

# Business Cluster Specialisation in the Highlands and Islands

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# 1. INTRODUCTION: SCOPE AND METHODS

## 1.1 Objectives and scope of the study

In October 2016, Highlands and Islands Enterprise commissioned this study on business clusters and value chains in the Highlands and Islands (H&I). The study provides a comparative and in-depth examination of business specialisation and cluster linkages and sought to identify emerging or unexploited opportunities to boost value added in the regional economy.

Clusters are defined as regional concentrations of activities in groups of related industries. Clusters emerge naturally through market processes, as spill-overs among such activities enhance performance at the firm and regional level. Examples of such positive effects, that usually grow with the critical mass in a given location, are a labour market with specialised skills, local supplier networks with specialised capabilities, and a local knowledge pool driven by the innovation activities of firms and knowledge institutions. Clusters differ from cluster organisations, which are the organisations that manage the networks of firms and other entities within a given cluster<sup>1</sup>.

The analysis is structured in four steps:

1. Specialisation patterns and cluster mapping
2. Investment, R&D and innovation activity driving business clusters
3. International linkages and value chain positions
4. Future options for Highlands and Islands business clusters

In part, the study is a follow-up to the Scottish Cluster Mapping 2015 study (Izsak, Markianidou and Reid, 2016)<sup>2</sup> and provides an in-depth analysis for the Highlands and Islands. However, this report develops additional insights through a more detailed exploration of the relative position of Highlands and Islands 'clusters' compared to a set of benchmark regions. By comparing with the performance of similar clusters in the benchmark regions, the aim is to identify examples that may provide inspiration for enhancing the performance of the Highlands and Islands business clusters.

## 1.2 Methodological framework and definitions

The assessment of Highlands and Islands clusters compared to the European average and selected benchmark regions was carried out applying the data, methodology and cluster definitions of the European Cluster Observatory (ECO)<sup>3</sup>. The ECO uses the location quotient as an indicator to assess the importance of clusters in an economy compared to other regions. A short note on the ECO's methodology for cluster analysis and all definitions of the cluster categories used in this section are presented in Annex 1.

The ECO defines 51 traded cluster categories and 10 emerging industries and treats the rest of the economy as local business activities. The categories were constructed based on

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<sup>1</sup> See: <http://ec.europa.eu/DocsRoom/documents/20381>

<sup>2</sup> Kincsó Izsak, Paresa Markianidou, Alasdair Reid: Scottish Clusters Mapping 2015. Report for Scottish Enterprise. DOI: 10.13140/RG.2.2.17225.13924

<sup>3</sup> See: [http://ec.europa.eu/growth/smes/cluster/observatory/index\\_en.htm](http://ec.europa.eu/growth/smes/cluster/observatory/index_en.htm)

linkages across industries through co-location (employment, establishments), skills use (occupations), and supplier relationships (input-output tables) that are applicable for both the US and EU economies, hence they allow for cross-country and cross-regional comparisons.

Emerging industries are *“the establishment of an entirely new industrial value chain, or the radical reconfiguration of an existing one, driven by a disruptive idea (or convergence of ideas), leading to turning these ideas/opportunities into new products/services with higher added value”*. They are in many cases new combinations of existing industrial sectors that are changing in response to new technologies, new business models and market demands. The Cluster Panorama empirically identifies broad sets of ‘emerging industries’ in which such new combinations of related activities were likely to emerge

The 2016 ECO data is based on firm- and plant-level data sources from the Orbis Historical dataset supplied by Bureau van Dijk (June 2016 release). The data provides detailed information on the economic performance of firms, including turnover, wage bill, capital, materials and employment. Three Eurostat datasets are also used for calibration: the business demography to obtain counts of businesses in missing legal forms, the Structural Business Statistics to provide aggregate values to match to, and the Regional Economic Accounts to calibrate the final numbers to be comparable across countries. More methodological details are available in the European Cluster Panorama 2016 report<sup>4</sup>.

The **degree of specialisation** is measured by the relative size of regional employment in each (sectoral or cross-sectoral) cluster category reflected in its location quotient (LQ). This relative measure indicates how much stronger a region is in a cluster category than would be expected given its overall size, compared to the average employment size in the specific cluster category across all EU28 regions. A location quotient below 1.0 means that a region is not specialised in the given industry. In contrast, a location quotient value higher than 1.0 is an indication that the region has proportionately more employment than the EU average in the cluster. This implies in certain cases that the region produces more of a product or service than is consumed by residents.

The ECO calculates the location quotient based on employment, but this can also be calculated using **gross value added**<sup>5</sup> (GVA), which could be more relevant for the Highlands and Islands given its low levels of unemployment. The specialisation ratio based on GVA is defined as the industry’s share of total value added in a region to the industry’s share of total value added in all other EU regions.

Additional data sources and methods used for the subsequent steps of the study to analyse the relative performance of the key sectors and clusters are detailed in the specific chapters.

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<sup>4</sup> See: <http://ec.europa.eu/DocsRoom/documents/20381>

<sup>5</sup> Often also called the Herfindahl-Hirschman Index.

## 2. MAPPING HIGHLANDS AND ISLANDS' CLUSTERS

### 2.1 Highlands and Islands relative specialisation in the European cluster landscape

The **most specialised Highlands and Islands cluster categories**<sup>6</sup>, with a specialisation index based on employment data higher than 2, are fishing and fishing products, environmental services<sup>7</sup>, metalworking technology<sup>8</sup> and forestry. The Highlands and Islands specialisation in fishing and fishing products has declined by about 18% since 2010. In contrast, the Highlands and Islands specialisation in environmental services increased by 72% and that of metalworking technology by 64% from 2010 to 2014.

While **most clusters categories increased, or maintained, their specialisation** compared to equivalent EU clusters from 2010-2014, a quarter lost specialisation during the same period (Figure 1). In addition to fishing and fishing products, the most important loss in specialisation has been in the forestry cluster, followed by education and knowledge creation<sup>9</sup>, and upstream chemical products<sup>10</sup>.

