Atlantic margin holds a substantial potential for hydrocarbon reserves; however considerable drilling is required to test this. Appreciable resources have already been used in exploration activity, with an estimated cost at around €3 billion that has resulted in four commercial discoveries. Five percent of the Irish economy's supply currently comes from these offshore gas reserves.

In the period 2004–2010, the SEAI (Sustainable Energy Authority of Ireland) has identified and categorized over 700 energy-related research and development projects on the island that are led by over 200 Principal Investigators across twenty-one academic institutions. These projects represent €174 million in research and development funding from various sources, including government, industry, and the EU.

The SEAI works on creating improved coherence in the nation's energy research landscape and on presenting a useful resource for stakeholders in government, academic institutions, and industry.

The marine renewable sector is still comparatively small with a turnover of around €101 million in 2007. But there is potential for growth. According to a report published in 2010 by Siemens Ireland,

Ireland has one-third of all of North West Europe's renewable energy resources, including the world's most energy-intensive waves and Europe's highest wind speeds.

#### **Cluster activity**

##### **IMERC (Irish Maritime and Energy resource cluster)**

IMERC was launched in March 2010. The cluster's vision is to promote Ireland as a world-renowned research and development location that will unlock the island's maritime and energy potential. The idea is to develop an ecosystem of innovation that will support job creation in a unique cluster and campus location. The cluster is situated in the National Maritime College of Ireland in Ringaskiddy.

Three public bodies—University College Cork, the Cork Institute of Technology, and the Irish Naval Service—have embarked on a bottom-up approach to public sector transformation. The transformation is being achieved via reorganisation within the respective organisations and via strategic collaboration across them.

This tripartite alliance which forms the core of IMERC is working to provide researchers, technology developers, companies (especially SMEs), and investors with the critical tools to build value in terms of creating relationships that will make alliances and supporting infrastructure more accessible and effective in the maritime and energy sectors.

The cluster has set specific targets such as creating 70 new research jobs by 2014, incorporating five companies by 2015, and securing two foreign direct investment clients by 2016. Today IMERC industry clients range from small and medium enterprises (SMEs) to multinational corporations.

For further information, log on to the cluster's website: <http://www.imerc.ie>

#### ***Sweden***

Sweden has invested heavily in the search for alternative energy sources, an investment that has proven relatively successful. In 2009, oil accounted for 32 percent of energy consumption and 45 percent of Sweden's energy supply—in electricity, district heating, and fuel—came from renewable energy. However, Sweden has not been active in developing the offshore energy sector, and only two percent of all the electricity produced in Sweden comes from offshore wind power. This inactivity notwithstanding, a number of shallow waters and offshore banks within Sweden's territorial sea and exclusive economic zone are of interest for the establishment of such installations.

#### **Cluster activities**

##### **Ocean Energy Centre**

Ocean Energy Centre was established in 2011 as an innovation platform for ocean energy technologies, ranging from marine biofuels to wave, tidal, and offshore wind power.

The centre's mission is to advance the ocean energy sector domestically and internationally. This is being done by initiating and coordinating collaborative research and development projects based on generic industry challenges, strengthening the stakeholder network, and increasing the visibility of ocean energy.

Nine partner organizations contribute both financially and in kind to the centre. They include four leading Swedish development companies within wave and tidal power, one consultancy, and two research institutes, Chalmers and the Region of Västra Götaland. In addition, the centre is building a member network with private companies and public organizations that have an interest in promoting the ocean energy sector.

Ocean Energy Centre is hosted by the Department for Shipping and Marine Technology at Chalmers in Gothenburg, Sweden.

For further information, log on to the centre's website: <http://oceanenergycentre.org>

### ***Finland***

With five different power sources each contributing more than 10 percent of total supply, energy supply in Finland is quite diverse. Domestic production is largely based on renewable sources, with significant nuclear energy production. There has been little emphasis on offshore wind or on marine-related energy.

### ***Iceland***

Iceland has been active in harnessing renewable energy for almost 50 years. 80 percent of the country's electricity needs are met with hydropower plants and 20 percent by geothermal fields. Geothermal water is used to heat around 90 percent of the island's homes. The energy sector is expanding continuously, and the country is now exporting expertise in this field. New hydroelectric power stations have been built and untapped opportunities are still waiting to be tapped. Many ideas are being developed on exporting electricity by means of cable to the UK or Scotland.

One of the outstanding problems that need to be solved is how to move the country's remaining fossil-fuel dependent sectors to clean technology: Iceland's fishing fleet, and its imported cars and buses are all still run on oil and petrol.

Two areas on the Icelandic Continental Shelf exist that are thought to have potential for commercial accumulations of oil and gas: the Dreki area east and northeast of the island and Gammur on the island's northern insular shelf.

### ***Faroe Islands***

The Faroes are extremely dependent upon imported oil, both for domestic heating and for the fishing fleet. Though oil-based thermal energy still supplies most of the electricity, there has been an increased focus on sustainable energy resources in recent years. Hydropower capacity now amounts to over 100,000 megawatt hours, an increase of 33 percent in 15 years, while wind turbines account for more than 15,000 megawatt hours. Apropos of wind energy, the potential for harnessing the energy is vast, but wind force variations, especially the powerful gales that can damage the equipment, are causing numerous difficulties.

There is an on-going exploration for potential oil reserves in the seas around the islands, but the results have not returned the anticipated results. The activity associated with the exploration has however created a number of new initiatives associated with the energy sector.

### ***Greenland***

Greenland is seen as a potential future exporter of oil and energy. For instance, some mapping of the west coast of the country has been carried out, the results of which have revealed the possibility of utilizing 20 percent more hydropower energy than in Iceland. Though the east coast of the country has not been mapped, it is not unlikely that scientists would find as many opportunities for hydropower energy there.

### **Opportunities**

Numerous possibilities for growth in the offshore energy sector exist. Utilizing new oil reserves in northern regions will be easier with climate change and better technology. The Northern Hemisphere is home to approximately 25 percent of all unused energy resources. The biggest challenges in tapping these sources are lack of transportation infrastructure to markets and the difficulty of spill clean-up after accidents in inhospitable Arctic waters.

Many possibilities associated with the construction of new hydropower plants also exist. Modern technology has made cable energy transfer easier than ever before. And with this form of energy transfer there would only be an energy loss of between 2–5 percent.

21st century governments are under increasing pressure to reduce the use of fossil fuels and to increase the harvesting of renewable energy. Part of the solution is the development of offshore energy and wave and tidal energy technology. EU countries have introduced the 20/20 plan, for example, which revolves around increasing the use of renewable energy to 20 percent in 2020.

For some years now there have been plans in Scotland and the UK concerning wind farms and the distribution of energy from Scotland to the rest of UK. These plans can be linked to ideas about the European supergrid, the idea for which gained momentum in December 2011 with the signing of an agreement by all 10 nations bordering the North Sea to coordinate the deployment of new HVDC cables. The North Sea offshore grid initiative aims to link renewable energy generation across the North Sea, including wind power from the UK, solar power in Germany, and hydropower in Scandinavia, maximizing the use of renewable energy (Carrington, 2011). Under the current EU global warming plan “to save the planet”, the UK and Ireland are to become large producers of offshore wind energy, and eventually tidal and wave energy too. In time its intended this renewable source of energy will be fed into an evolving European supergrid (Irvine, 2011).

As large offshore islands jutting out into the North Atlantic and close to the energy producing countries of the North, the islands of the UK are propitiously placed to site large-scale wind projects. In this decade and the next, a whole slew of new projects are in the pipeline..

## Marine Transport

The shipping industry plays an indispensable role in connecting consumers with their most valued goods. Some 90 percent of world trade tonnage is transported by sea. Increasing activity and demand translate to growth in demand for services of freight companies. Indeed shipping can be looked at as a barometer of world economic activity. Steady growth in world trade and increased globalisation have been the causes of the vigorous growth in seaborne trade in the last 40 years—from 2,566 million tonnes in 1970 to 8210 tonnes in 2009. Not surprisingly, there was a drop in activity to 7843 million tonnes following the economic crisis in 2008.

The past 40 years have also seen strong growth in the number of seaborne ships along with a noticeable trend toward larger vessels. The growth has primarily been in the tanker fleet, particularly the dry-bulk cargo fleet. The number of vessels with a size of 100 gross tonnes or more has increased by 75 percent to a total of 81,400 vessels. At the same time, a trend towards larger vessels has contributed to an increase in capacity of 129 percent to a total of 1,306 million deadweight tonnes.

