

EXCERPT FROM  
STATE OF THE NORDIC REGION 2018

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# THE RAPIDLY DEVELOPING NORDIC BIOECONOMY



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Nordic co-operation is one of the world's most extensive forms of regional collaboration, involving Denmark, Finland, Iceland, Norway, Sweden, the Faroe Islands, Greenland, and Åland.

Nordic co-operation has firm traditions in politics, the economy, and culture. It plays an important role in European and international collaboration, and aims at creating a strong Nordic community in a strong Europe.

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*The Rapidly Developing Nordic Bioeconomy* is an excerpt from the Nordic Council of Ministers' **STATE OF THE NORDIC REGION 2018**. The State of the Region report is published every second year and contains core chapters on demography, economy, the labour market and education in the Nordic Region, along with special focus chapters. The areas in focus in the 2018 edition are bioeconomy, digitalisation, health and welfare, as well as culture and the arts – a key area for Nordic co-operation. A horizontal focus on integration also recurs throughout many of the chapters.

The new bioeconomy, and the general shift from a fossil-based to a bio-based economy, is an area with vast potential for the entire Nordic Region, although it is more relevant to some geographical areas than to others. The bioeconomy already makes up around 10% of the total Nordic economy – and given the Region's enormous natural resources, there is clearly great potential in fields such as fisheries, aquaculture, forestry and bioenergy.

*The Rapidly Developing Nordic Bioeconomy* presents infographics that depict the scale of the Nordic countries' biological resources and industries, and maps land ownership in the Nordic countries. The rapid development of the bioeconomy may lead to conflict over land use, ownership and management and the publication discusses potential pitfalls and critical areas that the public authorities must take into account as part of the ongoing development of the bioeconomy.

The publication also maps the scale and distribution of bio-based industries, such as forestry, fisheries, aquaculture and biogas production. On this occasion, agricultural production has been omitted, as it is better known than some of the other sectors.

The bioeconomy holds great promise for replacing many existing products with bio-based alternatives, delivering clean and sustainable energy and providing myriad ecosystem services. However, all of this is dependent upon the sustainable management of biological resources and the fair distribution of economic benefits.

# THE RAPIDLY DEVELOPING NORDIC BIOECONOMY

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The bioeconomy is conceived as an economy based on land and marine-based natural resources including biowaste. It produces vital goods and services: food, drinking water, fresh air and energy as well as a range of ecosystem services including climate regulation. Bioeconomy can also replace many goods and services currently produced from fossil-fuels, including a range of biofuels, bioplastics and biopharmaceuticals. The Nordic Council of Ministers expresses it in the following way: *"The bioeconomy is all-encompassing and comprises those parts of the economy that make responsible use of renewable biological resources from the land and water for the mutual benefit of business, society and nature"* (Nordic Council of Ministers, 2017). In this way, moving from a fossil fuel to a bio-based economy can contribute both to the fight against climate change, but also to new economic activity in and around rural regions.

Transition from a fossil-fuel to a bioeconomy generates significant technical and institutional innovation (Bryden et al., 2017a). Bioresources are mostly located in rural and coastal areas (forests, fish, algae, farm by-products) but appear also as e.g. organic waste. Their productivity and accessibility differ between localities, given variation in natural conditions and the management of ownership and use. However advanced are the technologies involved, the biological raw materials used stem from – and impact on – land, water and sea-based bioresources. Alternative and competing uses touch on human rights and common property. Their exploitation may therefore be subject to conflicts and

require public regulation to prioritise use in relation to human welfare and to limit or prevent use for non-essential yet potentially highly-priced products.

The potential utility of these bioresources and the products and services based on and developed from them thus depends not only on the availability of land, sea, inland waters, human and social capital but also on wise institutional arrangements and regulation, across multiple scales and levels of governance, including regional and local initiatives.

There is global interest in the Nordic approach to bioeconomy. Nordic countries have developed unique regulatory frameworks for natural resource management, including laws on land ownership; regulation of fisheries and the marine environment; forestry management and regulation; bioeconomy strategies; and participation and engagement in local natural resource management decisions. This chapter provides insight into the rapidly developing Nordic bioeconomy. We have included figures on land use as an initial basis for utilisation while preferred data on ownership and user rights are not available. Examples of both existing and new bio-products based on land and sea are also discussed. We have not however included examples of bioeconomy services. In future, we hope to be able to provide a broader and more inclusive picture with data from the wider bioeconomy.