One other cluster, textile manufacturing, and one emerging industry, **environmental industries** also increased specialisation to become highly specialised since 2010. The latter includes renewable energy; material and energy efficiency; waste management; reuse, recycling and remanufacturing; repair and maintenance; sharing economy, including renting and leasing; environmental services, including environmental engineering; water; and environmental protection. Environmental industries is one of two emerging industries in which the Highlands and Islands is specialised, together with **blue growth industries**.

Moreover, several clusters that were specialised (score above 1) in 2010 have lost ground to become non-specialised these are:

- Transportation and logistics (1.241 in 2010 versus 0.865 in 2014)
- Logistical services (1.21 versus 0.925)
- Experience industries (1.071 versus 0.943)
- Biopharmaceuticals (1.078 versus 0.853)
- Wood products (1.229 versus 0.989), and
- Video production and distribution (1.364 versus 0.589).

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<sup>6</sup> See Appendix A for the definitions of cluster categories.

<sup>7</sup> Environmental Services includes water collection, treatment and supply; collection, treatment and disposal of hazardous waste; and recovery of sorted materials.

<sup>8</sup> Including manufacture of metal structures, tools, machining and treatment and coating of metals.

<sup>9</sup> This category includes research and experimental development on biotechnology, natural sciences and engineering, and social sciences and humanities; post-secondary non-tertiary education, tertiary education, cultural education, educational support activities; and activities of professional membership organisations.

<sup>10</sup> This includes the manufacture of industrial gases, other inorganic and organic basic chemicals, synthetic rubber, pesticides and other agrochemical products.

**Figure 1 Highlands and Islands clusters ranked by specialisation (employment), 2010-2014**

Clusters	2010	2011	2012	2013	2014	Change 2010-14
Fishing and Fishing	14.650	13.163	13.192	12.980	11.961	↓ -0.18
Environmental Services	1.777	4.810	4.448	3.369	3.049	↑ 0.72
Metalworking Technology	1.572	2.060	2.444	2.645	2.585	↑ 0.64
Forestry	3.959	3.339	3.264	3.159	2.547	↓ -0.36
Upstream Chemical Products	2.274	2.595	2.322	1.967	1.974	↓ -0.13
Agricultural Inputs and Services	1.992	1.487	1.397	1.628	1.843	→ -0.07
Electric Power Generation and Transmission	1.674	1.930	1.667	1.589	1.553	→ -0.07
Nonmetal Mining	1.394	1.335	1.463	1.294	1.431	→ 0.03
Hospitality and Tourism	1.309	1.288	1.227	1.253	1.305	→ 0.00
Education and Knowledge Creation	1.889	1.930	1.948	1.333	1.292	↓ -0.32
Distribution and Electronic Commerce	1.323	1.258	1.206	1.203	1.216	→ -0.08
Recreational and Small Electric Goods	1.058	1.080	1.507	1.349	1.154	→ 0.09
<b>Blue Growth Industries</b>	<b>1.255</b>	<b>1.176</b>	<b>1.160</b>	<b>1.180</b>	<b>1.143</b>	→ <b>-0.09</b>
Downstream Chemical Products	1.062	1.084	1.511	1.333	1.140	→ 0.07
Textile Manufacturing	0.644	1.472	1.142	1.156	1.036	↑ 0.61
<b>Environmental Industries</b>	<b>0.910</b>	<b>1.517</b>	<b>1.276</b>	<b>1.116</b>	<b>1.024</b>	↑ <b>0.13</b>

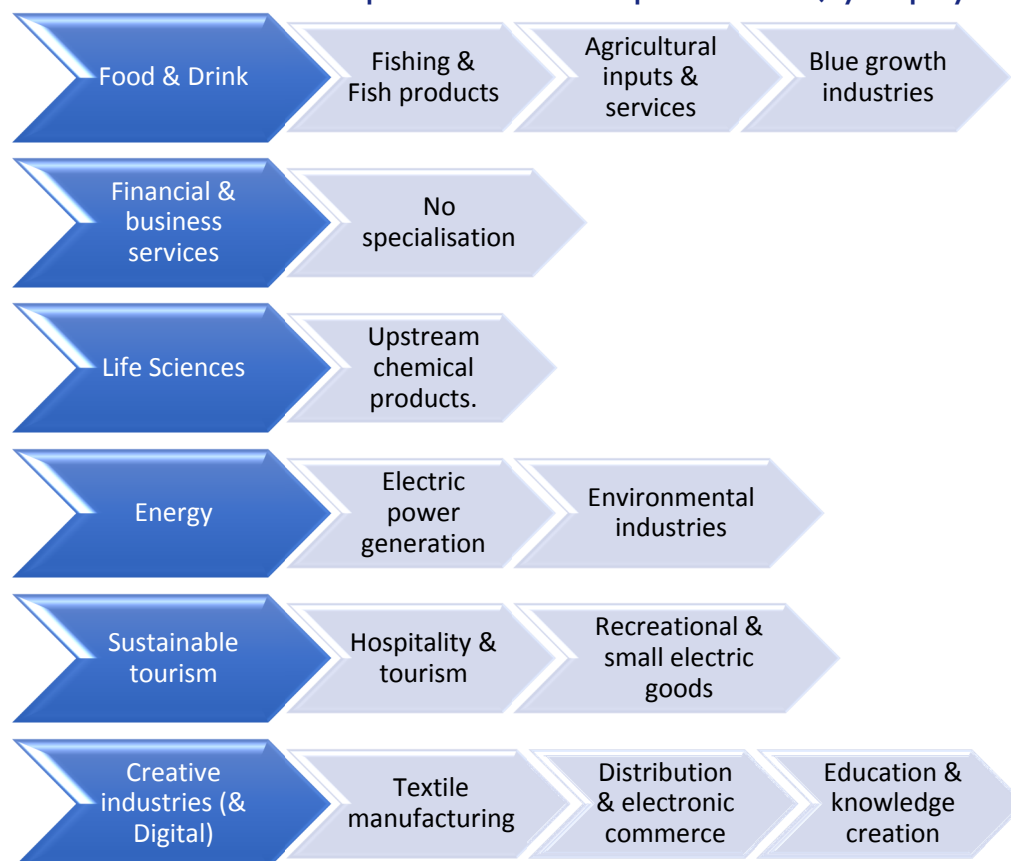
Source: authors, based on European Cluster Observatory data 2016

In addition, the experience industries emerging industry category was specialised in 2010 (1.071) but dropped below the threshold (to 0.943) in 2014. In contrast, several clusters have improved their relative position and are close to ranking as specialised in 2014: **performing arts** (0.976) and **construction** (0.964).