**Table 13. Development of World Seaborne Trade- Selected years in millions of tons loaded**

Year	Million Tonnes
1970	2,566
1980	3,704
1990	4,008
2000	5,984
2008	8,229
2009	7,858

(Source: UNCTAD, 2011)

**Table 14. Development of World fleet by millions of dwt (Cargo Carrying vessels of 100 GT or more), selected years**

	1980	1990	2000	2010
<b>Other</b>	31	49	75	92
<b>Container</b>	11	26	64	169
<b>General Cargo</b>	116	103	101	108
<b>Dry bulk</b>	186	235	276	457
<b>Oil Tanker</b>	339	246	282	450

(Source: UNCTAD, 2011)

Because of differences in reporting standards and fluctuating currency values, worldwide totals are hard to grasp, but the industry's major trade group, the International Chamber of Shipping, estimates that marine shippers transported over 7.7 billion tonnes of cargo in 2008, covering more than 32 trillion miles and generating roughly \$380 billion in freight charges alone. Responsible for those shipping totals is a worldwide fleet of more than 50,000 merchant ships that are registered in more than 150 countries and employ more than one million crewmembers (Spears, 2011).

The Ports sector worldwide was worth €25bn according to figures from 2004, with Europe's share amounting to €10.5 billion. Over 8,000 ports and terminals are in existence worldwide, of which some 2,000 are significant. However, only the top 50 handle the majority of business (Marine Industries, Global Market Analysis).

Around 1,400 shipbuilders and repairers are listed worldwide. While Asia dominates the 'bulk' vessel market, Europe's emphasis has been on higher-tech, low-volume vessels (e.g. cruise and offshore vessels). In Asia, China's emergence as a shipbuilder now threatens the main players, Japan and Korea.

Performing an outlook analysis of the shipping industry is not an uncomplicated task. Conventional wisdom says that a higher level of economic activity means shipping services will be in greater demand, and shippers can charge higher rates and reap larger profits. But such a demand-profit relationship will not always prevail (Spears, 2011).

The decline in demand for goods during the 2008 crisis and the large supply of transport capacity in its wake resulted in great losses for the major shipping companies in the world. Some of the measures these companies took included reducing their capacity by reducing the number of ships or cutting costs by slowing down sailing speeds. In the first quarter of 2011, container freight rates climbed because of improving economic prospects combined with a shortage of shipping capacity. As a result, the average daily earnings for a ship capable of carrying 4,250 20-foot-equivalent units (TEUs)—an industry standard for measuring container freight, based on the length of a typical shipping container—rose to \$28,603, according to the Journal of Commerce. However, the profits of many shipping companies—and the prices of their stocks—actually fell in that time because of higher fuel prices, prices that substantially increased operating costs (Spears, 2011).

**Table 15. World Merchant fleet in 2011 according to type and owner domicile**

	Container	Tank	Dry Bulk	Gen. Cargo pas.
1	Germany	Japan	Japan	Japan
2	Japan	Greece	China	Germany
3	<b>Denmark</b>	Bermuda	Greece	China
4	China	USA	Korea South	Panama
5	Greece	Germany	Germany	<b>Norway</b>
6	Taiwan	China	Marshall Isl.	USA
7	France	<b>Norway</b>	Hong Kong	Italy
8	Singapore	Singapore	Chinese Taipei	Greece
9	South Korea	U.K.	Bermuda	Netherlands
10	U.K.	<b>Denmark</b>	U.K.	<b>Sweden</b>
11	Bermuda	Russia	Panama	Russia
12	<b>Canada</b>	Korea South	Liberia	U.K.
13	Israel	Italy	Turkey	Hong Kong
14	Marshall Isl.	Hong Kong	Singapore	Turkey
15	USA	Bahamas	<b>Norway</b>	Bermuda
16	U.A.E.	Saudi Arabia	India	South Korea
17	Cyprus	Panama	Italy	Indonesia
18	Islena Man	India	USA	<b>Finland</b>
19	Netherlands	Chinese Taipei	Cyprus	<b>Denmark</b>
20	Turkey	Iran	Brazil	Malaysia
21			<b>Denmark</b>	
22			Isle of Man	
23			<b>Canada</b>	

(Source: Clasen & Clausen, 2011).

During early spring 2011, demand continued to rise, but freight rates slipped because a number of new ships were launched and the major shipping lines had sufficient capacity to meet the demand (Spears, 2011).

Present prospects for a rebound in shipping look fairly promising. Global economies, while certainly not robust, continue to grow, a trend that should keep shipping demand sufficiently on the rise to absorb the recent excess cargo capacity (Spears, 2011).

Opportunities might lie with the operators of fleets that consist mostly of smaller vessels. This is because these operators have more flexibility in the types of cargo that they can carry, have proportionately lower fuel costs and have suffered less in the recent downturn (Spears, 2011).



It is also worth looking at companies that provide both ocean-going and inland shipping services, or that have non-shipping subsidiaries or divisions, since enhanced diversification of this kind will provide some extra downside protection if the broad economy falters (Spears, 2011).

The maritime sector is facing major challenges in today's globalized world. Competition from Asia is fierce and the countries in the North Atlantic region must be innovative to ensure that the region maintains its status as one of world's major shipping players. This is best done through increased cooperation.

The development towards increased wealth in emerging economies also offers opportunities. With 61.2 percent of all goods loaded and 55 percent of all goods unloaded, developing countries account for the largest share of global seaborne trade at the time of this report, a fact which reflects these countries' increased ability to face economic setbacks and to play an ever-increasing leading role in driving global trade. By contrast, developed economies' shares of global goods loaded and unloaded were 32.4 percent and 44.3 percent respectively. Transition economies accounted for 6.4 percent of goods loaded and 0.8 percent of goods unloaded (UNCTAD, 2010, p. 6).

### **North Atlantic Marine Transport Clusters**

Many of the countries that belong to the North Atlantic marine cluster have a substantial shipping tradition, evidenced in their large merchant fleets and strong service sectors associated with shipping. Countries such as Norway, Denmark, and Canada are among the world's leading nations in many areas associated with the transport sector.

Though Sweden and Finland do not occupy the same position in terms of merchant fleets, they are both formidable players when it comes to the subsector of passenger transport. Other countries have a smaller fleet but rely heavily on the shipping sector for the transportation of goods and in harvesting their resources. These countries are also experiencing the increase in ocean-related traffic in the marine areas that they are controlling.

### **Denmark**

With its more than 11.8 million gigatonnes, the Danish merchant fleet constitutes 1.2 percent of the world fleet, which makes it the 18th largest in the world. In addition, Danish shipping companies own a significant number of ships under foreign flags, thus bringing the Danish-owned fleet up to more than 25 million gigatonnes (excluding specialized vessels), or 8th in world ranking, only exceeded by the largest industrial countries and *the* traditional shipping nation, Greece. A further doubling of numbers in terms of Danish shipping's international importance results from including vessels chartered or otherwise controlled by Danish interests, i.e. as a result of operator activity. This brings the figures up to more than 1,600 ships or 46 million gigatonnes, making Denmark among the 10 largest shipping nations in the world. Danish owners and operators transport approximately 10 percent of the world's seaborne trade.

Shipping is Denmark's single largest export industry, with approximately 17 percent of national exports. Danish shipping's foreign currency earnings have shown strong growth in the last decade, culminating in 2008 with 190 billion DKK, though the financial crises did set the figure back to 140 billion in 2009. An improvement on earnings was expected in 2010, but the final figure of 175 billion exceeded all expectations. It seems safe to say, then, that shipping maintains its position as the single most important contributor to the Danish balance of payments.

### **Cluster activity**

#### **Maritime Development Center of Europe (MDCE)**

MDCE has a joint co-operation with the Society for the Promotion of Danish Shipping and the Society for Naval Architecture and Marine Engineering. This joint co-operation is designed to strengthen the maritime sector and facilitate a single point of entry for the industry. MDCE represents the Danish Maritime Cluster and Shortsea Promotion Denmark.

MDCE is a non-political network organisation working to support and strengthen the maritime industry in Denmark. They do so by supporting the implementation of the European Maritime Transport Strategy; by attracting resources and international projects to the industry; by encouraging and supporting maritime entrepreneurs; and by working to develop maritime education at all levels. MDCE also supports innovation and knowledge sharing and promotes the Blue Denmark internationally.

The goal of the Danish Maritime Cluster project is to strengthen the level of competence in the maritime business cluster. The activities associated with the project are intended to contribute to growth in the maritime sector. It aims to secure jobs and to maintain the Danish maritime business cluster's position as a world leader.