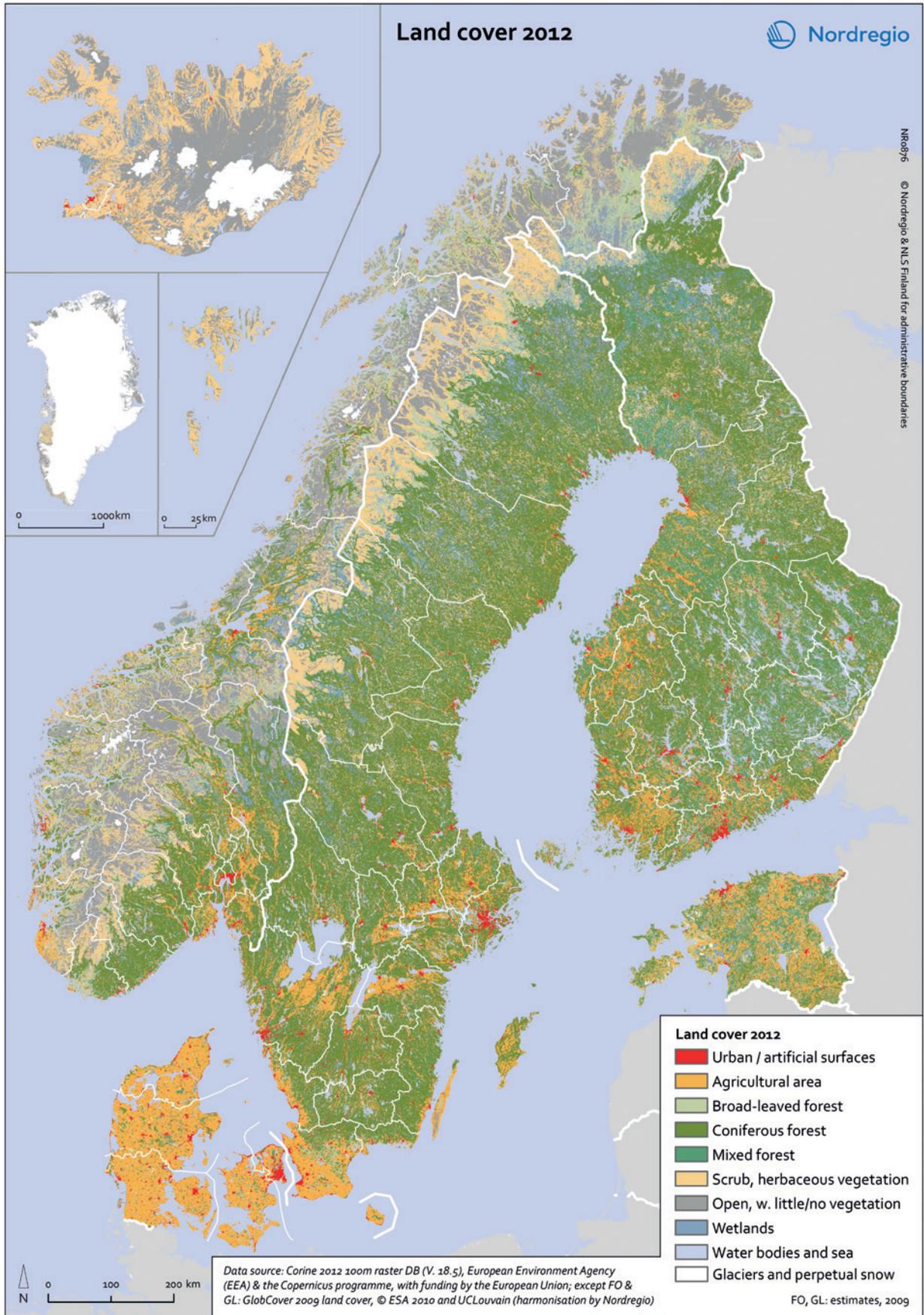
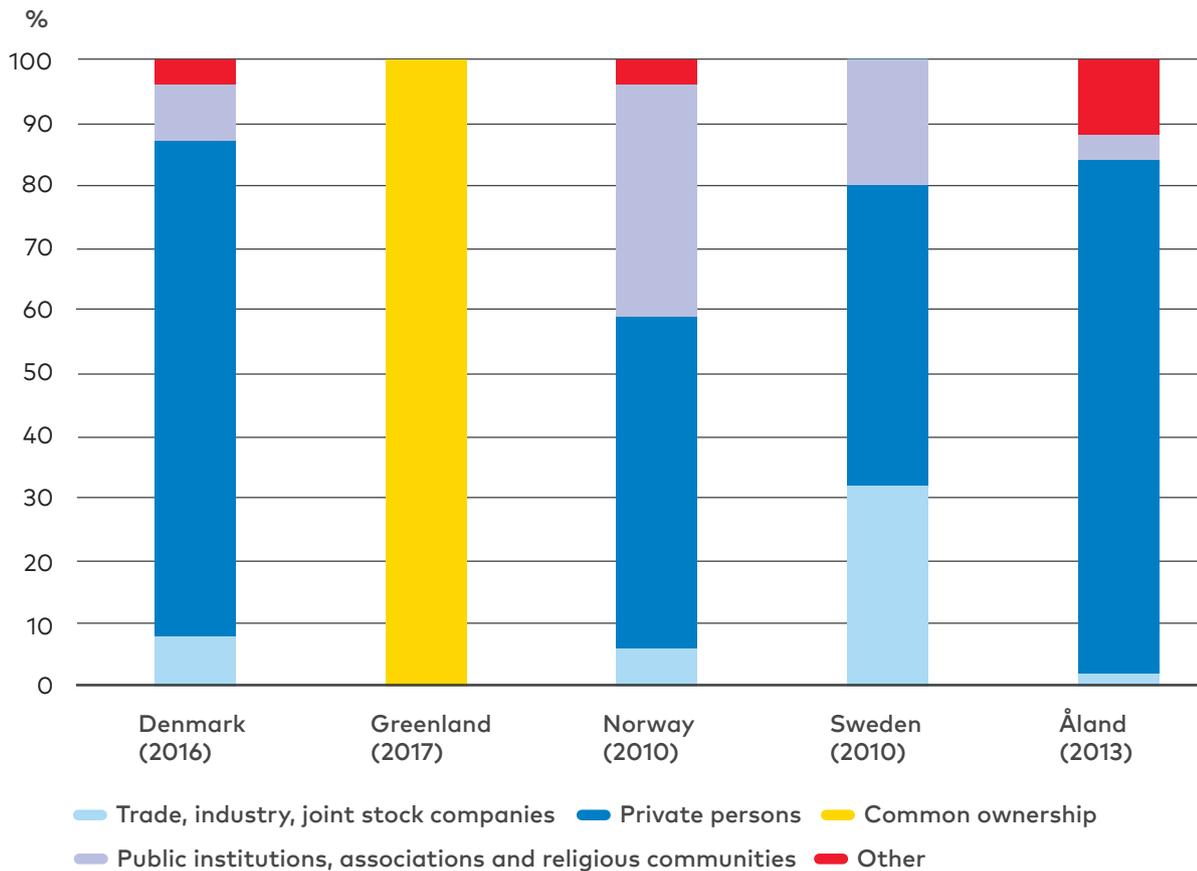


Figure 11.1 Land cover 2012.

Figure 11.2 Land ownership by category.



Data source: NSIs & Greenland Ministry of Finance. Note: FI, IS: No data. AX: Estimates. "Common ownership": GL: impossible to own, buy, and sell land. "Public institutions, associations and religious communities": DK: includes land owned by counties and municipalities; NO: includes land owned by counties and municipalities, state owned forest, organisations and companies; SE: includes public institutions, associations and communities; AX: includes Åland government and parish owned land.

## Access and rights to the utilisation of products and services from land and sea is key

Land is a key resource for most biological and human activities: agriculture, forestry, industry, transport, housing and other services. Land is also an integral part of ecosystems and indispensable for biodiversity and the carbon cycle. The regulation of ownership and management of land, and user rights to the land, the sea and freshwater resources, or to the key products and services arising from them, is crucial for their sustainable development potential. Such rights, their allocation and distribution, taxation and associated rules, determine productivity and the distribution of costs and benefits, including related public goods and "bads".