The specialisation pattern (by employment) contrasts with the sectoral focus of the Scottish Government's key 'growth sectors' adopted by Highlands and Islands Enterprise to underpin their strategy, as illustrated in Figure 2. The relevant clusters or emerging industries are mapped against the 'growth sectors' and illustrate that in at least two cases, there is no direct specialisation – financial & business services and life sciences. For the latter, we have linked it to upstream chemical products as it is commonly considered to fall into the broad life science sector and the ECO links biopharmaceutical, upstream and downstream chemicals to the biopharma emerging industry.



**Figure 2: Growth sectors – compared with cluster specialisation (by employment)**



Source: authors, based on European Cluster Observatory data 2016

Blue growth industries have been linked to the food and drink growth sector due to the importance of fishing and fish as a component of this cross-cutting industry in the Highlands and Islands; while environmental industries have been linked to energy due to the presence of different types of energy sectors in the Highlands and Islands economy, notably renewables. The analysis in the following chapters refines the cross-linkages and components of these two emerging industries in the Highlands and Islands economy.

Sustainable tourism is linked most directly to the hospitality and tourism cluster and the recreational and small electric goods cluster, which includes two sub-clusters of businesses active in the manufacture of musical instruments and the manufacture of sports goods. Textile manufacturing could be linked to tourism, however, it is most directly linked to the creative industries sector along with distribution and electronic commerce.

We have also linked education and knowledge creation to the creative industries, however, this cluster is clearly of cross-cutting importance for all key sectors.

Several specialised clusters do not fit readily with the growth sectors, these include:

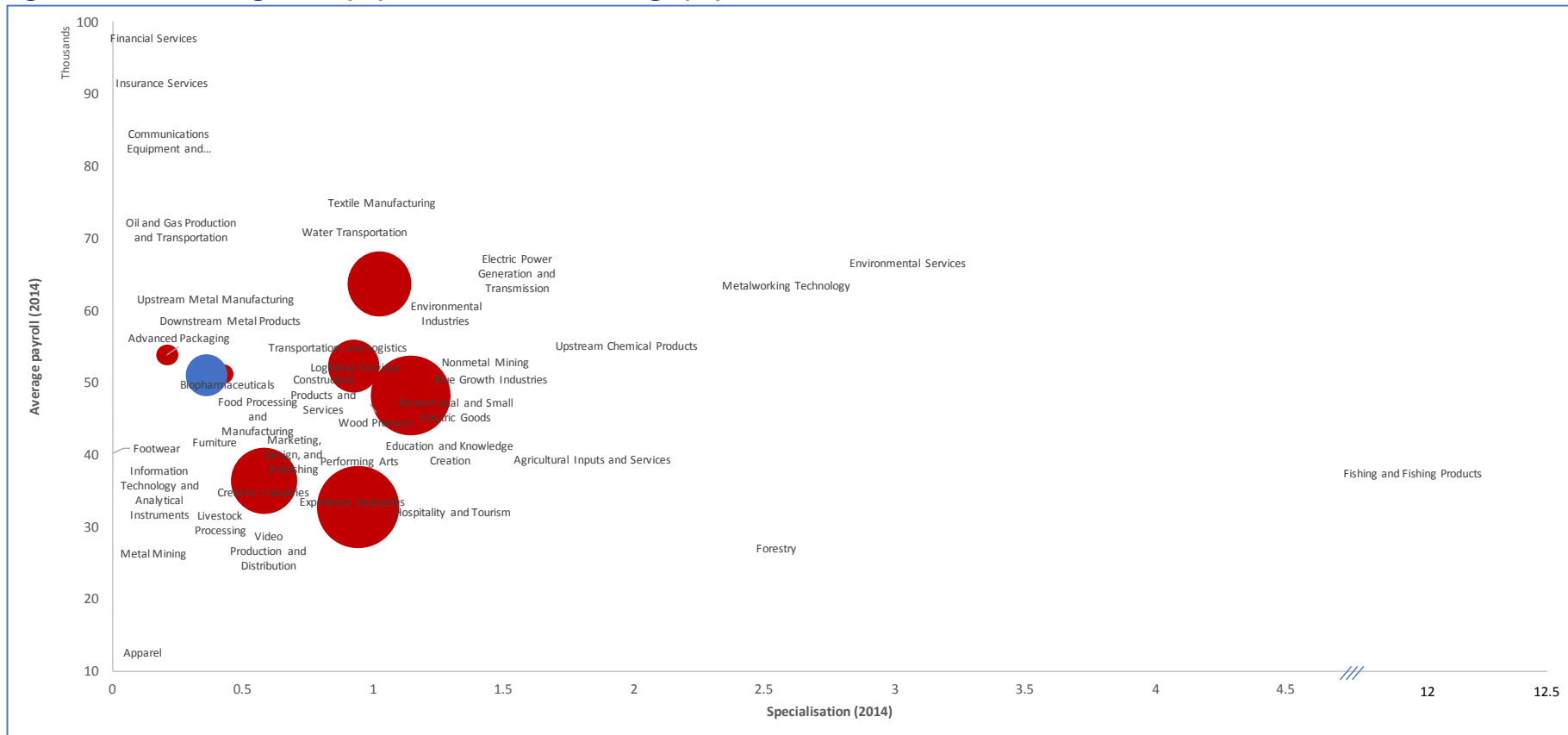
- Metalworking technology
- Forestry
- Non-metal mining, and
- Downstream chemical products

The latter cluster could be linked to life sciences but it requires a more in-depth understanding of the types of firms in this sector. Metalworking technology may well

reflect the relatively strong engineering base in the Highlands and Islands that is linked to both energy but also other sectors as a cross-cutting specialisation.