To bring the maritime competencies to the highest level, the existing offers of education must be strengthened. The project will include the development and creation of several graduate programmes, as well as the creation of better opportunities for the likes of engineers, officers, navigators, and shipbrokers in their pursuit of higher education.

In addition to the need for highly qualified maritime employees, there is also a need to support growth and innovation in the business sector. To this end, the project will also include efforts to promote the use of graduates in Danish SMEs. Moreover, the project will launch activities to map and develop innovative projects, along with promoting collaborative efforts between businesses, educational institutions, and authorities. The goal is to increase innovation and value creation capabilities in the maritime business sector.

The most important part of the project is the collaboration between businesses, authorities, associations, research institutions, and educational institutions. The involvement of the maritime industry and other maritime stakeholders will ensure that the developed competencies are tailored to both current and future challenges. This sort of collaboration creates a situation in which the projects in the Danish Maritime Cluster can be focused on the very specific needs that will ensure that the Danish business sector is ready to compete on the global market.

The Maritime Development Centre of Europe also has a particular focus on innovation through the facilitation of the Transport Innovation Network (TINV). TINV is a cross-sectoral network that works to encourage and support increased innovation in the entire Danish transport sector. The network is dealing with present and future challenges and has a particular focus on sustainable solutions in the transport sector such as alternative fuels, short sea shipping, CSR, and mobility management among other things. An important part of TINV's focus areas is to support matchmaking between SMEs, to support and initiate public private partnerships, and to encourage cooperation between private stakeholders, authorities and research institutions. All this is done to strengthen the competitiveness of the Danish transport sector by developing new technologies and investigating new business opportunities.

For further information, log on to the centre's website: <http://www.maritimecenter.dk/>

### ***Norway***

Norway is a large exporter of traded goods and this has led to demand for ships to carry goods. The country has one of the world's largest fleets and a strong maritime industry. Though Norway represents only 0.1 percent of the world's population, the country controls over 5 percent of the world's merchant fleet and has the second largest offshore fleet in the world, after the USA. Shipping companies are the core and driving force of many communities; their work includes everything from ocean transport to ship's equipment, shipbuilding, shipbrokering, financing, insurance, classification, and maritime offshore oil-related activities. A number of studies have characterised this community as being the most internationally competitive and know-how based industry in Norway. It is estimated that this sector provides around 80,000 jobs in Norway today.

Norway also occupies a strong position when it comes to land-based shipping operations. In marine insurance, Norwegian companies claim a 30 percent share of the global market, and Norway classifies 15 percent of the world tonnage. In addition, Norway is also home to many manufacturers of marine gear, several large shipbrokers, two of the world's largest shipping banks, and internationally renowned institutes in shipping economics and technological research and development.

### **Clusters activity**

#### **NCE Maritime**

NCE Maritime is based in Ålesund on the west coast of Norway in the Møre region. The cluster is composed of

- 15 design companies;
- 14 ship yards;
- 17 ship-owner companies; and
- 155 equipment suppliers.

The cluster employs a total of 20,000 people and has a turnover of around 49 billion NOK.

NCE Maritime comprises a complete value chain and includes players from the shipping, ship design, shipbuilding, equipment supply, research, education, and finance sectors. The cluster companies operate on a global scale and are leading international heavyweights. Many of them operate all over the world. Famous brands such as Rolls Royce Marine, STX OSV, Farstad Shipping, and Ulstein Group have their main activities in Møre, together with many others.

For further information, log on to: <http://www.ncemaritime.no>

#### **Oslo Maritime Network (OMN)**

Oslo's maritime community spans services from finance, equipment, shipbrokers, legal, insurance, classification, to research and development and education. The greater Oslo region is the centre of the deep-sea shipping and services industry, with 10,000 maritime employees stretching from the southern cities of Sandefjord and Larvik northward to Kongsberg and Drammen.

OMN's main task is to facilitate cooperation across the sectors and bring to life ideas that will enable more efficient and environmentally friendly shipping.

Oslo Maritime Network is a non-profit membership network gathering members from all segments of the maritime cluster in the greater Oslo region. There are currently 60 members.

The most important OMN initiative has been the creation of the Global Maritime Knowledge Hub. So far the hub has set up 14 of 20 planned professorships at Norwegian universities. Each professorship is funded by a maritime company and given a specific priority focus of study.

Another important initiative within the field of innovation falls under the concept of "Springboard," which has its origins in the Silicon Valley ICT environment. Springboards provide an intensive meeting between promising young companies and expert panels with a view to putting companies on a fast track to successful commercialization and new markets.

For further information, log on to: <http://www.oslomaritime.org>

#### **Arena Maritime CleanTech West, Hordaland**

Maritime Clean Tech West received an Arena cluster status in 2011. The cluster consists of yards, ship owners, equipment producers, research institutes, and maritime services on the western coast of Norway.

The cluster's projects include:

- Implementing new energy systems in coastal vessels

- Combining new energy systems, e.g. batteries, LNG /gas, fuel cells, double layer capacitors
- Developing/implementing infrastructure for testing the technology needed
- Looking for international partners, e.g. R&D institutes and/or suppliers of energy systems (batteries, fuel cells) that would like to join the project

The project has applied for funding from Innovasjon Norge. EU financing is also relevant for the project.

For further information, log on to the cluster's website: <http://www.maritimecleantech.no>

#### **Arena Leisure Boat Manufacturers**

Through Arena Leisure Boat Manufacturers, manufacturers and specialist environments seek collaboration on long-term initiatives with a view to strengthening the boat manufacturing industry in Norway.

The largest business cluster associated with the leisure boat sector is located in Agder county and comprises 118 boat manufacturers and 40 percent of all Norwegian boat manufacturing. The common challenge faced in this structure is strong and increasing competition from large scale manufacturers in low-cost countries. In addition, the industry is highly affected by economic fluctuations.

By sharing competence between cluster participants and other specialist environments, both smaller businesses and the Norwegian leisure boat industry as a whole will be strengthened. The cluster is also seeking collaboration with R&D institutions. Its ambition is to strengthen the entire industry and the Agder region through long-term collaboration with the end goal of creating a strong and innovative boat manufacturing industry in Norway.

Formalised collaboration projects and initiatives that improve cost efficiency are initiated within areas such as industrial development, product development, market orientation, and increasing competence. Other important focus areas are environment-friendly manufacturing production and joint initiatives that aim to increase the export of Norwegian leisure boats.

For further information, log on to the cluster's website: <http://www.arenafritidsbaat.no>

#### **Sweden**

In 2008 Sweden had 451 Swedish-flagged vessels in the size category of 100 gross tonnes or larger. Swedish companies on the other hand operated 687 vessels, with a combined tonnage of 9.4 million tonnes. It was estimated that sales were around SEK 45 million. The number of people employed in the shipping industry/maritime transport in 2008 was estimated at between 13,200 and 18,900 people, of which between 9,400 and 14,100 were employed on board ships. It has been estimated that together with those that are employed in the shipping and related industries, the total number comes to around 105,000 people.

Approximately 70 percent of the industry is concentrated in the three metropolitan areas of Gothenburg, Stockholm, and Malmö.

#### **Swedish Maritime Technology Forum (SMTF)**

Established in 2007, Swedish Maritime Technology Forum is a not-for-profit organization. Its goal is to gather the complete maritime industry into one network. SMTF has 200 companies involved in all of its projects and has a regular membership of 40. The cluster focuses both on heavy shipbuilding equipment and components and on leisure yacht design and construction (Cooke, n.d.).

SMTF has resources of €1.2 million in public and private sector funding through Tilväxtverket (the Swedish Economic Development Agency), Region Västra Götaland, the European Regional Development Fund, and services to the market and membership fees (Cooke, n.d.).

The organization is currently working on the development of new and less environmentally damaging products, on efficient production, and on encouraging cooperation between firms, universities and public representatives. SMTF has put emphasis on the development of LNG shipping (liquefied natural gas) in Sweden. It is also working to increase recruitment and enhance regeneration in the maritime industry.

Greenshipping is one of the major projects promoted by SMTF. The project has resulted in the production of innovative designs for two merchant ships: a Ro Ro Ferry and a Tanker. Key parts of these ships are capable of massive reductions in CO<sub>2</sub>.

The Forum is addressed to the companies that are suppliers for the shipping, offshore and leisure boat industry. Its members specialize in engineering solutions, manufacturing, products and services in these areas.

SMTF's head office is located in Uddevalla.