Compared to the EU, the Nordic Region has vast amounts of land relative to the size of its population (Eurostat, 2016). In 2015, Denmark (132) was the

only country with a population density above the EU28 average of 117 inhabitants per square meter (Eurostat, 2017). The averages for Sweden (24), Finland including Åland (18) and Norway (17) were significantly lower. Iceland is extremely sparsely populated (3). There are also significant differences between the Nordic countries in terms of their land use. Denmark is largely agricultural (62%), while Finland (73%), a large part of Sweden (69%) and south-eastern Norway (28%) are all dominated by forest, mainly coniferous. Iceland and the Faroe Islands have large areas of scrub and herbaceous vegetation, suitable for grazing livestock. Open land with little vegetation is significant for many regions in Norway and Iceland. Vast parts of Greenland and parts of Iceland are glaciers. The Nordic countries all have long coastlines and easy access to marine resources. Figure 11.1 visualises the different types of land cover in the Nordic countries.

## Rights for land owners to resources beyond the coast in Iceland

In Iceland landowners' rights to resources extends beyond the coast to 115 m from the low-water mark. This is called the net zone (netlög) and is first set in law in Jónsbók in 1281. This private property right addresses natural resource utilisation in its entirety, including fishing rights, unless otherwise limited by law. In some ways, this complicates maritime spatial planning such as regarding aquaculture development. Aquaculture utilises both land-based as well as off shore facilities, often both within and outside net law. In practice, this means that the responsibility for planning and zoning on land and within the net law is at the municipality level, but the responsibility for planning outside of net law is at the national level. Currently there are no laws governing planning of coasts and oceans outside net law. Until that changes, aquaculture development is only controlled through licensing and individual decision on where aquaculture is allowed or not. Other examples of potential complications are commercial fishing of near-shore species such as lumpfish (*Cyclopterus lumpus*), mussels (*Mytilus edulis*), and harvesting of seaweed. In all these cases it is important that national and municipal governments and landowners are all involved in planning processes and decision making (Althingi, 2010).

Figure 11.2 shows the distribution of land ownership at the national level for some Nordic countries, in harmonised format. Denmark has the highest share of privately owned land – 61% of the land is used for agriculture of which 93% is owned by private persons. In Finland, the share of productive forest area of total land is 67% of which private persons own 60%. Of the 57% productive forest in Sweden 56% is owned by individuals and other private owners, while companies own 25% and the state and state-owned companies have a share of 17% (Swedish Forest Agency, 2012). Norway, being especially mountainous and with more marginal land, has a larger share of land owned by the public or by associations. A major source of the livelihood in Greenland is hunting and fishing. Ownership to land or nature as such has little meaning here. The land in Greenland is therefore commonly owned

land. People can however get access to e.g. housing through user rights, but the land surrounding the house is common. A dominant part of Åland is privately owned land, mainly forest (around 80%) and agricultural land (around 15%).

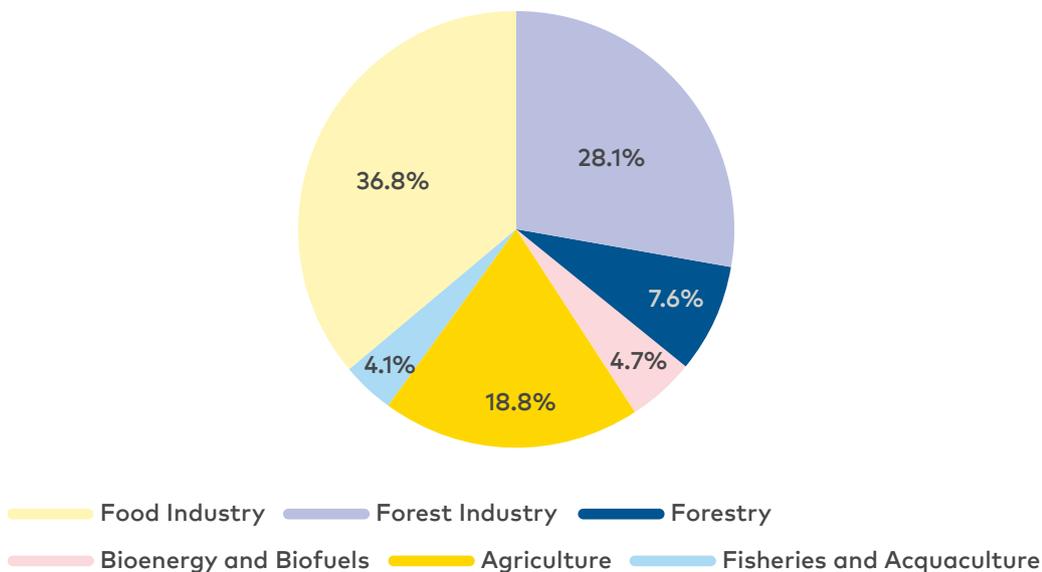
### The abundant regional resources from land and sea

Sweden generates 16% of EU forestry turnover while Finland is responsible for 10.6% of EU turnover in the paper manufacture sector (Ronzon et al., 2017). Total turnover of the key bioeconomy sectors in the Nordic countries was estimated to be EUR 184 billion, equal to 10% of the total Nordic economy (Rönnlund et al., 2014). Table 11.1. gives an overview of the bioeconomy turnover in selected Nordic countries.

|         | Turnover     |                       |
|---------|--------------|-----------------------|
| Country | Billion Euro | 1,000 Euro per capita |
| Denmark | 49.5         | 8.8                   |
| Finland | 48.8         | 9.0                   |
| Sweden  | 62.3         | 6.5                   |

Table 11.1 Bioeconomy turnover in Denmark, Finland and Sweden. Data source: Ronzon et al., 2017.

Figure 11.3 The share of the sectors included in the bioeconomy in the Nordic countries.



Data source: Rönnlund, Pursula, Bröckl & Hakala, 2014; Lange et al., 2015.

