Chapter 9
INNOVATION:
Nordic lead the charts

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Existing global challenges and continuing economic pressures place innovation at the forefront of Europe's efforts to transform the economy and stimulate global competitive advantage. The Europe 2020 Flagship Initiative, Innovation Union aims 'to improve conditions and access to finance for research and innovation, to ensure that innovative ideas can be turned into products and services that create growth and jobs' (COM 2010). In the Nordic Region, innovation is also high on the agenda. Sweden, Denmark, and Finland are the top performers according to the European Commission's Innovation Union Scoreboard 2015 and therefore offer interesting examples of how to create conditions that facilitate innovation and contribute to the EU's smart growth strategy.

This chapter explores the current status and the change in innovation performance of the Nordic Region. First, a comparative overview of the Nordic innovation performance along with a reflection on the change in performance levels over time is presented. Second, the chapter reviews some of the primary enabling factors in innovation performance e.g. the availability of a highly-skilled workforce, business R&D investment and employment in the knowledge-intensive sectors of the economy, in a European context. Third, an overview of the Nordic performance on eco-innovation is presented.

Nordic countries among the top European performers on innovation

There is a general consensus in the literature that place matters for innovation and regions play an important role in enabling innovation and in the achievement of national and regional growth objectives (OECD 2013). This section provides a comparative assessment of the regional innovation performance of the Nordic countries in the European context. The regions' performance is measured by the Regional Innovation Scoreboard (RIS) index which incorporates three types of Innovation indicators i.e. enablers e.g. tertiary education and R&D expenditures as a percentage of GDP; firm activities e.g. EPO patent applications, SMEs innovation/patents and R&D expenditure in the business sector as a percentage of GDP; outputs e.g. knowledge-intensive activities (Hollanders et al., 2014). Regions are classified into four groups showing different levels of regional innovation performance: innovation leaders, innovation followers, moderate innovators and modest innovators. Figure 9.1 illustrates the current position of the Nordic Region in respect to their relative performance on the RIS index compared to that of the EU and highlights changes in performance over the period 2008-2014.

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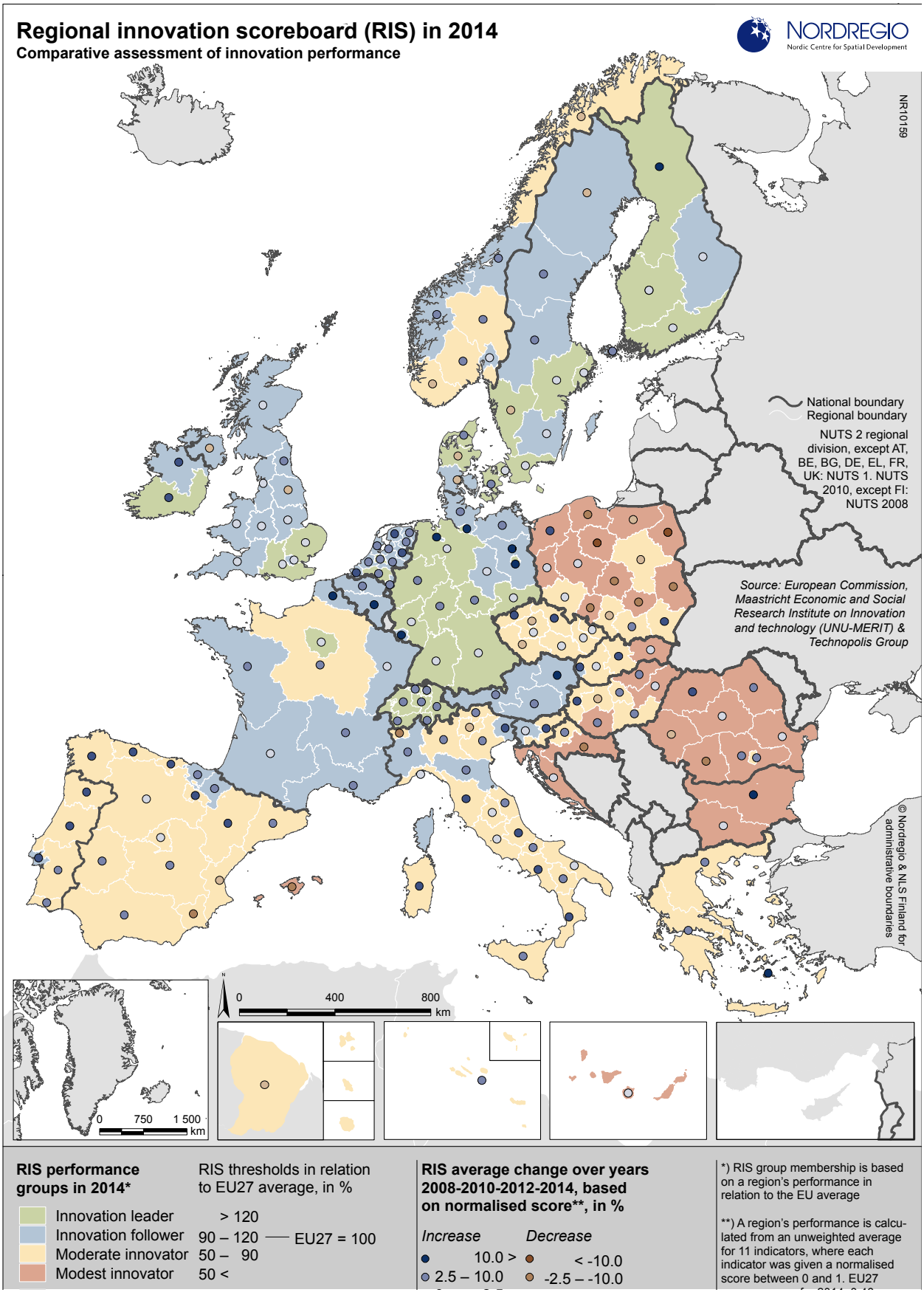