For further information, log on to the forum's website: <http://www.smtf.se/>

#### **MARITIME FORUM—Shortsea Promotion Centre Sweden**

The Maritime Forum (in Swedish "Sjöfartsforum") was established in 1996. The Forum is based in Stockholm and is an association of around 100 fee-paying members. These members are companies, organizations, and authorities such as shipping lines, port companies, shipbrokers, universities, schools, unions, banks and finance institutes, technical suppliers and consultants, shippers, shipping organizations, authorities, and other companies related to the shipping industry.

The Maritime Forum's objective is to:

- increase knowledge about shipping as an industry and as a mode of transportation;
- communicate the possibilities and advantages of seaborne trade and transportation;
- highlight the important role that shipping brings to both the Swedish society and its industry;
- highlight the benefits of shipping as an interesting sector for employment and education; and
- stimulate openness, co-operation, and discussions within the shipping cluster.

The Forum's main external target groups are politicians, decision-makers, media, and young people. The cluster promotes intermodal transportation, short sea shipping, and inland waterway transportation. It also promotes the environmental benefits of sustainable ships design, along with the reduction of emissions from ships and knowledge of how sea transportation can contribute to a better environment. Other important promotional topics for the Forum include the importance of ports as economic and social hubs within Sweden, the challenges that future shipping faces, EU programmes such as Marco Polo and Motorways of the Sea, and recruiting.

The Maritime Forum is responsible for the Swedish celebration of World Maritime Day each September and arranges different types of networking activities for the shipping industry. The Maritime Forum is one of 20 members of the European Shortsea Network, which is a co-operation between the national short sea promotion centres within the European Union.

For further information, log on to the Forum's website: <http://www.maritimeforum.se>

#### ***Finland***

The Finnish maritime sector includes approximately 2,900 companies and employs around 43,000 people. The maritime industries have an indirect employment effect on around 500,000 people, however. Turnover in the Finnish marine industry was around €6 billion in 2010. The main strengths of the Finnish maritime transport sector are, among others, high technological and professional know-how and good know-how on arctic conditions.

The country has a number of companies that are leading in the field of ship engines and cargo handling and shipyards. Finland has a strong tradition in building cruise and passenger ships. The recession has however been the cause of some difficulties and a number of shipyards are currently empty. Sea transport has decreased and the registered merchant fleet is dwindling. There is also a strong need to renew the ageing segment of the merchant fleet. With the strong trend towards increased internationalisation, more foreign companies are operating in Finland and more Finnish companies are seeking partners from abroad.

#### **Cluster activity**

##### **Oske Maritime Cluster programme**

An extensive and diverse network of technology and equipment suppliers has developed around the maritime industry in Finland. The cluster pays particular attention to sustainable development and cost-effectiveness. Furthermore, it utilizes the business-driven development of products and network-generated services to create lead markets.

The Maritime Cluster Programme is surveying and identifying international growth-oriented business opportunities and new internationally competitive core competence bases with growth potential.

The maritime cluster encompasses five centres of expertise: Lappeenranta Innovation Ltd. (Southeast Finland Centre of Expertise), Technology Centre Oy Merinova Ab (Western Finland Centre of Expertise), ProMetal Oy (Raahe Region Centre of Expertise), Prizztech Ltd. (Satakunta Centre of Expertise), and Koneteknologiakeskus Turku Oy (Southwest Finland Centre of Expertise).

The strategy of the Maritime Cluster Programme is both to promote the development, training, and applied research in the maritime industry, shipping, and related businesses, and to improve the visibility of the maritime cluster. One of the Programme's strategic steps is to promote the creation of innovative products and services. It does so by focusing on activating the R&D operations of businesses and on measures that encourage enterprise growth.

Networks are of major significance to the cluster's operations. A special characteristic of project activities within the industry is networked operations, by means of which the cluster is reinforcing the competence of networked companies and research and product development. The various parts of the maritime cluster and other sectors are being encouraged and stimulated to cooperate in R&D with the maritime industry in order to reinforce the cluster's value chains and for the more effective implementation, commercialisation, and utilisation of Finnish innovations throughout the cluster.

The Maritime Cluster Programme coaches companies in adopting an international perspective and analysing their potential for operating in the international market. The national operations of the programme's centres of expertise, regions and cluster reinforce the nationwide networking of businesses and experts in the most strategic areas.

For further information, see the cluster's website:  
[http://www.oske.net/en/competence\\_clusters/maritime/](http://www.oske.net/en/competence_clusters/maritime/)

#### **Canada**

As a large exporter of raw material and competitor in the global market, Canada is in need of a strong and efficient maritime transportation industry.

Every year the Canadian shipping sector is responsible for 456 million tonnes of cargo and \$10 billion in economic activity. The country has 10,000 shipping companies trading while operating 50,000; the sector employs approximately 100,000 people. Nearly 600 public ports exist in Canada, with approximately 70 percent located in the eastern half of the country.

Most of Canada's ports are relatively small. The Port of Vancouver is the country's largest in terms of tonnage handled. It is the main terminal for goods moving between Canada and other Pacific Rim countries. The more northerly Port of Prince Rupert on the west coast offers the shortest sailing

distance between North America and Asia. The eastern ports of Montreal and Halifax are central to the country's trade activity with Europe, Africa, and the Middle East.

In addition to Canada's ports, the Great Lakes–St. Lawrence Seaway System play an important role in both domestic and international marine transportation. The seaway was opened in 1959 and is under the joint responsibility of the Canadian and United States governments.

#### **Cluster activity**

The OceansAdvance cluster has some members that are a part of the shipping sector, but most of its participants are in the service sector offering communications solutions, vessel monitoring, navigation, and performance evaluation, to mention a few areas of interest. The cluster's main focus is on improving cost efficiency and satisfying regulatory requirements that result from international conventions on operational safety, security, and the protection of the environment.

The Port of Montreal is playing a key role in a plan to create a logistics and transportation industrial cluster for the Greater Montreal region. The idea is to form a cluster that would bring together all players in the logistics and transportation sector in the region. The project is an initiative of the Montreal Metropolitan Community and has the support of the Quebec government.

### ***Ireland***

Sea-based transport accounts for over 99 percent of the total volume and approximately 95 percent of the total value of goods traded by the Irish economy. According to figures from 2007, the turnover generated by shipping in 2007 was €693 million, €294 million of which was from exports. The turnover generated by Port and Maritime Logistic services was €196 million.

Shipping employed 1,149 individuals in 2007, while related Port and Maritime Logistics services employed 1,045 individuals. The majority of shipping activity occurs around the nine commercial ports on the island's coast: Cork, Drogheda, Dublin, Dundalk, Dun Laoghaire, Galway, New Ross, Foynes, and Wicklow.

A major boost to the industry was the introduction of the highly competitive tonnage tax regime, which made Ireland an attractive fiscal environment for shipping companies. It encouraged existing Irish companies such as Arklow shipping and others, to expand their Irish fleet and to put a halt to the trend of moving Irish fleets to foreign registers (Mason Hayes & Curran, 2005).

The new style Irish Ship Register is the only register capable of noting financial interests other than mortgages on the register, such as leading arrangements. The register will not be open to ships wishing to sail under a flag of convenience. Eligibility to register will however be opened up to nationals and legal entities of EEA countries, treaty countries, EU countries, and British Commonwealth countries. It should therefore attract new shipping business to Ireland and provide a further boost to the blossoming Irish ship finance industry (Mason Hayes & Curran, 2005).

#### **Cluster activity**

There is no official shipping cluster in Ireland, but there is an ambition to create a maritime cluster associated with shipping.

### ***Scotland***

The shipping sector in Scotland is mostly associated with shipbuilding and ship repair. The focus in the sector is mostly on the manufacturing and serving naval ships and special more complex vessels for niche markets. In 2009, Scotland's shipbuilding sector had a turnover of £1,138 million. The sector's share of the UK industry's turnover was 37 percent. 6,500 people are directly employed in the shipbuilding industry in Scotland. The Glasgow area has been and remains a leading world centre for commercial ship management. This status is built on the strong legacy of Scotland's sea-faring tradition. Other important areas are Fife, Aberdeen city, and Aberdeenshire.

The authors of this report could find no specific organized cluster linked to the shipbuilding sector in Scotland. In a report published in 2005 on the viability of organizing a cluster, the conclusion was that

the development of the industry alone was not justified. The reason was because the shipbuilding and marine industries were already embedded in a broader engineering cluster along with industries such as aerospace, electronics, and construction.