Estimates for the different sectors are shown in figure 11.3. In Finland the estimated share of the bioeconomy is over 16% with the industry currently employing more than 300,000 people (Ministry of Employment and Economy of Finland, 2014). Despite regional variations, the bioeconomy potential is large (Lange, et al., 2015, p. 10): *"Upgrade of biomass from waste fractions from agriculture, forestry and fisheries has huge potential for improved use of the biological resources. Globally, approximately 50% of the primary production is still not utilized, but wasted. Biomass to bioenergy is already developed for up-scaling and commercialisation. However, development of biobased products into products of higher value, such as healthy food and feed ingredients, speciality chemicals and functional materials is still in its early stages."*

We have chosen examples based on abundant resources in different regions contributing to their economic growth (Gíslason & Bragadóttir, 2017).

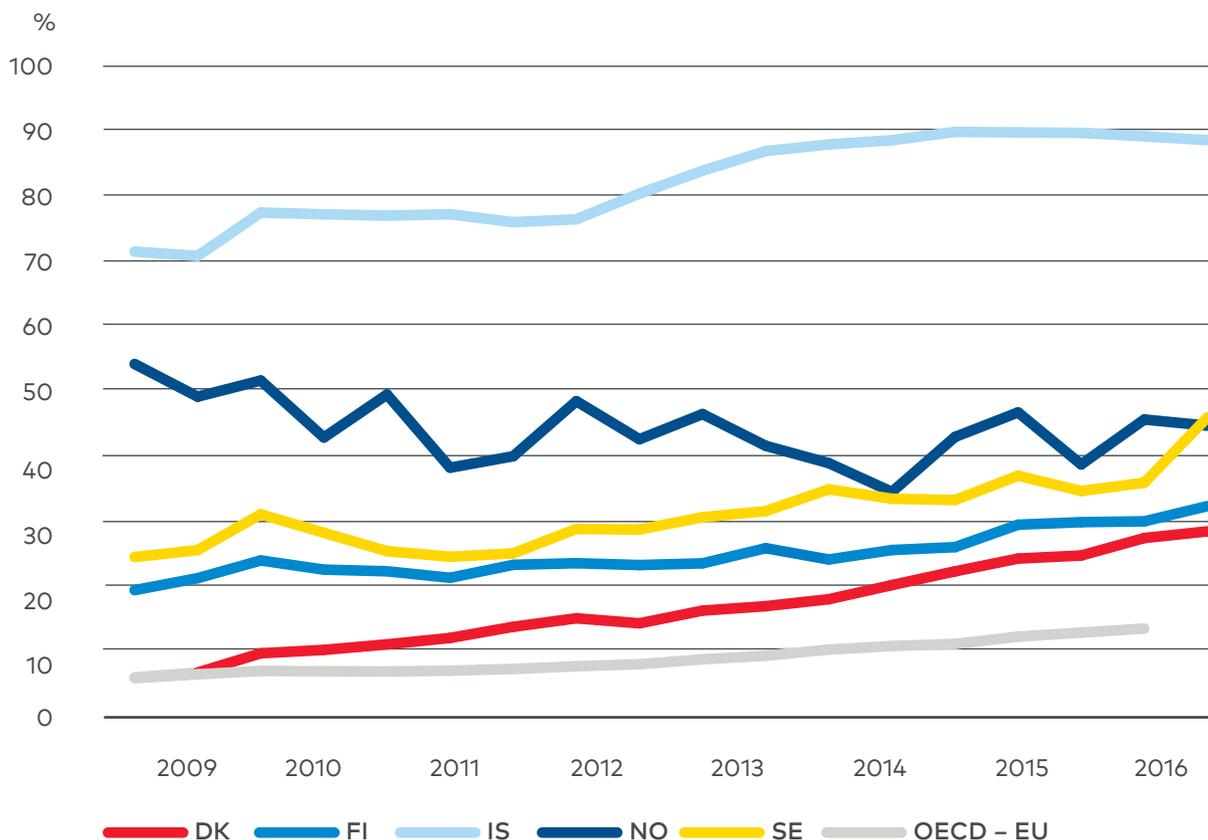
**Land with forest felling and its uses:** Sweden and Finland have extensive forests and we show potentials in respect of forest felling and the production of pulp and paper, construction materials and services and to "newcomers" such as heat, biofuels and bioplastics.

**Agricultural land and the cities providing waste resources for bioenergy and biogas:** The fertile soils of Denmark with an agriculture sector specialising in pig and dairy production provide abundant food but increasingly also energy production; based on manure and in combination with wastewater and organic waste from cities and industry. This is used in the production of biogas and refined fertiliser in Denmark and also in Sweden and Finland.

**Marine areas with a focus on fish landings and aquaculture:** The Faroe Islands, Greenland, Iceland and Norway have abundant marine resources. They utilise marine biomass such as fisheries and aquaculture, including related waste streams. New and previously underutilised bioresources such as algae and seaweed are now also being developed, especially in Norway, the Faroe Islands and Iceland.

**Bioservices:** The land and sea also offer opportunities for service creation and provision: recreation, including tourism, berry and mushroom picking and other anthropogenic uses as well as non-anthropogenic outcomes such as biodiversity and CO<sub>2</sub>-sequestration. While bioservices indeed is an important aspect of the broad field of bioeconomy, this chapter will be limited to the other three aforementioned aspects of the bioeconomy, namely: land and forest use; agriculture and waste; and marine areas with fish landings.

Figure 11.4 Renewable energy as a share of total primary energy supply.



Data source: OECD Green Growth Indicators.

## The developed biomass to bioenergy sector

Figure 11.4 shows Nordic renewable energy supply as a share of renewable sources in total primary energy supply for the period 2000–2015, based on OECD data. All Nordic countries are well above the average of European OECD countries, with Iceland emerging as a clear leader. As of 2015, Iceland met 88% of their energy needs in this way, Sweden met 46% closely followed by Norway at 45%, Finland 32% and Denmark 28%.