Figure 9.1: Regional innovation scoreboard (RIS) in 2014

The Nordic countries, together with Germany, Switzerland, Benelux countries, the UK and Ireland, come out on top in the RIS rankings, displaying a high level of innovation performance. Both Sweden and Denmark are represented by regions of two performance groups i.e. innovation leaders and innovation followers, whereas Finland shows a relatively homogeneous innovation performance as all regions with an exception of Itä-Suomi (East Finland) are innovation leaders. Over the period 2008 – 2014, the majority of the Nordic Regions have exhibited positive trends in innovation performance. Across all Nordic NUTS 2 regions, the most positive change in growth performance (above 10%) took place in Pohjois-Suomi (North Finland) followed by Hedmark og Oppland and Vestlandet (both in Norway), Norra Mellansverige and Mellersta Norrland (Sweden) and Nordjylland (Denmark) with an average change above 2.5%. In contrast, innovation performance in Midtjylland and Syddanmark in Denmark, Västsverige and Övre Norrland in Sweden, and Agder og Rogaland in Norway dropped by an average of between 2.5% and 10%.

Enabling factors in innovation performance

Advanced research degrees

With a shift toward knowledge-based economic activity and increasing specialisation in science and research, the demand for human resources with advanced research degrees has substantially increased (OECD 2015). In international comparison with respect to the share of individuals with doctoral degrees (out of the population aged 25-64), the Nordic countries, with one exception (Sweden), do not feature in the top 5. Switzerland has the highest share in Europe (27.5‰) followed by Austria (15.8‰) and Sweden (13.6‰). While Switzerland accounts for the largest share of working population holding PhD degrees in Europe, Sweden has the highest share among the Nordic countries, with the other four Nordic countries following them in the top half of the list.

Norway has the highest share (36%) of international PhD graduates followed by Denmark (33%), Sweden (29%) and Iceland (26%).

Table 9.1: **Number of people who earned a PhD in 2013, by citizenship**

Country	Total	Own country	Foreign country	Un-known
Denmark	1 949	1 305	644	0
Finland	1 724	1 420	304	0
Iceland	57	42	15	0
Norway	1 524	972	552	0
Sweden	2 650	1 786	777	87

Data source: NIFU, NSI's. Note: Finland: Includes Åland. Faroe Islands and Greenland: No data

Foreign PhD graduates constitute a substantial share of the total number of doctoral graduates in Europe, including the Nordic countries, helping to increase the knowledge potential of the host country as well as building up networks with research and development institutes abroad. Table 9.1 presents the number of doctoral graduates in the Nordic countries, by citizenship. Norway has the highest share (36%) of international PhD graduates followed by Denmark (33%), Sweden (29%) and Iceland (26%). The share of foreign doctorate holders in Finland falls below the 20% margin (18%). It is however worth mentioning that the share of international doctorate holders in Finland has significantly increased in the past decade (as they constituted only 8% of PhD graduates in Finland, in 2000).

Business R&D investment

Figure 9.2 illustrates the change in research and development (R&D) investments in the business sector in the Nordic Regions in the period 2007-2013. It should however be noted here that the map does not depict the current size of the business sector, only the change in R&D investments, both in absolute terms (size of the circles) and in percentages (blue hues for positive change, red for negative). There is a clear difference here in respect of R&D investments in the dominant Nordic cities and