Relative specialisation does not necessarily reflect the absolute importance of the clusters in a regional economy. To put the relative employment specialisation in context, Figure 3 maps the absolute employment scale of the cluster and emerging industries in the Highlands and Islands economy by relative specialisation and average 'payroll' (as a proxy for wealth creation in the economy). As can be seen, some of the more specialised clusters are relatively small in absolute employment terms, while non-specialised clusters account for a significant share of employment or pay higher 'wages' than some of the specialised clusters.

**Figure 3: Cluster categories by specialisation and average payroll**



Source: Authors based on European Cluster Observatory data 2016.

Notes: Blue bubbles refer to cluster categories whilst red ones are the emerging industries. Bubble size corresponds to total employment in the cluster. Average payroll is in thousand Euros. The X axis has been adjusted for Fishing and Fishing products which is off the scale compare to all other clusters.

In terms of employment share, only four of the most specialised clusters by employment are in the top ranked clusters (see Figure 4): hospitality and tourism, metalworking technology, environmental services and fishing and fishing products. However, when specialisation with respect to other EU regions is calculated based on Gross Value Added (GVA) the top 5 ranked clusters change considerably, with **metal mining**<sup>11</sup> leading, followed by **aerospace vehicles and defence, printing services, lighting and electrical**. In addition, one emerging industry, **medical devices**, is amongst the top ranked clusters in terms of GVA relative specialisation. The relatively specialised clusters in terms of GVA account for only 11% of total regional employment, the most important in absolute employment being downstream chemical products, wood products, furniture and food processing and manufacturing. In contrast, the 15 clusters with GVA specialisation produce with 11% of the workforce 52.3% of regional GVA, with metal mining as the outlier producing 20% of regional GVA.

**Figure 4: Highlands and Islands clusters ranked by specialisation based on GVA, share in total employment and average annual payroll (wage)**

Rank and percentage change (2010-2014) in the GVA share of the cluster within HIE compared to the GVA share of the cluster in the EU			Rank according to the share of the cluster in the total employment of all clusters within HIE		Rank and percentage change (2010-2014) in the average annual payroll / head (Euros)		
Metal Mining	22.18	↓ -24%	Distribution and Electronic Commerce	11.7%	Financial Services	97,855	↑ 38%
Aerospace Vehicles and Defense	2.57	↓ -11%	Hospitality and Tourism	9.6%	Aerospace Vehicles and Defense	94,038	↑ 40%
Printing Services	2.45	↑ 38%	Experience Industries	9.0%	Insurance Services	93,545	↑ 28%
Medical Devices	1.84	↓ -16%	Blue Growth Industries	8.5%	Communications	85,809	↑ 48%
Lighting and Electrical Equipment	1.79	↓ -28%	Creative Industries	5.9%	Equipment and Services	85,809	↑ 48%
Plastics	1.77	↑ 34%	Environmental Industries	5.5%	Textile Manufacturing	75,022	↑ 692%
Jewelry and Precious Metals	1.73	↓ -6%	Business Services	5.0%	Water Transportation	70,922	↑ 94%
Appliances	1.68	↓ -29%	Metalworking Technology	4.8%	Oil and Gas Production and Transportation	70,880	↓ -33%
Recreational and Small Electric Goods	1.62	↑ 18%	Education and Knowledge Creation	4.0%	Environmental Services	66,712	↓ -62%
Wood Products	1.54	↑ 52%	Logistical Services	3.6%	Electric Power Generation and Transmission	63,998	→ 9%
Downstream Chemical Products	1.43	↑ 52%	Transportation and Logistics	3.1%	Environmental Industries	63,670	↓ -32%
Vulcanized and Fired Materials	1.41	↑ 13%	Environmental Services	2.7%	Metalworking Technology	63,551	→ 2%
Furniture	1.37	→ 9%	Mobility Technologies	2.4%	Upstream Metal	61,652	↑ 14%
Production Technology and Heavy Machinery	1.30	↓ -19%	Performing Arts	2.2%	Manufacturing	61,652	↑ 14%
Food Processing and Manufacturing	1.21	↑ 796%	Fishing and Fishing Products	1.9%	Downstream Metal	58,711	→ 6%
					Products	55,244	↑ 18%
					Transportation and Logistics	54,992	↑ 38%

Source: Authors based on European Cluster Observatory data 2016.