### ***Faroe Islands***

The Faroe Islands have the infrastructure to support a large fleet of ocean-going ships. The country has a deep-rooted maritime culture. A substantial number of the islanders have worked as sailors, either on domestic or overseas fishing vessels or serving in international merchant shipping and related industries. To encourage growth in the merchant shipping sector, Faroese authorities introduced the Faroe Islands International Ship Register (FAS) in 1992. FAS offers a number of financial advantages, including a flexible, efficient, and uncomplicated administration. These advantages have caused the number of merchant vessels flying under the Merkið ('The Mark' or 'The Banner') to rise steadily, with an expected 100 in 2012. (Faroe Business Report, 2011)

### ***Iceland***

Marine transportation is very important for the Icelandic economy. For a country that depends so heavily on exporting, shipping is a key, determining element in the choice of business partners. Because of the strong connection to the fishery sector, the industry has specialized in the shipping of refrigerated or frozen goods. There are around 3,500 individuals employed in the shipping industry, most of whom work for the largest shipping companies and in the service sector. But the shipbuilding sector has been struggling, and competition with other regions in the world where wages are lower has been difficult.

#### **Cluster activities.**

The Iceland Ocean Cluster has been active in creating cooperation between the transportation companies and the fisheries and service sector. There have been 12 active members in the logistics cluster work since it started in the beginning of 2012.

Logistics projects initiated by the Cluster are primarily those devoted to different ways and means of increasing cooperation among Icelandic firms that provide services to foreign ships. The project entails the development of shipyards, the mapping of available services, and marketing abroad. Another project has evolved around how to increase imports of products for domestic fish processing through increased cooperation among transport and processing companies.

### ***Greenland***

It has been estimated that shipping activity in the oceans around Greenland will increase. Potential mining opportunities exist in the northern part of the country, opportunities which would call for an increase in shipping activities in that area. Mining and oil and gas opportunities have already sparked some interest in the country's closest neighbours. Canada is for example looking more in the direction of Greenland, and even Iceland, than ever before. The Canadian East Coast has been perceived as the less well-off brother, but this perception may change with the increased activity because of oil and gas. The St. John area is a point in case.



## Opportunities

Opportunities are often associated with threats, even as positive change is often the result of crisis. One example of this dynamic is the increased cost of energy for the shipping sector and how it has encouraged a number of parties to look for new means of designing ships that use less fossil fuels and pollute less as a consequence. Most of the Ocean clusters around the North Atlantic are working on projects that have evolved around these problems. Solutions to them should be beneficial to all of those that are running shipping companies. By uniting clusters in this effort, steps might be taken to go further along the way towards a lasting solution.

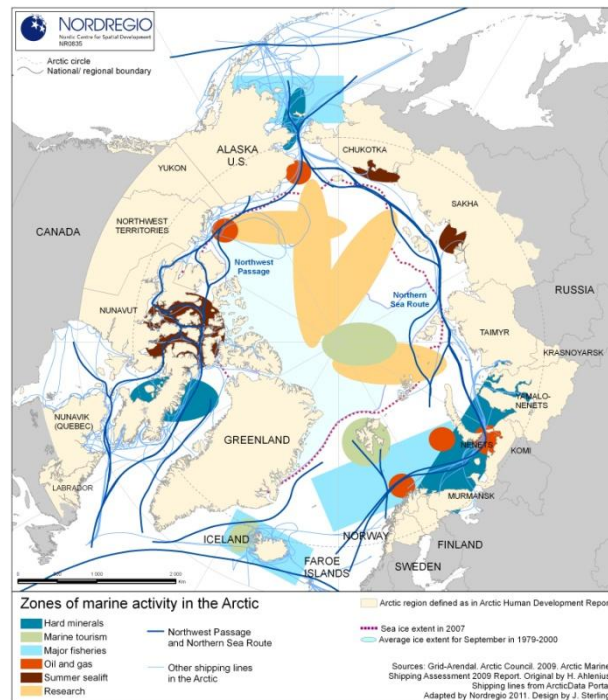
The largest opportunities associated with shipping in the North Atlantic region are those associated with the opening up of shipping routes in the Arctic region. The forecasted retreat of the polar ice could open up a shorter shipping route between the North Atlantic and North Pacific regions. At first the changes would create a shipping route along the coast of Siberia, with a further additional route opening up at a later stage through the north of Canada and north of Alaska. This Arctic route expansion would reduce the importance of sea routes that go through the Suez and the Panama canals, but both of the prospective routes are in politically unstable areas and are unable to allow the passage of large new container ships. The increased traffic in the region is not only leading to new opportunities, however. Certain threats associated with accidents and pollution do of course exist and have to be taken into account. Increased activity calls for greater surveillance and there is an even greater need for a support system to be put in place in case of emergencies. For all the countries that are using ocean resources in this area, it is important to take measures—such as cooperation—to reduce the danger of accidents and, in the event of an accident, to be ready to reduce the effect of such accidents.

Shipbuilding in the countries of the North Atlantic marine cluster has to face an international market characterized by overcapacity and market-distorting trade practices. By working together, these countries might be able to create a force that attracts talented people and reduces the effect of these business practices.

## Marine Biotechnology

It is estimated that the long-term potential of the marine biotechnology sector is very large, arguably greater than conventional (non-marine) biotechnology activity. In the case of marine biotechnology, the living organisms derive from marine sources. Even though 80 percent of living organisms are found only in aquatic ecosystems, little is known about their biochemical characteristics. Marine Biotechnology is a new sector with considerable interest being shown by the US, Japan, the UK, and others (Marine Institute, 2005).

Marine biotechnology may include techniques such as bioprocessing and bioharvesting; bioprospecting and bioremediation, using bioreactors (so called “process biotechnology techniques”); aquaculture/fisheries; gene, protein, or other molecule based techniques; while applications may



**Figure 16.** Zones of marine activity in the Arctic. Source: Nordregio, 2011.

include health, food, cosmetics, aquaculture and agriculture, fisheries, manufacturing, environmental remediation, biofilms and corrosion, biomaterials, and research tools (EC background paper, 2006).

Marine biotechnology is in the early stages of its development and information about the sector is quite fragmented. In 2010, the global marine biotechnology market was valued at €2.8 billion with a cumulative annual growth rate of 4–5 percent. Aquaculture, seaweed and processing related industries that should also be partially attributed to marine biotechnology are not included in these figures. The value is therefore likely to be underestimated. During the years 2008 and 2009, the global marine biotechnology market witnessed a slowdown owing to the global economic meltdown. Nonetheless, the market gained momentum in 2010 with the recovery of the economic situation and is expected to post substantial growth in ensuing years.

The United States represents the single largest region for marine biotechnology worldwide, as stated by a new market research report on Marine Biotechnology. The US is the world leader in marine science research and is home to highly developed international marine research centres specializing in marine biotechnology.

The marine bioactive substances market is forecast to register the fastest growth rate of more than 4.0 percent during the period 2009–2015. The marine biomaterials market is projected to reach US\$1.7 billion by 2012. In terms of end-use, healthcare/biotechnology constitutes the largest as well as the fastest growing end-use segment for marine biotechnology. By the year 2017, the world market for marine biotechnology is projected to reach US\$4.6 billion. Growth will be primarily driven by the increasing need for environmentally safe, bio-derived feedstock across a wide range of industries worldwide and by effervescent technology developments and the ensuing diversity in the range of marine derived products and processes.

#### **Commercial applications**

There seems to be four main areas of marine biotechnology applications:

- Bio-prospecting—high-throughput screening for novel compounds, especially drugs (other uses include in foodstuffs, nutraceuticals, adhesives, paints, cosmetics, environmental remediation, and research);
- Improving the production of marine organisms—main applications include the development and the production of healthcare products for farmed fish (preventives and therapeutics), the development of new and/or improved breeds of farmed fish and biotechnology based reproduction technologies;
- Production of novel products, particularly food and feed products—a wide range of companies are involved in the extraction of marine compounds for food and other purposes, such as chitin and related compounds from shellfish waste, omega 3, and other fatty acids from fish oils, carotenoids, pigments and flavourings, alginates, carrageenans and other compounds from marine algae and other nutritional supplements such as salts and so forth;
- Diagnostics and biosensors—for use in health management, environmental monitoring, product safety and quality, traceability, antifraud, fisheries management, and monitoring and compliance by government agencies in all of these areas.

#### **North Atlantic Marine Biotechnology clusters**

Marine biotechnology is still young industry, but it is estimated that the growth potential is considerable. The authors of this report found it difficult to obtain accurate information on the industry, and clusters directly related to marine biotechnology are few.

#### **Canada**

When it comes to marine biotechnology, Canada occupies a strong position in the market, claiming a number of biotech clusters whose focus is heavily on marine biotechnology.