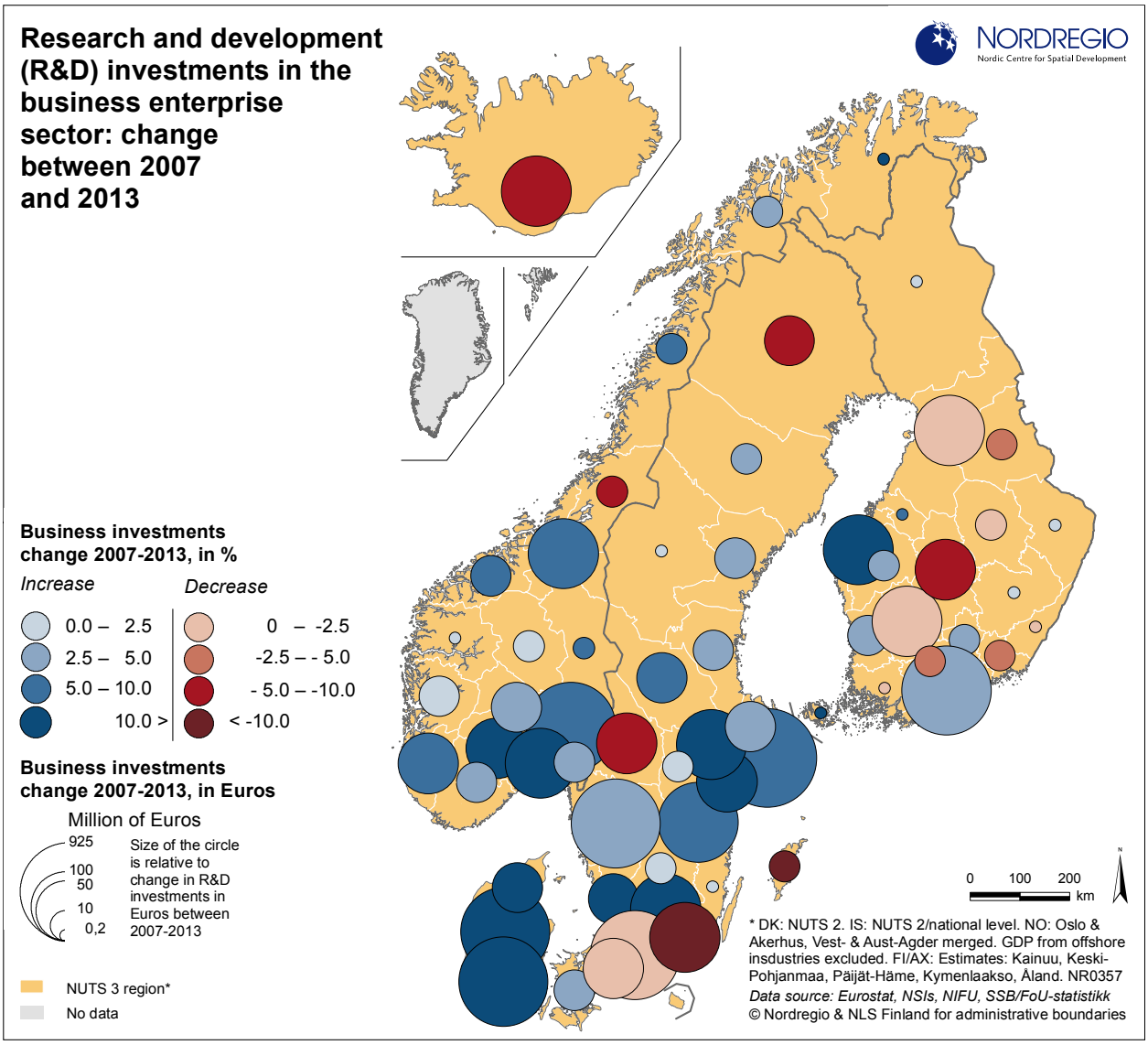
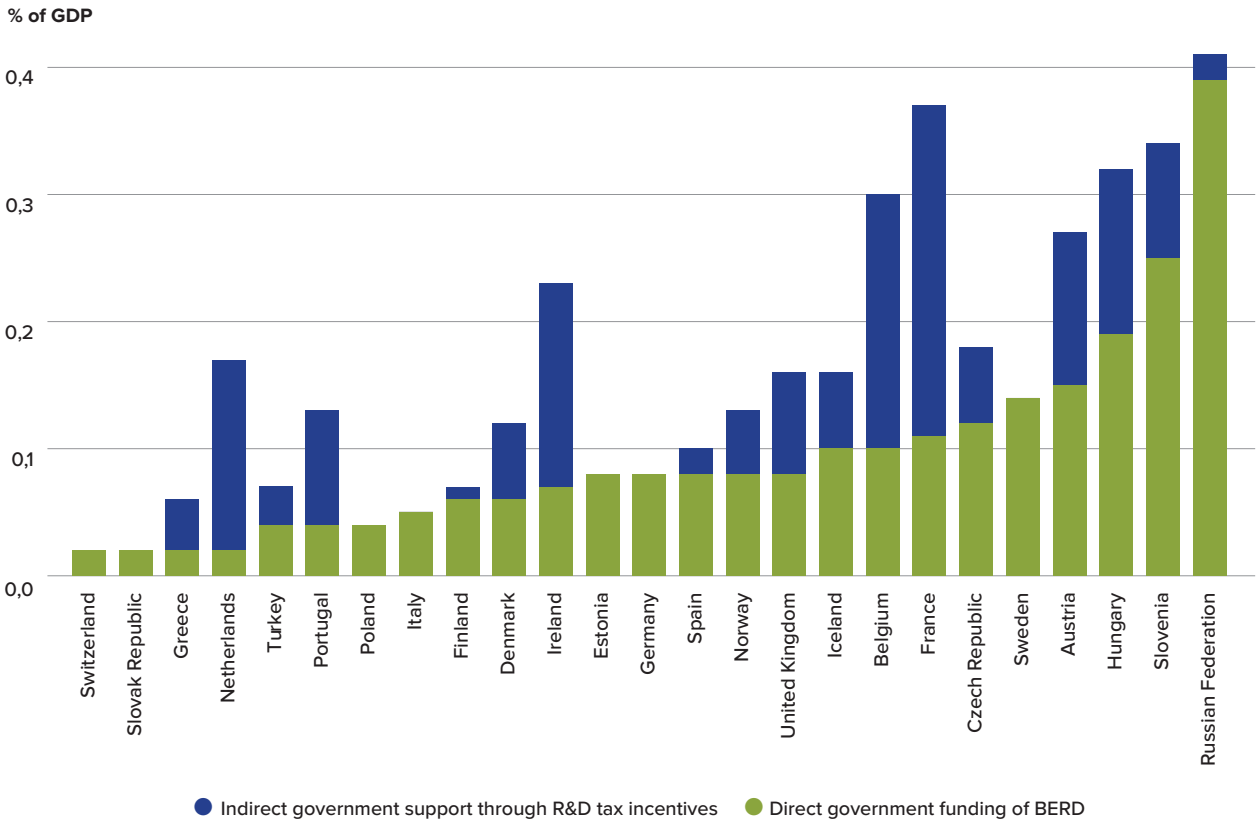