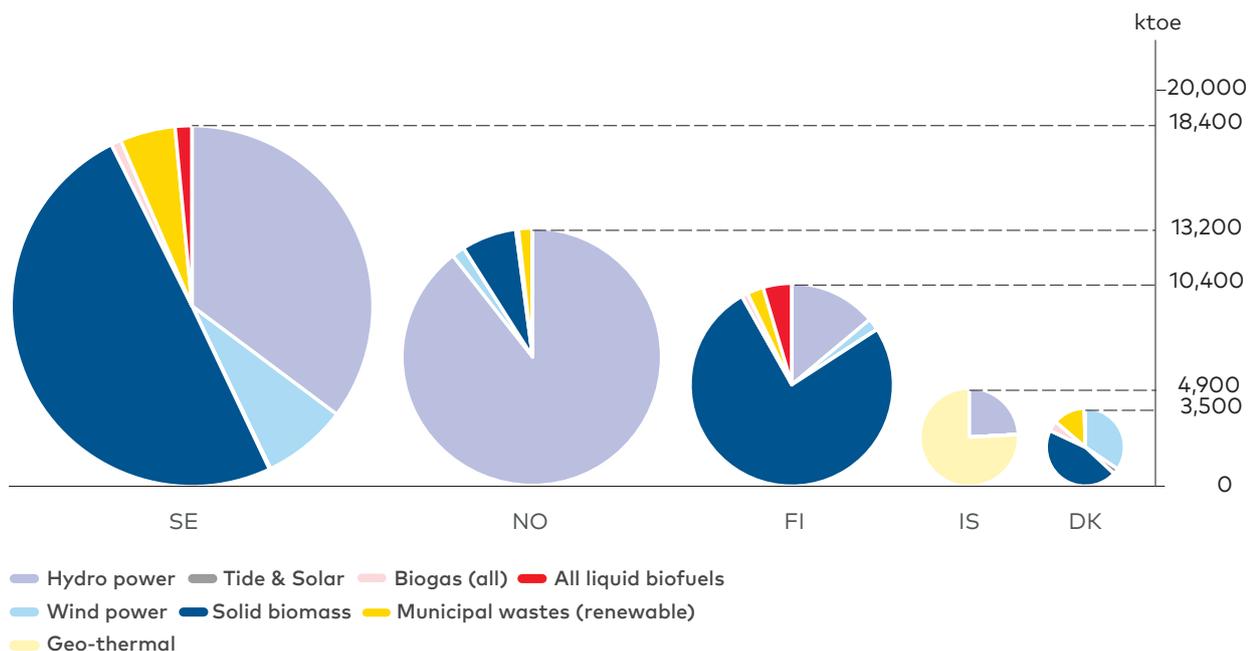
In figure 11.5 we see that biomass and waste dominate the renewables sector for generating electricity, heat and transport fuels in Sweden, Finland and Denmark. The lack of biomass utilisation in Norway is due to low electricity prices and political support (Bryden et al., 2017b). Renewable electricity is generated from hydropower in Norway and, apart from biomass, predominantly by wind power in Denmark. Geothermal heat and power production

supplemented by an abundance of rivers supplying hydropower are the most important energy sources in Iceland.

## Large potential for forest multiuse

Figure 11.6 shows average forest felling and a vast regional distribution, especially in Sweden and Finland. Annual growth currently exceeds annual harvest. As a percentage of annual growth, Norway harvests 35%, Finland 56%, Sweden 77% and Denmark 51% (Rytter et al., 2015). Wood bi-products is extensively used for energy purposes and the forests display a large potential for increasing the production of renewable energy as well as other biobased products. Rytter et al. (2015) calculated the total potentially available forest fuel of the region between 195 and 368 TWh depending on the restriction level for management, although its optimal use will not always be for energy.

Figure 11.5 Renewable energy production 2015, in kilotonnes of oil equivalent (ktoe) (top) and renewable energy share in total energy production 2015 (bottom).



**Renewable energy share in total energy production 2015.**



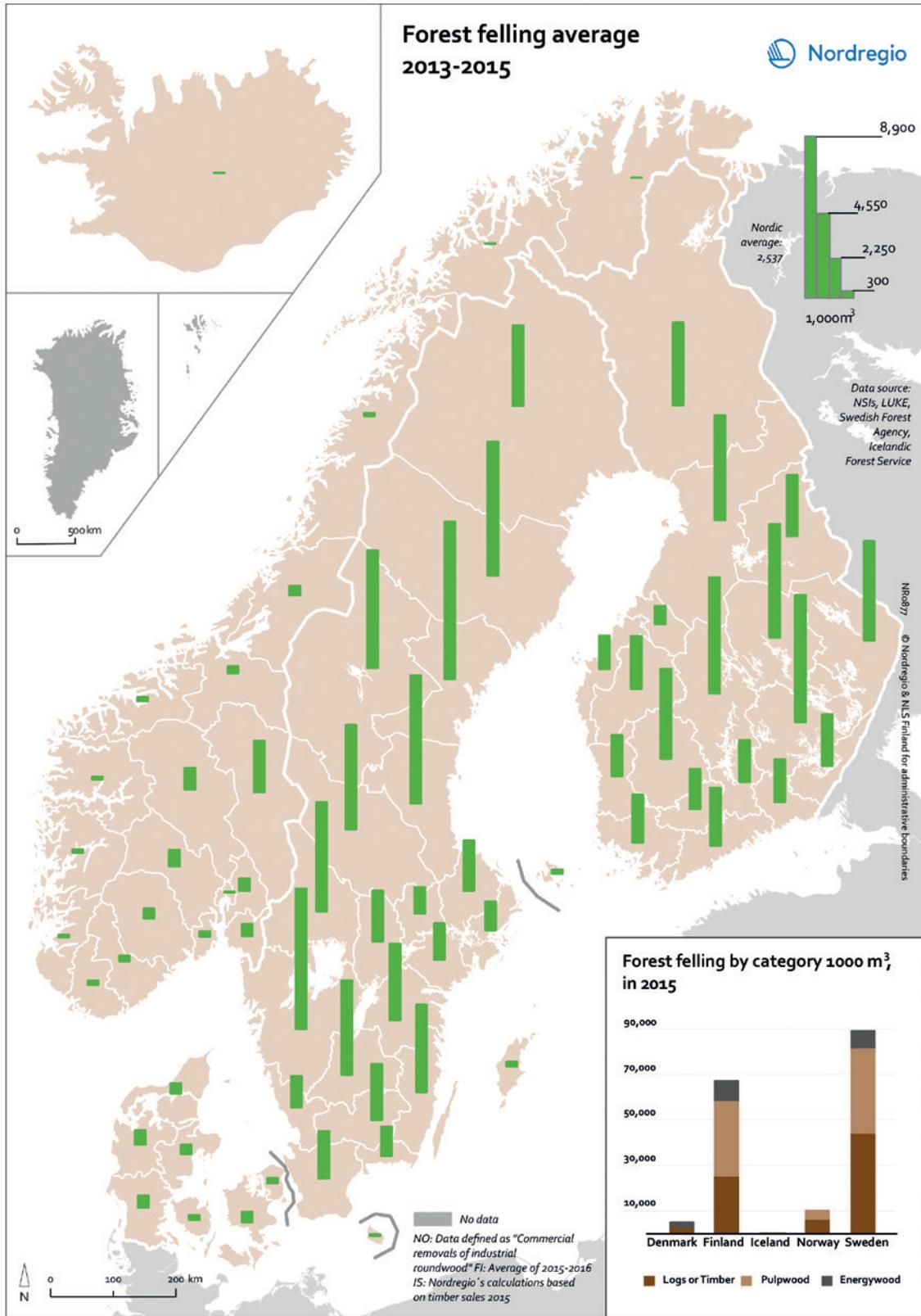
Data source: Nordregio's calculations based on Eurostat.