### **Halifax, Nova Scotia - Life Sciences Cluster**

Halifax is home to two rapidly growing life sciences technology cluster sectors: one in marine biosciences and the other in neuroscience and biomedical imaging. Together, the sectors consist of more than 50 cluster companies that benefit from \$110 million a year in research investments.

Halifax's marine biosciences community, which generates \$250 million in sales annually, produces more than 70 percent of Atlantic Canada's research-based products, 400 of which compete globally, and with 300 more in development. NRC's Institute for Marine Biosciences (NRC-IMB) functions as the R&D arm for local life sciences companies and is also home to an Industry Partnership Facility (IPF) that hosts life sciences companies such as Origin BioMed, whose researchers work collaboratively with scientists at the Institute.

### **Prince Edward Island Bioscience Cluster**

PEI's Bioscience Cluster is made up of leaders from business, research, government, and academia, all working together as an ambitious and dynamic team.

Currently, the Prince Edward Island Bioscience Industry accounts for more than \$80 million in sales and employs over 800 people. There are currently 32 companies working with the PEI Bioscience Cluster.

Cluster activities include research and development initiatives, including the development of a \$30-million BioCommons Business and Research Park, and hosting international conferences, including VetHealth Global.

### **Technopole Maritime du Québec (TMQ)**

The "Technopole Maritime" network, commonly known as the "Marine Resource, Science and Technology Cluster", is made up of stakeholders from the institutional, research, business and governmental sectors. Currently there are 29 contributing members. Together, these partners have created an environment that fosters an exchange of resources and expertise. This collaborative approach results in synergies and a critical mass of knowledge that increases each partner's efficacy and ability to act effectively.

Technopole Maritime's mission is to accelerate the development of the marine science, technology and biotechnology sectors in Quebec by ensuring its national and international exposure. At the same time, it strives to provide value-added services to its members and support for long-term priority projects.

TMQ's main objective is to position itself as a leader in Quebec and Canada in the marine biotechnology and maritime technology sectors, in order to create wealth through growth and new investments by businesses, institutions, and organizations.

The Technopole Maritime du Québec is based in Rimouski, regional capital of the Lower St. Lawrence. Rimouski is situated on the south shore of the St. Lawrence River, 530 kilometres northeast of Montreal and 310 kilometres northeast of Quebec City. Its geographical location makes it an easily accessible regional centre.

### **Norway**

Norway has spent substantial resources on research in biomedical, marine and agricultural biotechnology, and it is estimated that biotechnology associated with marine resources will yield interesting opportunities in the future. The most significant marine biotechnology activities are in Tromsø and Bergen, although Trondheim and the Oslo region have important players. The focus in Tromsø and Bergen is on bioprospecting, bioprocessing, exploitation of by-products from the fisheries, aquaculture breeding and feed, and on food technology.

A report on the Norwegian Life Science industry in 2005 classified around 110 Norwegian companies in accordance with their technology/product area. All of the companies were utilizing biotechnology

as an important part of their business. The dominating sub-sector of the industry is biomedicine, with 48 companies or close to 50 percent of the total. It was estimated that this segment had a turnover of about 4 billion NOK and 1350 employees. About three-quarters of the revenue was directly related to aquaculture, with feed and bulk ingredients accounting for more than 2.5 billion and with the fish health and breeding total close to 0.4 billion (Marvik, 2005).

### **Clusters activity**

#### **BioTech North**

The aim of this project is to increase innovation and commercialisation activities out of the biotechnological and aquacultural knowledge base in Tromsø. It is composed of enterprises and R&D organizations that cooperate closely with regional funding and development actors (triple helix).

As bioactive molecules and compounds from Arctic marine resources form the basis of activities for the majority of the cluster members, BioTech North serves as a marine biotech cluster. The majority of BioTech North's enterprises are active within life science applications and markets.

The cluster has created the following values to enhance positive attitude and relations, values that work toward realizing BioTech North's vision and objectives:

- **Fellowship**—the cluster cooperates where it can and competes where it should;
- **Perseverance**—the cluster is determined to realize individual and common goals;
- **Curiosity**—the cluster looks continuously for new, smart and innovative solutions and applications;
- **Knowledge**—the cluster values its knowledge as knowledge is the basis of its success.

To date, the cluster contains around thirty organizations from both the private and public sector. In 2010 the cluster received a secretariat (BioTech North Secretariat), which is established and administrated by the Troms Chamber of Commerce and partly financed by the regional development fund, RDA –Tromsø. The cluster was accepted as a new Arena project in 2012 and will be supported by the Arena programme for the next 3 year period.

For further information, log on to the cluster's website: <http://biotechnorth.no/>

### **Denmark**

Denmark has built up a strong knowledge base in relation to the biotechnology industry and there are a number of large and active biotechnology clusters in Denmark. Of these the best known is probably the Medicon Valley cluster (MVA), which includes both Danish and Swedish firms and is organized by members from both countries. MVA is among the strongest life science clusters in Europe.

#### **The Technical University of Denmark (DTU)**

The Technical University of Denmark (DTU) places considerable emphasis on marine biotechnology. In addition to its teaching responsibilities, the University engages in extensive research and innovation projects and is an advisor to the government on food technology and the utilization of marine resources, with an emphasis on marine biotechnology. The Division of Industrial Food Research at the National Food Institute, or Food DTU for short, has seven research groups with a total number of staff of about 100. The research groups include discipline-oriented research within microbiology, biotechnology, nanotechnology, and food processing technology. Of particular interest right now is the Institute's participation in the CSA MarineBiotech programme. Other projects include the study of marine bacteria and their ecophysiology and biotechnology, the study of marine enzymes, and an improved utilization of macroalgae with emphasis on the antioxidants.

For further information, log on to the University's website: <http://www.dtu.dk/>

### **Biopeople**

Established and co-funded by the Danish Agency for Science, Technology and Innovation, Biopeople is a part of the permanent Danish infrastructure for innovation. The network's concentration and coordination of biotech, food, medtech and pharma within Biopeople aims to improve the possibilities within Denmark to operate across disciplines. The representation of several disciplines and the resulting wider competencies will, it is hoped, result in a strengthening of innovation.

Biopeople bring Danish and international researchers and stakeholders together in a unique collaboration for life science, food, biotech, biomedical, pharma, and medtech innovations. A number of marine biotech firms participate in the Biopeople cluster.

For further information, log on to the cluster's website: <http://www.biopeople.dk>

### ***Ireland***

Irish marine biotechnology is still in its development stage. It is an emerging industry that is seen as possessing considerable potential for knowledge creation and value-added growth in terms of food, drugs, biomaterials, nutraceuticals, and industrial processes.

At the time of this report, the industry is one of the most diverse in the country, spanning different industry sectors and contributing to an array of novel products and processes. Marine biotechnology applications are already evident in a range of bioproducts and include medical devices, pharmaceuticals, and food products—examples from these product categories would be functional foods, cosmetics, agrichemicals, fine chemicals, proteins and biofuels. The seaweed-based biotechnology category has seen a significant increase in growth as demand for seaweed-based products and derivatives increase both in Ireland and abroad.

According to a report published by the Socio-Economic Marine Research Unit (SEMURU) the Irish seaweed industry supplies a number of other sectors of the economy including the agriculture and horticulture, food processing, cosmetics, thalassotherapy and biopharma (functional foods and nutraceuticals) sectors. It should therefore be defined as a part of the biotechnology sector. Research is also on-going with regard to the use of marine microalgae as a bioenergy provider.

According to figures from 2007, the turnover generated by the marine biotechnology and bioproducts industry was €18 million. The export amounted to €6.3 million, mainly to the UK, Spain, France, and the US. In terms of full-time equivalence, 185 individuals were employed within the marine biotechnology and bioproducts industry in 2007.

### ***Scotland***

Scotland is a leading nation in the biotechnology sector, a fact evidenced by the existence of the BioDundee cluster, one of the leading biotechnology centres in the world. The country has also been quite active in developing the marine biotechnology sector. There are several centres of excellence in the marine biotechnology area based around Scottish centres of strength in the marine sciences.

In a report published in 2005 on the prospects for marine biotechnology in the United Kingdom, 13 of 21 biotech companies in the UK were cited as having their base in Scotland.

Located in Oban, the European Centre for Marine Biotechnology (ECMB) is part of the Scottish Association of Marine Science. The ECMB provides incubator facilities for an international culture collection, as well as a number of marine biotechnology SMEs. It emphasises the development of nutraceuticals, healthcare products (particularly antibacterials), and defined glycosides from marine sources with healthcare applications (Life Sciences Scotland, n.d.).