Figure 9.2: Research and development investments in the business enterprise sector: change between 2007 and 2013

regions compared to several peripheral regions; the strong Nordic RDI environments have experienced considerable growth regarding R&D business sector investments (ranging from 5 to 10%) whereas many of the Nordic peripheral regions i.e. Norrbotten, Värmland, Blekinge and Gotland in Sweden, Nord-Trøndelag in Norway, Iceland and Keski-Suomi in Finland have experienced a dramatic decrease (over 5%) in business R&D. In Norway, the more peripheral regions have not suffered significantly compared to their counterparts in Sweden and Finland, which is partially attributed to regional policy differences across the Nordic Regions. As noted previously, in Iceland (in this case measured only at the national level), business R&D investments have decreased significantly (over 5%) during the period 2007-2013. A significant increase in private R&D investments, both in terms of percentage change and in terms of millions of Euros, has however been observed in Vestfold and Telemark in Norway, in the Jutland regions of Denmark (Nordjylland, Midtjylland and Syddanmark), in Halland and Kronoberg regions in Southern Sweden as well as in Västmanland and Södermanland in Eastern Central Sweden and in Pohjanmaa, in Finland.

The existence of market failures e.g. knowledge spillovers and the lack of certainty over R&D benefits etc., are often suggested as reasons for introducing tax reductions. They are expected to prompt an upswing in private R&D investment and, in turn, to promote the growth of innovation outcomes and long-run expansion. In the Nordic countries however the major portion of R&D expenditure stems from the business sector despite the existence of rather modest (or even disincentives as in the

Figure 9.3: **Direct government funding of business R&D and tax incentives for R&D in 2013**



Data source: OECD, R&D Tax Incentive Indicators. Note: Finland: Includes Åland. Faroe Islands and Greenland: No data. Diverging data years: Belgium, Ireland, Switzerland, Spain: 2012, Iceland, Russian Federation: 2011

Figure 9.3: Direct government funding of business R&D and tax incentives for R&D in 2013: Indirect government support through research and development tax incentives, and direct government funding of BERD (Business enterprise expenditure on research and development). Selected countries.

case of Sweden) R&D tax incentive schemes. In 2013, Finland introduced a tax allowance as a temporary measure, although its volume was rather small. This supports the idea that tax incentives should be seen more as supplementary tools than as substitutes for the basic 'enabling conditions' such (OECD 2002). The chart contained in figure 9.3 illustrates the existence of a wide variation in R&D tax incentives across Europe. The overall level of government R&D support, which is crucial from the viewpoint of private sector, is a combination of direct government funding of business R&D and indirect government support through R&D tax incentives. In the overall comparison of direct and indirect R&D support, the Nordic countries are positioned in the mid-section of the graph (see figure 9.3). It is clear from the graph, however, that the size of government R&D support does not reflect the country's innovation performance per se; the key to the innovativeness of regional and national economies lies in the existence of favourable framework conditions and well-functioning innovation systems.