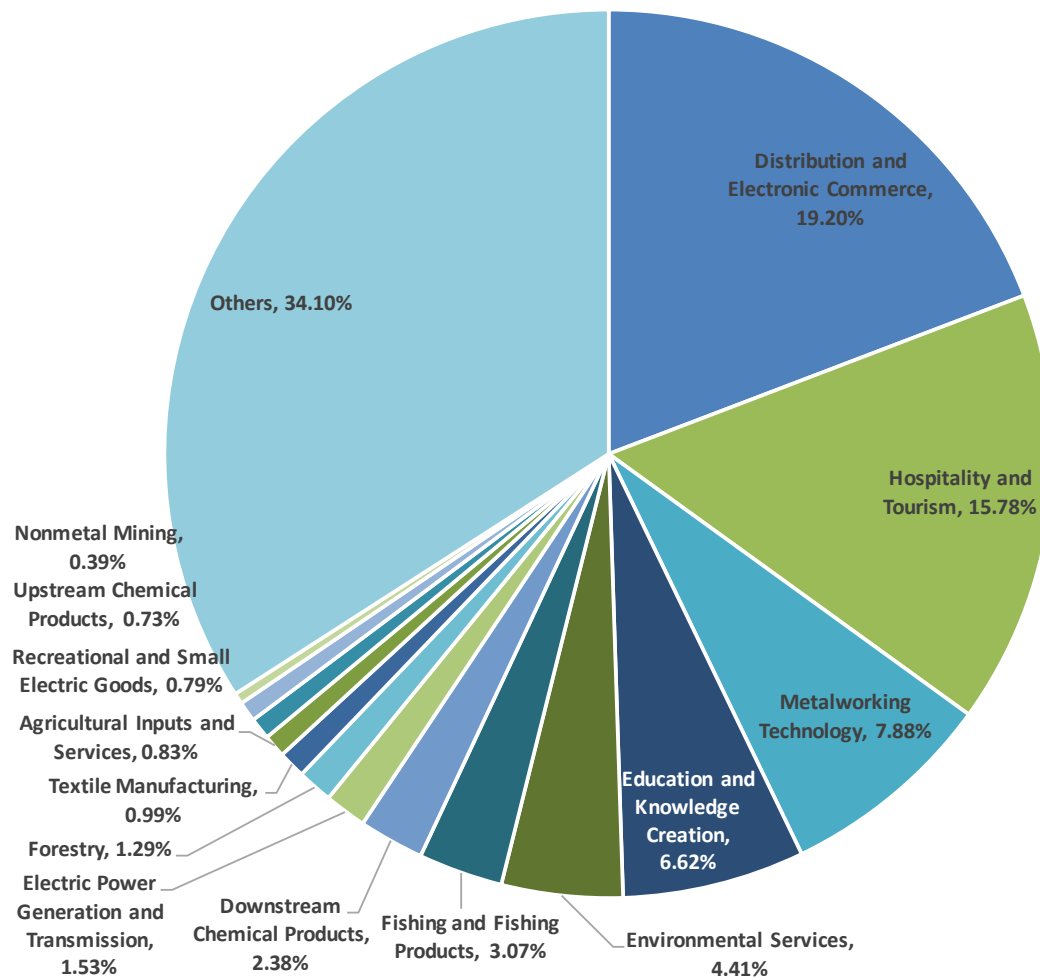
Only **recreational and small electric goods** and **downstream chemicals** are common to both (employment and GVA) top ranked specialisation tables. However, a cross analysis of the two lists provide a basis for an exploration of value chain or cluster interlinkages. For instance, a potential grouping would be forestry, wood products and furniture clusters (the

<sup>11</sup> Metal Mining includes mining of iron ores, mining of uranium and thorium ores, and mining of non-ferrous metal ores. The high share of GVA for this cluster is likely due to the Aluminium Smelter at Lochaber as well as other extractive industries.

first specialised in term of employment, the latter two in terms of GVA). This grouping could be viewed as a mega-cluster of **forest-based industries** (including plastic and other materials in the furniture value chain, paper and pulp, wood panels, biomass energy, etc.).

The 14 specialised employment clusters account for 66% of total cluster employment; the top two clusters generate over a third of employment (Figure 5).

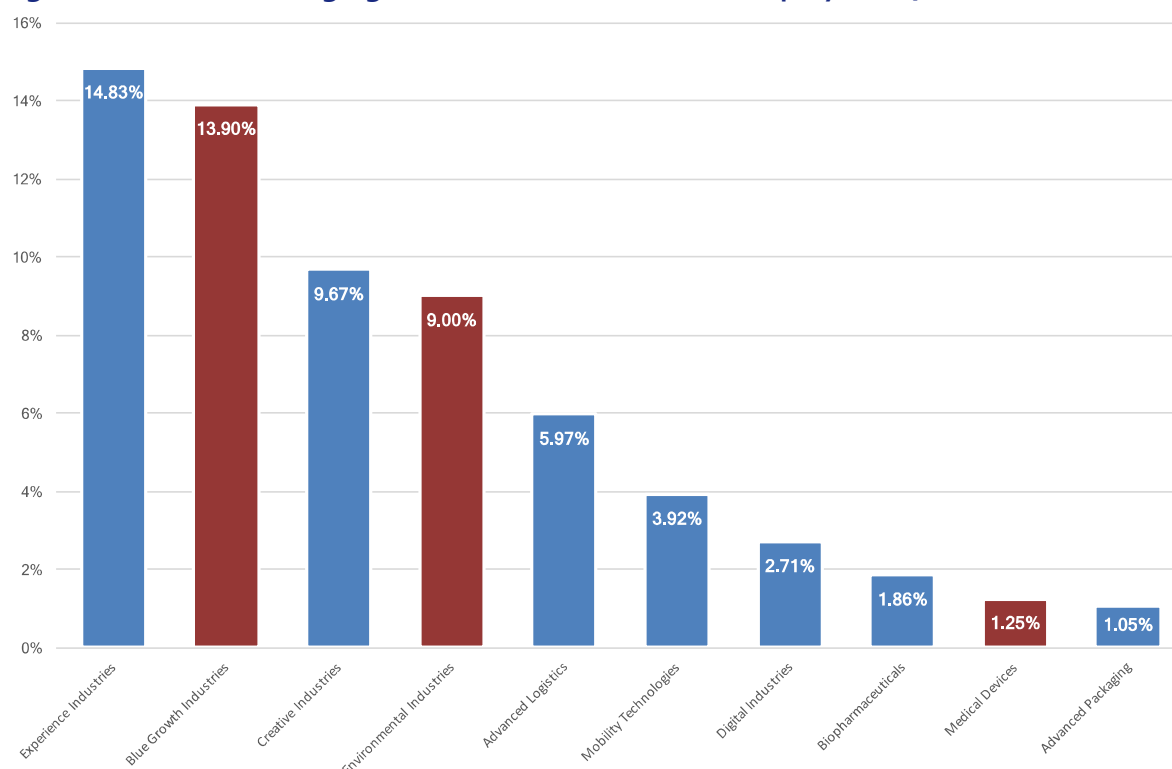
**Figure 5: Share of specialised clusters in total regional employment (2014)**



Source: authors based on European Cluster Observatory data 2016

Four of the European emerging industries (Figure 6) generate a significant share of total cluster employment, namely: **experience industries**, **blue growth industries**, **creative industries** and **environmental industries** (as several industries include a subset of the same SIC codes, the totals cannot be summed).