All Nordic countries have a recognised capacity to increase harvesting while remaining environmentally sustainable in terms of ecosystems, carbon neutrality and climate impacts (ibid.). This sustainable management capacity together with the unutilised forest potential is important for the future of remote and rural regions in the Nordic countries and provide opportunities for investments in education, training, technology and plants.

## Turning waste from agriculture and cities into energy

Biogas production is widely distributed across the Nordic Region and between the types of sources used (figure 11.7). In 2015, 18% of the energy use in Denmark came from biomass and waste. A large and underutilised potential for bioenergy remains (Energistyrelsen, 2014) and can be found in harvested dry matter and manure (Energistyrelsen, 2015; Gylling, Jørgensen & Bentsen, 2012). In the western part of Denmark, biogas is mainly based

on manure from farms supplemented with sludge and organic waste from wastewater plants. Biogas production has seen strong growth in Denmark with an expected trebling over the period 2012–2020 given increased support through the *Energy Agreement* (Energiaftalen in Danish) of 22 March 2012 (Energistyrelsen, 2014). Further, the vast infrastructure for gas makes it easy and accessible for farmers to link biogas to the existing energy net. The largest numbers of plants in Finland are based on farms and landfills. Norway produced 500 GWh biogas in 2016, mainly from wastewater treatment plants, but also based on organic waste, manure and fish waste. In general, significant focus is placed on the potential of utilising waste from fish and fish farms in Norway (Martin S. Kristensen, personal communication, 2017). In 2015 in Sweden, 282 facilities produced 1947 GWh biogas with the largest regional production being in Skåne (417.5 GWh), Västra Götaland (350.9), and Stockholm (255.8) (Statens energimyndighet 2016). Iceland had a biogas facility in Reykjavík at Álfsnes landfill with plans



**Figure 11.6 Forest felling at the regional level, average 2013–2015 (main map), and forest felling by category in 1,000m<sup>3</sup> at the national level 2015 (chart).**

Note: DK: The category of Energywood includes NSI categories "firewood" and "wood for energy chips & logs". NO: Forest felling data is defined as "Quantity removed for commercial purposes" but the figures equal the assorted wood type data at the national level. The category of pulpwood also includes small number of "unsorted saw logs" and the category of energywood in the NSIs data was defined as "fuelwood". SE: Figures are our estimates based on NSI gross felling data that is assorted by solid volume.

for expansion in 2018. The production will then increase from producing methane for 1,400 cars to 8,000 methane cars.

## Future food from abundant marine resources

Fisheries and aquaculture are highly important bio-economy sectors in the Nordic Region and are the most important contributors to the Faroese economy, accounting for over 91% of total exports in 2012 (Lange et al., 2015). Fishing is also the most important export sector in Greenland, amounting to 91% of merchandise exports (Lange et al., 2015; Ögmundsson, 2014). The Faroe Islands, Iceland and Greenland have huge fish landing amounts per capita. Figure 11.8 (large map) visualises fish landing in Norway, Iceland and Finland which is quite evenly distributed between communities distributed along the coastline. Since we do not have data on boat ownership we cannot however show which municipalities or regions are the primary beneficiaries of the income generated, where the fish is landed.

Finnish landing data is based on the municipality where the fisherman and the fishing vessel is registered. Foreign landings as a share of total landings, show remarkable variation across the Nordic Region, with both Denmark and Sweden having a share over 41% while Finland has only 0.8% (Norway 14.3%). It is primarily Greenlandic vessels that service fish factories in Greenland.

National objectives in respect of fisheries management in the Nordic Region vary, though each has the sustainable utilisation of marine life as a main objective. In global terms, the Nordic fisheries sector is doing well in terms of their ecological, economic and social impacts, though variation is evident. The Baltic Sea environment is, however, under huge pressure, with almost 70 species in danger of becoming extinct (Helcom, 2013; WWF, 2015) and fish stocks being 30–40% below historical levels (WWF, 2015). Nonetheless, the region is a forerunner in transboundary collaboration, inclusive of stakeholders in Marine Spatial Planning and developing best practices in ecosystem-based management (Kull et al., 2017). According to the WWF (2015) the

## Pohjois-Karjala – a Finnish forerunner in renewable energy

Pohjois-Karjala (North Karelia in English) – one of mainland Finland's 18 regions – is a forerunner in renewable energy terms, thanks to innovations emerging from its robust forestry industry in cooperation with strategic work carried out at the regional level. Renewable energy accounts for 63% of total energy use in Pohjois-Karjala (28.5% in Finland), with 82% of this coming from wood-based sources. The forestry industry makes a substantial contribution to the regional economy with over 10% of workplaces, and about 25% of turnover, equalling up to EUR 1.7 billion. The region has vast experience of commercial and intellectual engagement with the forestry industry. Given the strength of the inter-sectoral linkages and local ownership of the value-chain, the regional multiplier for employment in the forest supply chain is estimated at 2.3. Forest residues are used as feedstock for district heating systems in local communities. By owning district heating plants, the forest owners and cooperatives of forest owners capture additional revenue from the forest. Although the impact on job creation is not dramatic, diversification has offered small forest owner co-operatives a new source of revenue. According to Pohjois-Karjala's Climate and Environmental Programme 2020, wood-based energy is targeted to contribute almost 50% of the share of the Region's different energy resources. (OECD, 2012; Bryden et al., 2017b; Berlina & Mikkola, 2017)