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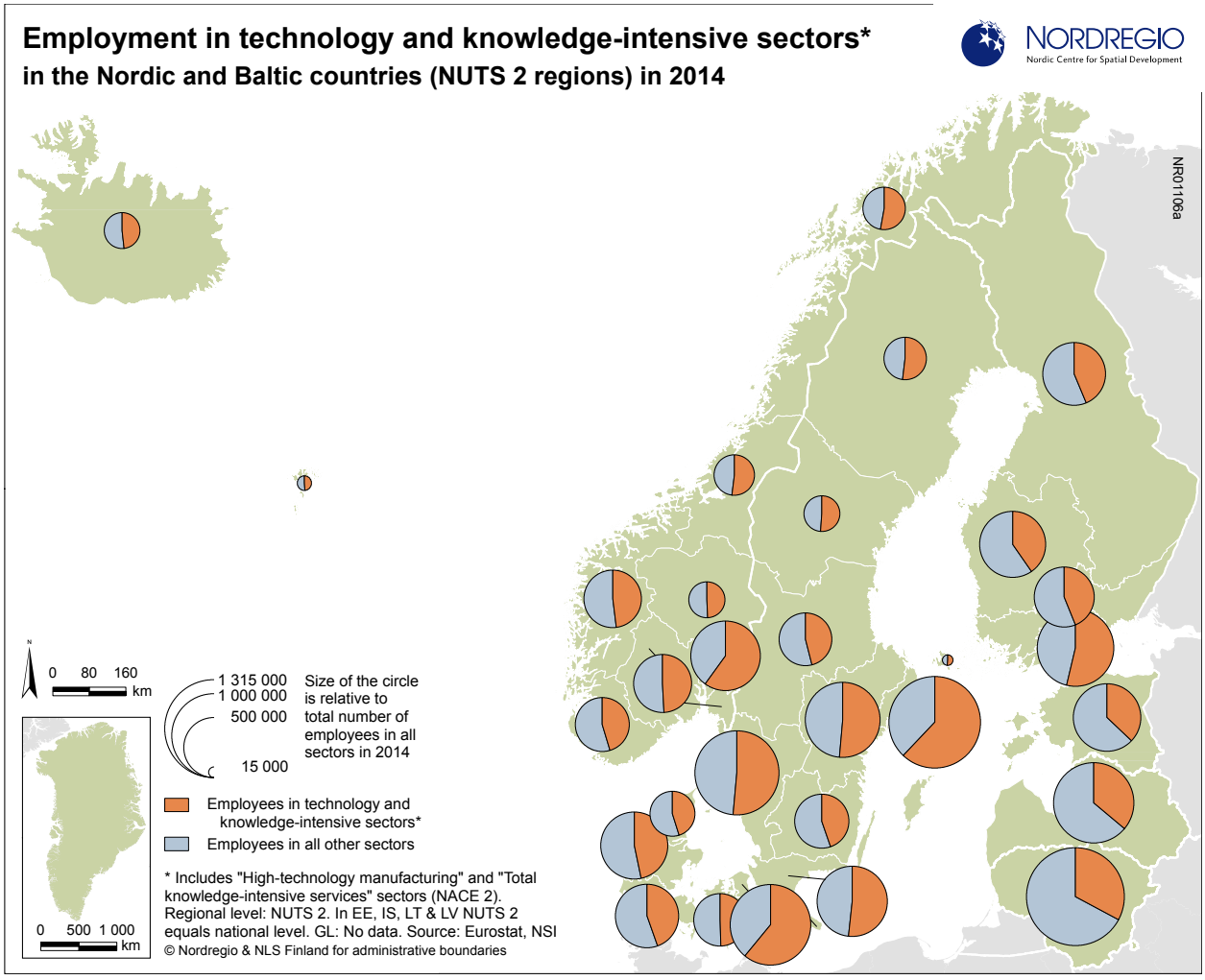

Figure 9.4: Employment in technology and knowledge-intensive sectors in the Nordic and Baltic countries (NUTS 2 regions) in 2014

Employment in knowledge-intensive sectors[2]

As noted previously, Europe has enhanced its academic tertiary education output in recent years. Moreover, many countries have set up national measures with the aim of attracting a highly qualified workforce and human resources into science and research, including a specific focus on encouraging more women into these fields. Figure 9.4 presents figures for employment in the technology and knowledge-intensive sectors in the Nordic and Baltic countries in 2014. The figure illustrates not only the absolute concentration of Nordic technology and knowledge-intensive jobs to the major cities and regions but also the high share of technology and knowledge-intensive jobs in the leading cities and regions, such as the capital areas. There are, however, some examples of the existence of relatively high concentrations of knowledge-intensive jobs in some Nordic Regions outside the major cities, as figure 9.4 illustrates, among them, in Norway, Trøndelag and Nord-Norge (Northern Norway), and in Sweden, Östra Mellansverige (East Middle Sweden), Mellersta Norrland (Middle Norrland) and Övre Norrland (Upper Norrland). In peripheral regions, economic diversification into knowledge-intensive activities is often prompted by rather limited venture capital inflow as in the case of Övre Norrland (Upper Norrland). Although medium-low and low-technology industries remain important for employment and value–added generation in Övre Norrland, the transformation of the regional profile towards more knowledge-based industries like life sciences and information and communication technologies significantly increases its potential to attract foreign investors to the region. Within the Nordic Region, the smallest shares of knowledge-intensive jobs are to be found in the three northernmost Finnish NUTS 2 regions, which is partially attributed to their traditional economic structures characterised by a predominance of basic and traditional industries. Moreover, figure 9.4 illustrates the relatively high share of knowledge-intensive jobs in the Nordic Regions compared to the Baltic

[2] Eurostat defines an activity as knowledge intensive if the tertiary educated persons employed represent more than 33% of the total employment in that activity (http://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an8.pdf)

countries (which, in this case of NUTS 2 regions, equate to the national level for Estonia, Latvia and Lithuania). The growing potential of knowledge and intellectual capabilities reflected in an increased share of employees in knowledge-intensive sectors, indicates the strong commitment of the Nordic economies to research and innovation for growth and productivity.