**Figure 6: Share of emerging industries in total cluster employment, 2014**



Source: authors based on European Cluster Observatory data 2016; Note: Industries in which H&I is specialised are in dark red.

## 2.2 Relative specialisation of Highlands and Islands clusters compared to selected European regional benchmarks

To provide a comparative perspective, a set of benchmark regions has been selected (see Figure 7) based on similarity in size (regional population in 2015), comparable population density (inhabitants per Km<sup>2</sup>) to the Highlands and Islands and due to similar broad economic specialisation. All regional benchmarks are identified using the Nomenclature of territorial units for statistics (NUTS) classification of the EU<sup>12</sup> at NUTS2 level which in most countries corresponds to the level at which regional policies are designed and managed. NUTS2 statistical codes for the regional benchmarks are used throughout the report. In addition, the Highlands and Islands performance is compared to the Scottish and UK averages.

The regions selected are drawn mainly from the neighbouring Nordic countries including four Norwegian NUTS2 regions namely the Hedmark & Oppland region bordering Sweden, the Trøndelag coastal region (the region around Trondheim), the region of Western Norway (including Bergen and Stavanger) and Northern Norway (Arctic region). The three most northern Swedish NUTS2 regions of North Middle Sweden (Norra Mellansverige, largest city Gävle), Middle Norrland (Mellersta Norrland, largest city Sundsvall with pulp and paper industry and aluminium production and the recently established Mid Sweden University), and Upper Norrland (Övre Norrland) the most northern region (largest city Umea, with a major university). In addition, the Danish region of North Jutland (centred

<sup>12</sup> See: <http://ec.europa.eu/eurostat/web/nuts/overview>

around the university and port city of Aalborg, exporting grain, cement, and spirits), the region of Western Finland (Länsi-Suomi, including the city of Tampere with significant engineering and metal-working technology expertise), the Irish region of Border, Midland and Western (major towns including Donegal, Galway, etc.), Northern Ireland (UK) and the Baltic State of Estonia.

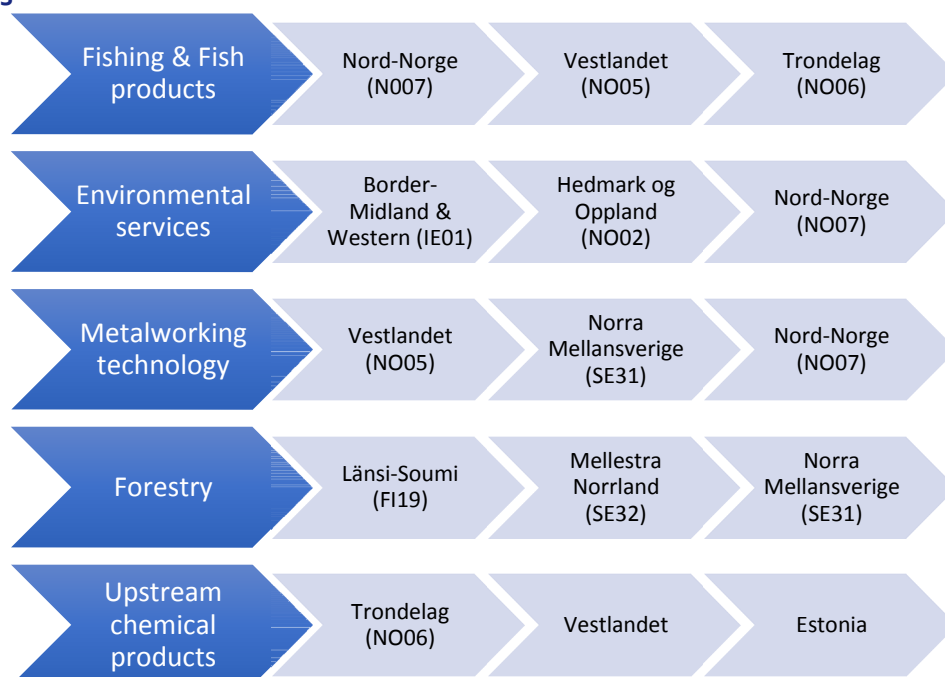
**Figure 7 : Selected benchmark regions**

Regional (NUTS) code	Name	Population 2015	Population density (inhabitants per km2)
DK05	Nordjylland	582,632	73.8
EE00	Estonia	1,313,271	30.3
FI19	Länsi-Suomi	1,377,281	23.6
IE01	Border, Midland and Western	1,226,421	38.3
NO02	Hedmark og Oppland	383,985	7.7
NO05	Vestlandet	884,316	18.8
NO06	Trøndelag	445,838	11.5
NO07	Nord-Norge	480,787	4.5
SE31	Norra Mellansverige	833,585	13.1
SE32	Mellersta Norrland	369,826	5.2
SE33	Övre Norrland	512,349	3.4
UKM6	Highlands and Islands	466,982	11.6
UKNo	Northern Ireland (UK)	1,847,088	135.8
UKM	Scotland	5,356,482	68.6
UK	United Kingdom	64,875,165	266.4

Source: Eurostat, calculations authors

Figure 8 identifies for the top 5 (by employment) Highlands and Islands specialisation clusters the three most specialised benchmark regions; while Figure 9 provides a more detailed overview of the relative specialisation of the Highlands and Islands clusters compared to the selected benchmarks.