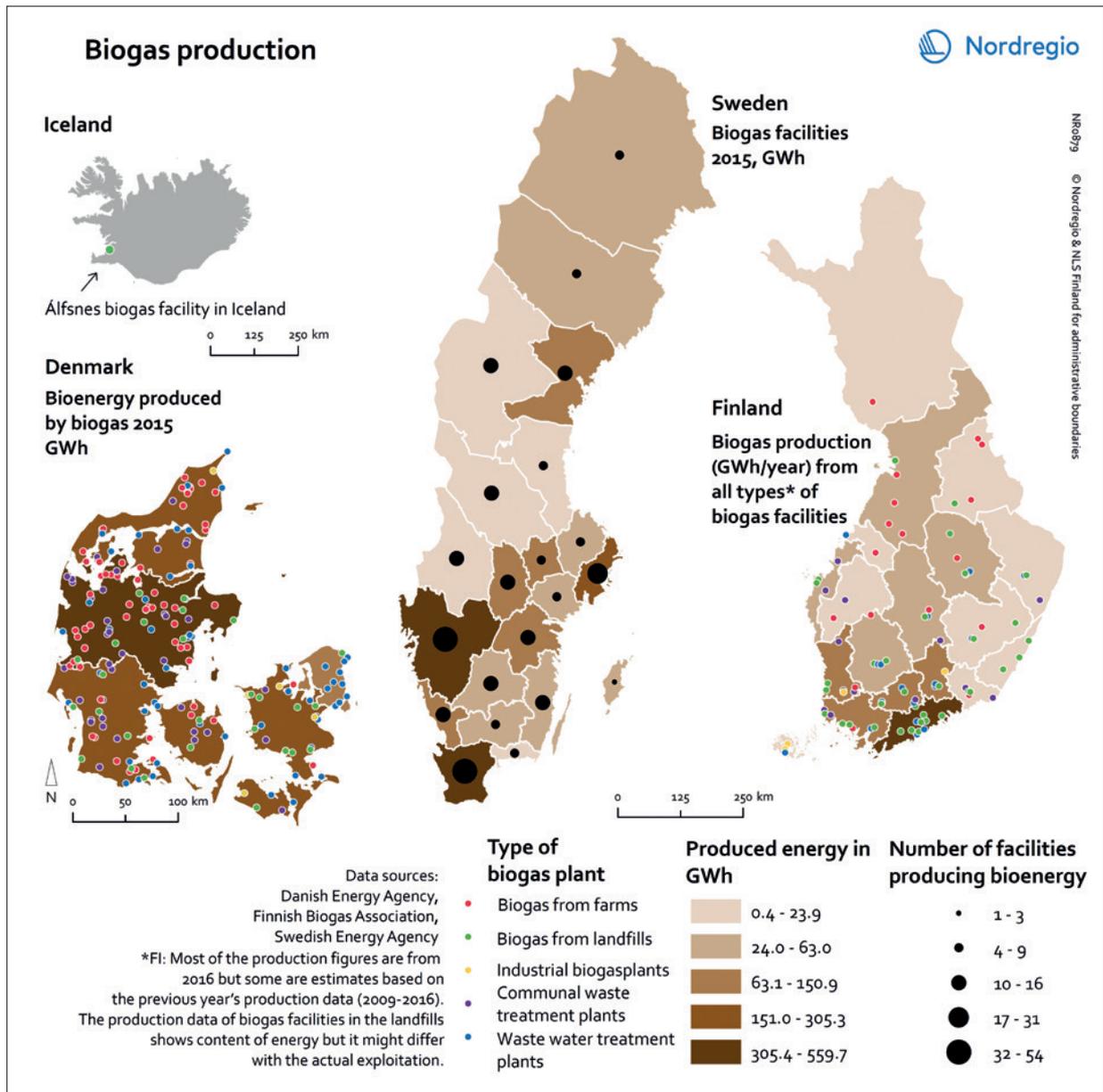


Figure 11.7 Regional biogas production in GWh.

area could become a global role model and change agent in the sustainable blue economy.

Nordic fisheries are characterised by innovation in products, services and markets. Rural and coastal development is clearly affected by fisheries policy, directing where fishing vessels can land their catch, such as in Norway, with positive economic impacts for smaller coastal communities. The Norwegian Fresh Fish Act (1938) gave the fishermen's organisation "the right to negotiate landing prices for the

whole coast, and settle them with reference to the export market opportunities. In effect, the Act implied that the resource rent went to the primary producer, rather than to the middlemen" and ensured local landings (Brox, 2006).

Large changes have however occurred in fisheries value chain management in recent years. The Nordic countries have been leaders in the development of sustainable fisheries management, with a focus on property based management and different