Eco-innovation

Given the EU's ambition to establish bio-economy as a cornerstone of the European economy green research is recognised as one of the investment priorities under the Horizon 2020 framework programme for research and innovation. Growing demand for green solutions has provided a niche for competition where the EU has been among the first movers; however, building a green economy requires multidisciplinary innovative solutions, the development of new business models, new opportunities and new skills. The Nordic countries are among the world's innovation leaders, having achieved a significant competitive advantage in the field of green solutions. The Nordic praxis, therefore, can serve as an example of how to create green growth in practice, thus contributing to the EU's market positioning and competitive advantage in the field of green solutions.

Figure 9.5 on Green patents in the Nordic Region illustrates how well the regions of the Nordic countries perform in this dimension of eco-innovation. The situation in 2011 is displayed by pie charts, in which the magenta (purple red) colour represents the share of the total number of patents (magenta colour in addition to grey colour of the pie charts, and the size of circles), while the annual average change over the years 2006-2011 is presented in background colours, i.e. green hues represent a significant positive change, yellow a rather neutral trend (between 5% and -5% annual average change), while orange hues show a significant negative trend. Green patents in this map cover patents classified as general environment, energy generation (renewable and non-fossil sources), technologies for mitigation potential, transportation emissions abatement/ fuel efficiency, and buildings/ lighting energy efficiency. There are several methodological issues related to measuring patents since e.g. not all inventions are patented or inventors may protect the inventions using other methods.

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Regions with the largest populations and a large number of total patents generally do not have large shares of green patents.

A high relative shares of green patents as a percentage of all patent applications, (above 25%) and also a relatively high number of total patents, are found in the Pohjanmaa region on the West Coast of Finland, in several regions in Denmark, e.g. in Østjylland, Vestjylland and Sydjylland, in Norway's Buskerud fylke and in Swedish Kronobergs län and Västerbottens län (see Figure 9.5). The number of green patents here can, in part, be assigned to the concentration of bio-related activities in some of these regions e.g. biorefinery (Västerbotten), green energy (Vestjylland). Moreover, in regions with a very small total number of patents, there are also several cases where the green patent share is above 25%: Kymenlaakso and Pohjois-Karjala in Finland, Finnmark and Hedmark in Norway.

A striking additional feature here is that those regions with the largest populations and a large number of total patents generally do not have large shares of green patents (although the actual number of green patents is likely, by far, to outnumber those of regions with smaller populations). Moreover, Nordic Regions are generally too small to independently secure their global position in the green technology sector. As such, closer cooperation on research and green technology development, as well as the establishment of common frameworks across the Nordic Region, will better enable all five countries to maximise the value of their competitive advantage enabling them to become a major force in the field of green growth.

The Eco-Innovation Scoreboard (Eco-IS) complements other measurement approaches in terms of the innova-