**Figure 8: Top benchmark regions for the five most specialised Highlands and Islands clusters**



Source: authors based on European Cluster Observatory data 2016.

Fishing and fishing products is the most specialised cluster in the Highlands and Islands, however, three Norwegian regions are more specialised, with *Nord-Norge* (NO07) an absolute outlier. North Jutland (Denmark) has a similar degree of specialisation. Environmental services is a clear comparative specialisation for the Highlands and Islands, with Scotland as whole being the only benchmark with a higher specialisation. The Highlands and Islands specialisation on metalworking technology and upstream chemical products is also the highest among the regional benchmarks.

Forestry is the fourth most specialised cluster for the Highlands and Islands, however, compared to the Finnish and Swedish regions and Estonia, H&Is forestry cluster is relatively weakly specialised. The most specialised regions for forestry are Länsi-Suomi (FI19), Norra Mellansverige (SE31) and Mellersta Norrland (SE32).

In the next section, an analysis of comparative specialisation and performance of the Highlands and Islands specialisation clusters is carried out against these benchmarks.



Figure 9 Cluster specialisation of the Highlands and Islands and selected regional comparators, 2014

Cluster	Highlands and Islands - UKM6	Nordjylland - DK05	Estonia - EE00	Länsi-Suomi - FI19	Border, Midland and Western - IE01	Hedmark og Oppland - NO00	Vestlandet - NO05	Trøndelag - NO06	Nord-Norge - NO07	Norra Mellansverige - SE31	Mellersta Norrland - SE32	Övre Norrland - SE33	UK (based on regional averages)	Scotland - UKM	Northern Ireland (UK) - UKN0
Fishing and Fishing Products	11,961	10,788	3,502	0,754	0,914	2,808	30,535	19,711	60,100	0,080	0,258	0,631	1,364	6,414	0,522
Environmental Services	3,049	0,243	0,711	0,787	2,329	1,132	0,811	0,715	1,413	0,344	0,239	0,265	1,752	4,260	0,569
Metalworking Technology	2,585	0,932	1,394	1,469	0,908	1,930	2,323	1,434	1,549	1,767	0,943	1,095	0,363	1,034	0,554
Forestry	2,547	0,483	4,736	8,335	0,884	6,948	0,637	2,572	0,837	5,299	7,188	4,309	0,389	1,230	0,480
Upstream Chemical Products	1,974	0,010	1,445	0,695	1,370	1,004	2,393	3,028	0,605	0,539	0,969	0,105	0,828	0,629	0,157
Agricultural Inputs and Services	1,843	2,832	1,398	0,943	0,228	9,471	6,170	9,239	5,523	0,175	0,258	0,126	0,549	0,565	0,398
Electric Power Generation and Transmission	1,553	0,108	0,630	8,022	1,456	0,585	0,481	0,347	0,695	0,106	0,310	0,671	0,489	0,694	0,286
Nonmetal Mining	1,431	0,796	2,348	2,795	0,871					1,026	0,815	1,200	1,126	1,433	5,712
Education and Knowledge Creation	1,292	0,634	0,931	1,939	1,152	0,707	0,615	1,144	0,593	2,396	1,380	2,773	1,459	1,049	0,809
Recreational and Small Electric Goods	1,154	0,267	0,846	0,423	1,411	1,203	0,181	0,205	0,125	0,304	0,425	0,253	2,395	2,124	5,517
Blue Growth Industries	1,143	1,310	1,405	1,173	0,805	1,111	4,764	2,223	2,875	1,007	1,080	1,226	0,847	1,679	0,505
Downstream Chemical Products	1,140	0,084	0,808	0,453	1,348	0,345	0,328	0,154	0,148	0,295	0,085	0,196	2,455	2,141	5,439
Wood Products	0,989	0,801	3,095	1,007	0,977	2,483	0,526	0,712	0,507	1,334	0,867	1,176	1,570	1,693	3,778
Water Transportation	0,931	3,601	3,024	1,185	0,365	0,679	27,887	5,427	9,799	0,246	0,346	0,237	0,948	1,350	0,114
Logistical Services	0,925	0,685	1,623	1,187	1,085	1,318	0,692	0,981	1,876	1,221	1,428	1,392	0,743	0,996	0,326
Transportation and Logistics	0,865	0,732	1,724	0,995	1,130	1,425	0,742	1,049	1,987	1,144	1,304	1,246	0,719	0,894	0,298
Video Production and Distribution	0,589	0,185	0,324	0,348	0,400	0,142	0,108	0,266	0,203	0,157	0,247	0,452	2,356	0,230	68,328
Downstream Metal Products	0,452	1,502	0,896	1,332	0,161	4,668	1,548	0,797	0,518	0,948	0,301	0,442	1,171	0,632	1,111
Livestock Processing	0,416	1,165	1,219	1,253	1,536	0,860	1,270	4,135	1,167	0,413	0,176	0,514	0,888	2,628	3,179
Upstream Metal Manufacturing	0,399	2,475	0,535	1,022	0,269	0,833	0,616	0,343	1,445	2,541	0,699	0,474	0,444	0,276	0,080
Advanced Packaging	0,210	0,948	0,731	1,231	0,718	1,255	0,705	0,986	0,439	1,986	1,310	0,959	0,719	0,466	0,669
Production Technology and Heavy Machinery	0,141	2,022	0,721	2,024	0,237	1,356	3,365	1,176	0,743	1,783	0,888	1,029	0,479	0,298	0,843
Paper and Packaging	0,112	0,594	0,666	1,637	2,120	0,085	0,359	0,846	0,107	5,221	4,244	1,554	0,601	0,317	0,333
Oil and Gas Production and Transportation	0,080	0,005	4,975	0,063	0,997	0,177	17,569	13,894	1,669	0,092	0,152	0,013	2,574	18,231	0,015
Communications Equipment and Services	0,077	0,512	2,007	0,126	3,906	0,065	0,180	0,575	0,509	0,253	0,109	0,201	1,343	0,532	0,466
Metal Mining	0,044		0,045	0,989	0,126					0,275		73,135	1,303	0,063	
Information Technology and Analytical Instruments	0,029	2,001	0,789	0,820	2,595	1,070	0,892	3,959	0,627	0,724	0,567	1,216	0,678	0,271	0,211
Medical Devices	0,024	2,901	0,852	0,948	1,197	0,959	0,413	0,721	0,889	0,573	0,218	0,561	0,331	0,323	0,081
Appliances	0,007	0,020	0,397	0,649	0,536	1,668	0,036	4,218		0,043	0,227	1,026	0,682	0,240	0,156
Biopharmaceuticals	0,005	0,002	0,220	0,503	2,607	2,028	0,342	1,215	0,109	0,033	0,468	0,055	0,921	0,257	3,968

Source: Authors based on European Cluster Observatory data 2016.