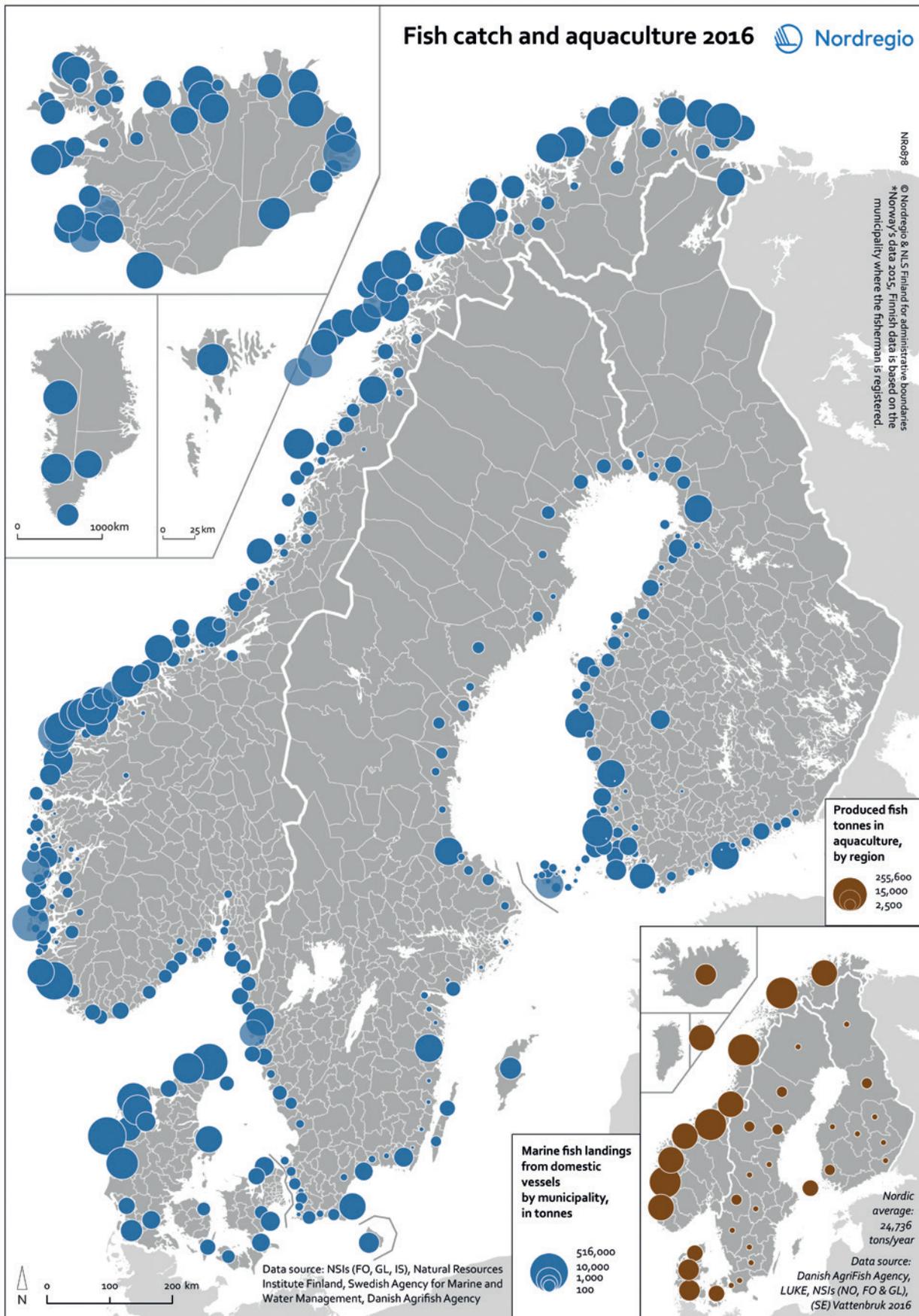
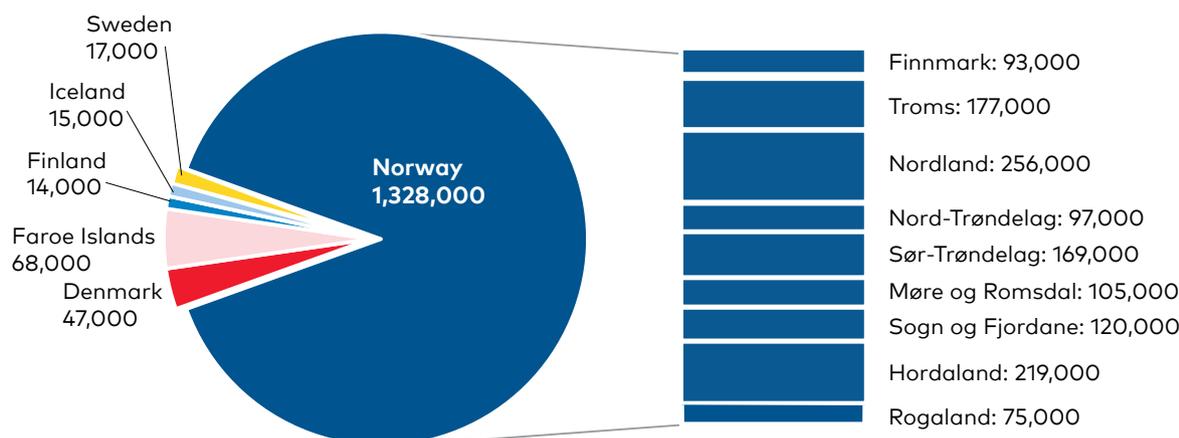


Figure 11.8 Fish catch and aquaculture 2016.

**Figure 11.9 Farmed fish in tonnes in the Nordic Region in 2016.**



Data source: Danish Agrifish Agency, LUKÉ, NSIs, Vattenbruk 2016.

variations of Individual Transferable Quotas (ITQs). The ITQ does not however consider either the regional or the inter-personal distributional impacts of the catch. The sea is a common resource fishing bank and property rights regimes that consider both distributional impacts as well as environmental and production outcomes are required.

Figures 11.8 (small map, bottom right corner), and 11.9, highlight aquaculture production in the Nordic Region in 2016 with the size of farmed fish production at the regional level. Norway, particularly its coastal regions in the west, clearly dominates the Nordic aquaculture sector.

## Concluding remarks

This chapter provides a series of snapshots from the different parts of the bioeconomy relevant to the Nordic Region with a focus on land and sea use. The need for additional data (at regional level) however remains – including that relating to the institutional (networks, ownerships, actors etc.) and the socioeconomic (employment and income) aspects of this subject.

The vast land resources and surrounding marine areas enjoyed by the Nordic Region provide significant opportunities for economic growth and employment in its diversified rural areas and can create value added and generate highly valued R&D jobs. The bioeconomy requires technological but also,

crucially, institutional innovation. Above all, policy must respond to the diverse and dispersed bioresources in rural and coastal areas and with competing uses crossing sectors. Instruments and regulations are required to promote and defend the interests, knowledge and user rights to the resources and their utilisation and to creative incentives promoting economic, social and environmental sustainability at multiple levels. New institutions including those overseeing land use and marine ownership, management of the resources and their utilisation, the power to take decisions and governance at the local and regional levels, are needed. This is required to support the development of new processes at the local and regional levels and to promote the establishment of new businesses and clusters, while at the same time considering the impacts of this transition on, and interests of, the local communities. As expressed by Sveinn Margeirsson, director of Biotech R&D institute Matis in Iceland: "The value creation depends on people that live outside the large urban centres and are prepared to grow the land, catch the fish and process the raw materials. These people and their skills are essential in developing the bioeconomy towards its next stage" (Finnsson, 2014, April, p. 7).

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The publication maps the scale and distribution of bio-based industries, such as forestry, fisheries, aquaculture and biogas production and contains informative and concise description of the Nordic Bioeconomy.

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