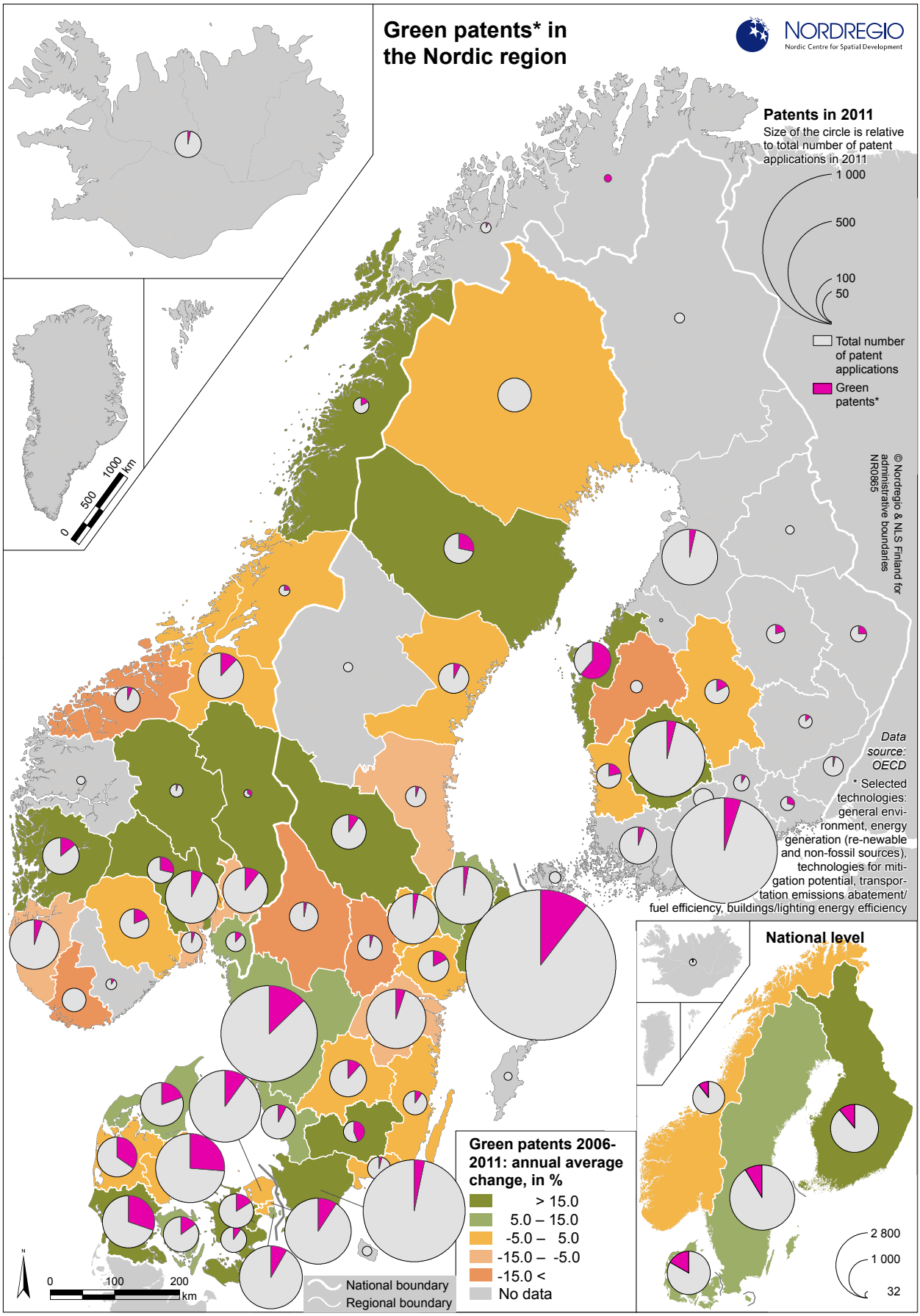

Figure 9.5: Green patents in the Nordic Region. Regions in which the number of green patents has been zero for at least two years during the period 2006-2011, or for which times series data were entirely missing, are coloured grey in the map