The ECMB is part of many larger projects in marine biotechnology, one such project being the Biomara project, a joint UK–Irish venture that will investigate macroalgae and microalgae for their potential to provide sustainable biofuel. Related projects are being funded by the Carbon Trust.

Life Sciences Scotland represents the entire life sciences community in Scotland, from industry and academia to healthcare and government.

Together, this community has developed a vision for a 2020 Scotland that will have:

“A globally focused, sustainable life sciences sector built on a fully connected national strategy that exploits strengths in scientific excellence, financial services and innovative business models, and that develops, retains and builds upon Scotland's talents.” (Life Sciences Scotland, n.d.).

For further information, please visit: <http://www.lifesciencesscotland.com>

### ***Finland***

Finland has a strong biotechnology sector, with one cluster in Turku focusing on the industry. Turku is home to the second largest concentration (after Helsinki) of biotechnology activities in Finland. Other regions with dedicated centres for biotechnology development are Oulu, Tampere, and Kuopio. The Turku region is especially strong in biopharmaceuticals, but its firms are also involved in diagnostics, biomaterials, and functional foods. In 2006, there were approximately 80 biotechnology-related companies in Turku, employing approximately 3,000 people. In Finland there is little emphasis on marine biotechnology and there is no industry cluster dedicated to that part of the biotechnology sector.

### ***Sweden***

A number of life science clusters are in existence in Sweden. Two of the most important clusters would be Uppsala BIO and Biotech Umeå. Both are involved in green and in industrial biotechnology, among other things. No industry cluster associated with marine biotechnology is in existence, however.

### ***Iceland***

Iceland has a small but innovative marine biotechnology sector. There are approximately 14 companies in existence with roughly 70 employees. The majority of these companies are still developing their products and several of them have made substantial sales. The greatest emphasis in the sector has been on using by-products from fisheries.

No formal cluster associated with biotechnology is in existence in Iceland, but the Iceland Ocean cluster has done some mapping in relation to the industry.

### ***Faroe Islands***

Few companies exist in the biotechnology sector on the Faroe Islands.

### ***Greenland***

There is little activity in developing biotech products in Greenland.

### **Opportunities**

The future of the marine biotechnology sector seems to be bright. The question at the moment however is less about the sustainability of the sector and more about the ways to grasp the latent and blatant opportunities that are out there. The countries in the North Atlantic Marine cluster are in an ideal position to join the ranks of the best in this segment of the biotechnology sector. They each have access to ocean resources that are waiting to be discovered and tapped into. They are each home to research institutions that are capable of tackling the most complex and challenging projects. And they each evidence a strong tradition for running innovative and strong biotech clusters. In a knowledge intensive industry as versatile and labile as this, sharing ideas and know-how can only be of mutual benefit to those engaged in the sharing process. By increasing collaboration between scientists, industry, and countries, the talent pool will become larger and deeper and the ideas rippling out from it will extend their reach to ever more distant shores and with ever-increasing power of impact.

## Conclusion

In this report the first steps have been taken to map the activities of marine-related industries in the northern part of the North Atlantic. The main objective of the report was to map ocean cluster activities. It is hoped that the report will serve as a basis for further discussion on how to increase cooperation between the countries covered in the report. Many opportunities can be created to increase cooperation between the countries, not only on a political level but on a business level as well. By combining forces and sharing know-how, these nations can mutually benefit in manifold ways, forging new opportunities even as they acquire additional strengths when competing on international markets.

All of the countries that fall under the scope of the North Atlantic Marine cluster have strong ties with the ocean, have unique know how about the ocean environment, or are in an optimal position to use ocean-related resources. They can share information about how to increase the utilisation of resources or to reduce waste or environmental impact. It might be difficult for example to increase the total quantity of fish catch, but some opportunities might reveal themselves in relation to the better utilisation of raw materials by collecting information on how to manage the fishing process more efficiently. Such information sharing activities are beneficial for all parties and can only enhance the image of the industry.

There is a conspicuous lack of research on the creation of opportunities vis-à-vis natural ocean resources. More extensive and insightful research might open up new avenues of possibilities regarding the production of food for human consumption and feed for aquaculture. The marine biotechnology sector is still in its infancy, and yet a plethora of opportunities exist that are linked to the development of pharmaceuticals, functional foods, cosmetics, agrichemicals, fine chemicals, proteins, and biofuels.

Increased demand for food in the world will, to a certain extent, be met with development in the aquaculture sector. The countries of the North Atlantic Marine cluster are in possession of unique know-how and have singular access to space and resources in terms of ocean industries and their related sectors. They are therefore in a position to become key players in meeting this demand.

Finally, there is no doubt that a number of opportunities exist in the Arctic region. The potential for finding valuable natural resources will call for increased activity and accountability in the region. It is important to review the opportunities linked to new shipping routes in the area and for the relevant countries to work together to ensure a beneficial outcome for all those that live in nearby regions.

The marine sector has a bright future, but only if the right steps are taken to utilize available and yet-to-be discovered resources and only if, through cooperation, new measures are taken to grasp the opportunities that emerge with the ongoing changes both in the marine environment and in the marketplace.

There are many opportunities for cooperation in marine-related affairs between the countries in the north. They may have different strengths and weaknesses, but their cultural ties are strong and there is a robust tradition of working together in many areas for mutually beneficial ends. The main message of this report is that these countries are facing similar challenges and are equipped with unique know-how and experience which should enable them to find common solutions.

## References

- Knowledge and enterprise clusters in Ireland - An Overview*. (2008). Department of Enterprise, trade and employment.
- Fish & Seafood Industry. (n.d.). Retrieved from <http://www.bordbia.ie/industryinfo/fishseafoodindustry/pages/default.aspx>
- Ministry of Food, Agriculture and Fisheries. (n.d.). Retrieved from <http://www.fvm.dk/home.aspx?ID=14541>
- Bekele, G. W., & Jackson, R. W. (2006). *Theoretical Perspectives on Industry Clusters*. Morgantown: Regional Research Institute, West Virginia University.
- BP Statistical Review. (2011). *BP Energy Outlook 2030*.
- Carrington, D. (2011). BritNed power cable boosts hopes for European supergrid. Retrieved from <http://www.guardian.co.uk/environment/2011/apr/11/uk-netherlands-power-cable-britned>
- Centre For Energy. (2011). *Canadian Leadership in Energy*. Calgary, Alberta: Author.
- Centre of Expertise Programme (OSKE). (n.d.). Centre of Expertise Programme turns top-level expertise into new business and jobs. Retrieved from <http://www.oske.net/en/oske/>
- Cooke, P. (n.d.). *Resilience and Potential in Maritime Clusters*.
- Delgado, C., Wada, N., Rosegrant, M. W., Meijer, S., & Ahmed, M. (2003). *The future of fish: issues and trends to 2020*. Washington, D.C. (USA): IFPRI.
- Esteban, A., & Crilly, R. (2011). *Fish Dependence – 2011 Update: The increasing reliance of the EU on fish from elsewhere*. London: New Economics Foundation & OCEAN 2012.
- European Commission. (2006). *Background Paper No. 10 on Marine Biotechnology*.
- European Commission. (2007). *Fishery Statistics - Data 1990-2006*. Luxembourg: European Communities.
- Fisheries and Oceans Canada. (2011). *Canadian Fishing Industry Overview*.
- Food and Agriculture Organization of the United Nations (FAO). (2011). *Fishery and Aquaculture Statistics 2009*. Rome: Author.
- Food and Agriculture Organization of the United Nations (FAO). (2011). *World aquaculture 2010. FAO Fisheries and Aquaculture Technical Paper (500/1)*. Rome: Author.
- Hall, S. J., Delaporte, A., Phillips, M. J., Beveridge, M., & O'Keefe, M. (2011). *Blue Frontiers: Managing the environmental costs of aquaculture*. Penang, Malaysia: The WorldFish Center.