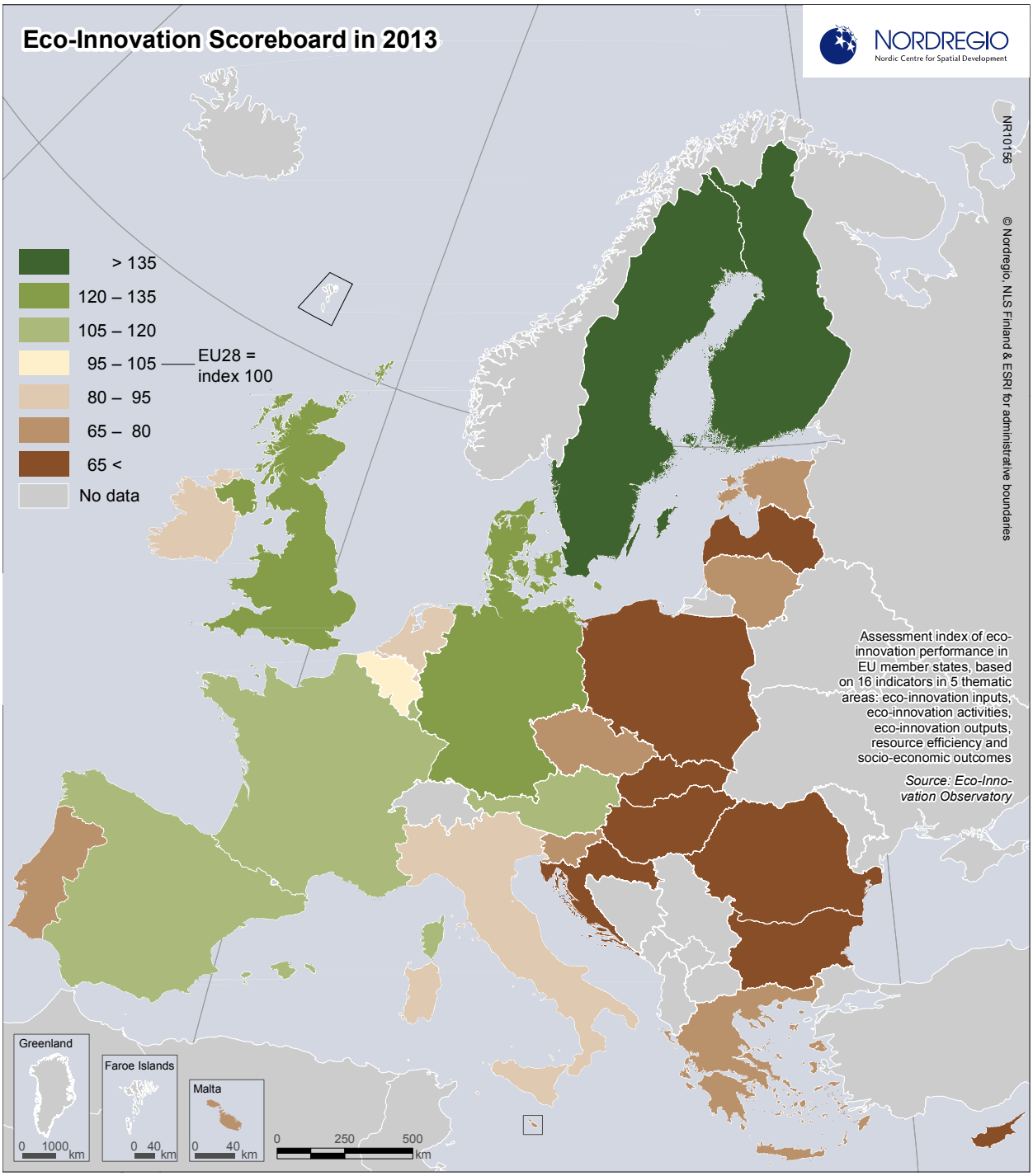

Figure 9.6: Eco-Innovation Scoreboard in 2013. Note: Finland: Includes Åland

tiveness of EU countries and aims to promote a holistic view of economic, environmental and social performance. It covers eco-innovation inputs, eco-innovation activities, eco-innovation outputs and resource efficiency and socio-economic outcomes .

The Faroe Islands, Greenland, Iceland and Norway are not however included in the Eco-innovation Scoreboard, limiting the scope of our analysis. As such, the future introduction of a coherent Nordic eco-innovation index covering not just five Nordic countries, but also Åland, Greenland and the Faroe Islands would simplify and enrich the analysis by enabling a comprehensive analysis to be undertaken of the entire Nordic Region.

Concluding comments

In this chapter, we have explored innovation performance in the Nordic countries and regions and analysed the Nordic innovation capacity. Based on the data provided, a few concluding remarks are worth making to reemphasise the key points (note however that our analysis on Nordic innovation largely focuses on Finland, Sweden, Denmark, and Norway due to lack of innovation statistics for Iceland, Åland, Greenland and the Faroe Islands. In consequence, comparability is rather limited. Even for the largest countries in the Nordic Region, innovation data at the regional standard levels and applicable in an international context (e.g. harmonised) can be hard to find).

First, the Nordic countries and regions currently represent a good to excellent level of innovation performance compared to other European countries and their regions. The Nordic Regions in Sweden, Denmark, Finland, and Norway are either innovation leaders or innovation followers. For instance, despite sudden changes in the Finnish ICT sector in recent years, the overall level of innovation performance has not yet been affected during the period covered by this report. In the long-term, however, Finland is likely to face a significant challenge in its attempt to maintain the economic and innovation boost generated by Nokia. The Finnish government has recently proposed cutting state funding for universities and research institutes, something which will, it could be argued, only further deepen the crisis in Finland.

Second, innovation performance and the competitiveness of the Nordic Region is explained by the existence of good preconditions for research and development:

- relatively high workforce share of doctorates (e.g. Sweden ranks third in Europe);
- high levels of direct funding of business R&D. During the period 2007-2013, in the three capital areas of Oslo, Stockholm and Helsinki the level of business R&D investments has continuously increased, and there were several other regions where R&D investments also significantly increased. The statistics on R&D investments in the business sector in Iceland reflect the national economic crisis that occurred during the period peaking in 2009-2010.
- high employment levels in the knowledge intensive sectors (although with some variations across regions). The northern parts of Finland, Sweden and Norway however continue to lag significantly behind their southern counterparts in the respective countries.

Third, eco-innovation seems to be regionally 'scattered' across the Nordic countries. There are numerous regions with eco-innovation potential in Finland, Sweden, Denmark and Norway when measured by green patents. As we have seen, high shares of green patents are found in several regions even outside the big Nordic cities, e.g. Pohjanmaa (Finland), Østjylland, Vestjylland and Sydjylland (Denmark), Buskerud (Norway) and Kronoberg and Västerbotten (Sweden). Moreover, in some Nordic Regions with a very small total number of patents, there are several cases where green patents predominate, e.g. Kymenlaakso and Pohjois-Karjala (Finland) and Finnmark and Hedmark (Norway). Regions with the largest population sizes and also a large number of total patents generally however do not have large quantities of green patents.

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How does our analysis on innovation capacity and performance in the Nordic countries and regions reflect the Nordic reality in 2016? Despite some differences in economic performance across the Nordic countries, no significant changes in the overall level of Nordic innovation capacity and performance had become evident by the end of 2015. One explanation for this is that the Nordic countries are characterised by a robust knowledge-intensive industrial structure, which appears to be more resistant to crisis than those of some other European countries. Nevertheless, it is still too early to determine any significant long-term trends in this respect.

As for eco-innovation, it opens up new opportunities for both large city regions and peripheral/sparsely populated regions in the Nordic countries. To give an example, it is not economically efficient to transport biomass on long distances. Proximity of the natural resource base and production (MacCormick & Kautto, 2013) creates innovation opportunities for both the regions that are dependent on the natural capital and resource bases and those that are not characterised by the geographic 'immobility' of the primary factors in production. As such, Bio-economy related innovations take place both in the big Nordic cities with universities and research centres and at the sites where raw material is acquired.