- Industry Canada. (n.d.). Oil and Gas Services Sector Profile Business Elements. Retrieved from <http://www.ic.gc.ca/eic/site/ogt-ipg.nsf/eng/og00200.html>
- Institute, M. (2005). Marine industries global market analysis: Marine Foresight Series No.1. Galway: Author.
- International, S. D. (n.d.). Scotland's energy industry strengths. Retrieved from <http://www.sdi.co.uk/sectors/energy/strengths.aspx>
- Irvine, G. (2011). UK Wind & the EU Supergrid. Retrieved from <http://www.raremetalblog.com/2011/05/uk-wind-the-eu-supergrid-.html>
- Clasen, J.K., & Clausen, M. B. (2011). *Danish Shipping Statistics - 2011*. Copenhagen: Danish Shipowners association.
- Ketels, C. (2009). *Clusters, Cluster Policy, and Swedish Competitiveness in the Global Economy. Expert report no. 30 to Sweden's Globalisation Council*. Västerås: Harvard Business School & Stockholm School of Economics.
- Ketels, C., Lindqvist, G., & Sölvell, Ö. (2006). *Cluster Initiatives in Developing and Transition Economies*. Stockholm: Center for Strategy and Competitiveness.
- Legendijk, A., & Charles, D. (1999). *Clustering as a new growth strategy for regional economies? A discussion of new forms of regional industrial policy in the United Kingdom*. Paper presented at the Boosting Innovation: The Cluster Approach, Paris.
- Life Sciences Scotland. (n.d.). Scottish Marine Biotechnology. Retrieved from <http://www.lifesciencesscotland.com/solutions/scotland's-strengths/marine-biotechnology.aspx>
- Malmberg, A., & Maskell, P. (2002). The elusive concept of localization economies: towards a knowledge-based theory of spatial clustering. *Environment and Planning A*, 34(3), 429-449.
- Margeirsson, S., & Edvardsen, T. (2009). *Innovation in the Nordic marine sector*. Oslo: Nordic Innovation Centre.
- Marine Institute. (n.d.). SmartOcean Ireland: Harnessing Ireland's Potential as a European and Global Centre for Ocean ICT. Retrieved from <http://www.marine.ie/home/SmartOcean.htm>
- Marshall, A. (1890). *Principles of economics*. London: Macmillan and Co.
- Marvik, O. J. (2005). *Norwegian Life Science Industry: Overview and Status*. Innovation Norway.
- Mason Hayes & Curran. (2005). The Maritime Cluster. Retrieved from <http://www.mhc.ie/publications/item/217/the-maritime-cluster/>
- Meade, B., & Rosen, S. (1997). Food & Marketing. *Agricultural Outlook(AO-242)*.
- Morrissey, K., Hynes, S., Cuddy, M., & O'Donoghue, C. (2010). *Ireland's Ocean Economy*. Galway: SEMRU.

- Morrissey, K., O'Donoghue, C., & Hynes, S. (2011). Quantifying the value of multi-sectoral marine commercial activity in Ireland. *Marine Policy*, 35(5), 721-727.
- National Research Council Canada. (n.d.). Canada's Technology Clusters - Collaboration leads to commercialization. Retrieved from <http://www.nrc-cnrc.gc.ca/eng/clusters/canada.html>
- Nevala, A. M. (2006). *An exhaustive analysis of employment trends in all sectors related to sea or using sea resources: Country Report - Finland (C3135)*. Birmingham: European Commission - DG Fisheries and Maritime Affairs.
- NORDREGIO. (2011). Zones of marine activity in the Arctic. Retrieved from <http://www.nordregio.se/en/Maps--Graphs/05-Environment-and-energy/Zones-of-marine-activity-in-the-Arctic/>
- North Atlantic Information Services Spf. (2011). Merchant Shipping Industry Presents Obvious Opportunity. *Faroe Business Report: The International Review of Faroe Islands Industry and Trade*.
- Norwegian Petroleum Directorate. (2012). The petroleum sector – Norway's largest industry. Retrieved from <http://www.npd.no/Templates/OD/Article.aspx?id=4323&epslanguage=en>
- OECD. (2007). *Competitive Regional Clusters: National Policy Approaches*: OECD Publishing.
- Ohlin, B. (1933). *Inter-regional and International Trade* (1967 ed.). Cambridge, MA: Harvard University Press.
- Popesco, I. (2010). *Directorate-General for Internal Policies: Policy Department B - Structural and Cohesion Policies. Fisheries in Sweden*. Brussels: European Parliament.
- Porter, M. E. (1998). *On competition*. Boston: Harvard Business School Press.
- Porter, M. E. (2000). Location, Competition, and Economic Development: Local Clusters in a Global Economy. *Economic Development Quarterly*, 14(1), 15-34.
- Pyke, F., Becattini, G., & Sengenberger, W. (1990). *Industrial districts and inter-firm co-operation in Italy*: International Institute for Labour Studies.
- Regmi, A., Deepak, M. S., Seale, J. L., & Bernstein, J. (2001). Cross-Country Analysis of Food Consumption Patterns *Changing Structure of Global Food Consumption and Trade / WRS-01-1*. Washington, DC: Economic Research Service/USDA.
- Rosiello, A. (2004). *Evaluation of Scottish Enterprise's Cluster Policy in Life Sciences: A Descriptive Analysis (Innogen Working Paper No. 16)*: Innogen & ESRC genomics network.
- Sigfusson, T., & Arnason, R. (2012). *The economic Impact of the Ocean Cluster*. Reykjavik: Islandsbanki & Iceland Ocean Cluster.
- Statistics Canada. (2010). *Shipping in Canada. (Catalogue no. 54-205-X)*. Ottawa: Author.
- Statistics Denmark. (2010). *Nordic Statistical Yearbook 2010*. Copenhagen: Author.

- Statistics Faroe Islands. (2012). *Faroe Islands in Figures 2012*. Argir: Author.
- Statistics Greenland. (2012). *Greenland in Figures 2012*. Retrieved from <http://www.stat.gl/publ/en/GF/2012/content/Greenland%20in%20Figures%202012.pdf>
- Statistics Iceland. (2011). *Economic Forecast 2011-2016. Statistical Series, 5*.
- Statistics Norway. (n.d.). *Fishing and Fish Farming*. Retrieved from [http://www.ssb.no/fiskeri\\_havbruk\\_en/](http://www.ssb.no/fiskeri_havbruk_en/)
- Statistics Norway. (2012). *Quantity of catch, by fish species and main group of fish species. 2009-2011\*. Tonnes live weight*. Retrieved from [http://www.ssb.no/english/subjects/10/05/fiskeri\\_en/tab-2012-01-26-01-en.html](http://www.ssb.no/english/subjects/10/05/fiskeri_en/tab-2012-01-26-01-en.html)
- Sullivan, M. (2010). *Global warming's silver lining: Northern countries will thrive, grow*. Retrieved 2012, from <http://newsroom.ucla.edu/portal/ucla/global-warming-s-silver-lining-169919.aspx>
- The Committee on Fisheries: Sub-Committee on Fish Trade. (2011). *Recent developments on fish trade*. Food and Agriculture Organization of the United Nations (FAO).
- The Scottish Government. (2009). *Energy Sector Key Sector Report*.
- The Scottish Government. (2012, 17. April). *Fishing income at record levels*. Retrieved from <http://www.scotland.gov.uk/News/Releases/2012/04/fishingstats170412>
- UNCTAD. (2010). *Review of Maritime Transport*. New York & Geneva: United Nations.
- UNCTAD. (2011). *Review of Maritime Transport*. New York & Geneva: United Nations.
- United Nations. (2008). *World Urbanization Prospects The 2007 Revision: Highlights*. New York: Author.
- United Nations. (2011). *World Population Prospects The 2010 Revision - Volume I: Comprehensive Tables*. New York: Author.
- United Nations. (2011). *World Population Prospects The 2012 Revision: Highlights and Advance Tables*. New York: Author.
- Watts, J. (2011, 14. June). *Fish farming is answer to increasing global meat demands, says report*. Retrieved from <http://www.guardian.co.uk/environment/2011/jun/14/fish-farming-global-meat-demands>
- Westhoek, H., Rood, T., Berg, M. v. d., Janse, J., Nijdam, D., Reudink, M., et al. (2011). *The Protein Puzzle: The consumption and production of meat, dairy and fish in the European Union*. The Hague: PBL Netherlands Environmental Assessment Agency.
- Worldwatch Institute. (n.d.). *Will Farmed Fish Feed the World?* Retrieved from <http://www.worldwatch.org/node/5883>

Zeller, D., & Pauly, D. (2005). Good news, bad news: Global fisheries discards are declining, but so are total catches. *Fish and Fisheries*, (6), 156-159. Retrieved from <http://www.seaaroundus.org/researcher/dpaully/PDF/2005/JournalArticles/GoodNewsBadNewsGlobalFisheriesDiscardDecliningSoAreTotalCatc.pdf>





## North Atlantic Ocean Clusters

Increased opportunities through cooperation

Iceland Ocean Cluster, The Ocean Cluster House, Grandagardur 16,  
101 Reykjavik, Iceland

For more information:  
[sjavarklasinn@sjavarklasinn.is](mailto:sjavarklasinn@sjavarklasinn.is)  
[www.sjavarklasinn.is/en](http://www.sjavarklasinn.is/en)