Notes: The top cluster for each of benchmark regions is highlighted in yellow, and the 2 to 5<sup>th</sup> ranked clusters in green.

## 2.3 Comparative performance of the Highlands and Islands specialisation clusters

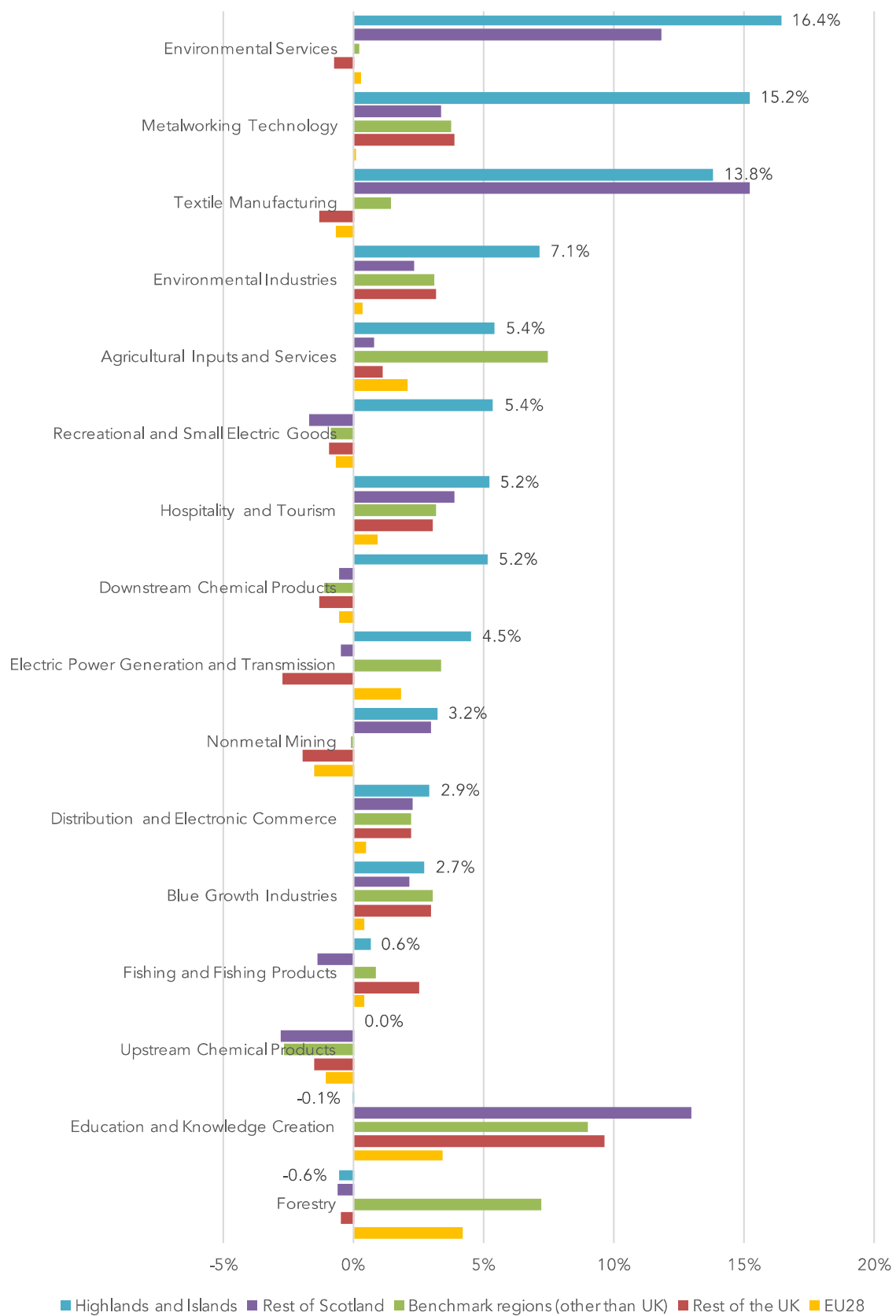
To provide a comparative perspective, employment growth and annual average wages and salaries per head of the Highlands and Islands specialisation clusters are compared to the selected regional benchmarks. Figure 10 shows the employment growth of the Highlands and Islands 16 specialisation clusters between 2010-2014 (growth rates) compared to the rest of Scotland, the benchmark regions, the rest of the UK and the EU28 average. The employment data suggests that the clusters that generated jobs during this period were environmental services, metalworking technology and textile manufacturing. In contrast, employment fell in upstream chemical products and forestry.

The highest wages and salaries are also paid in the fast-growing specialisation clusters (Figure 11). This is the case of environmental services and environmental industries, where salaries and wages are higher in the Highlands and Islands relative to the regional comparators, the rest of Scotland, the rest of the UK and the EU28; but also for non-metal mining and recreational and small electric goods.

We made use of a new addition to the European Cluster Observatory dataset on workers' skills. Skills indicators were obtained from Labour Force Surveys (LFS) to calculate the relative sophistication of workers in each cluster according to four skills levels (using broad sections of the ISCO 08 occupational classification):

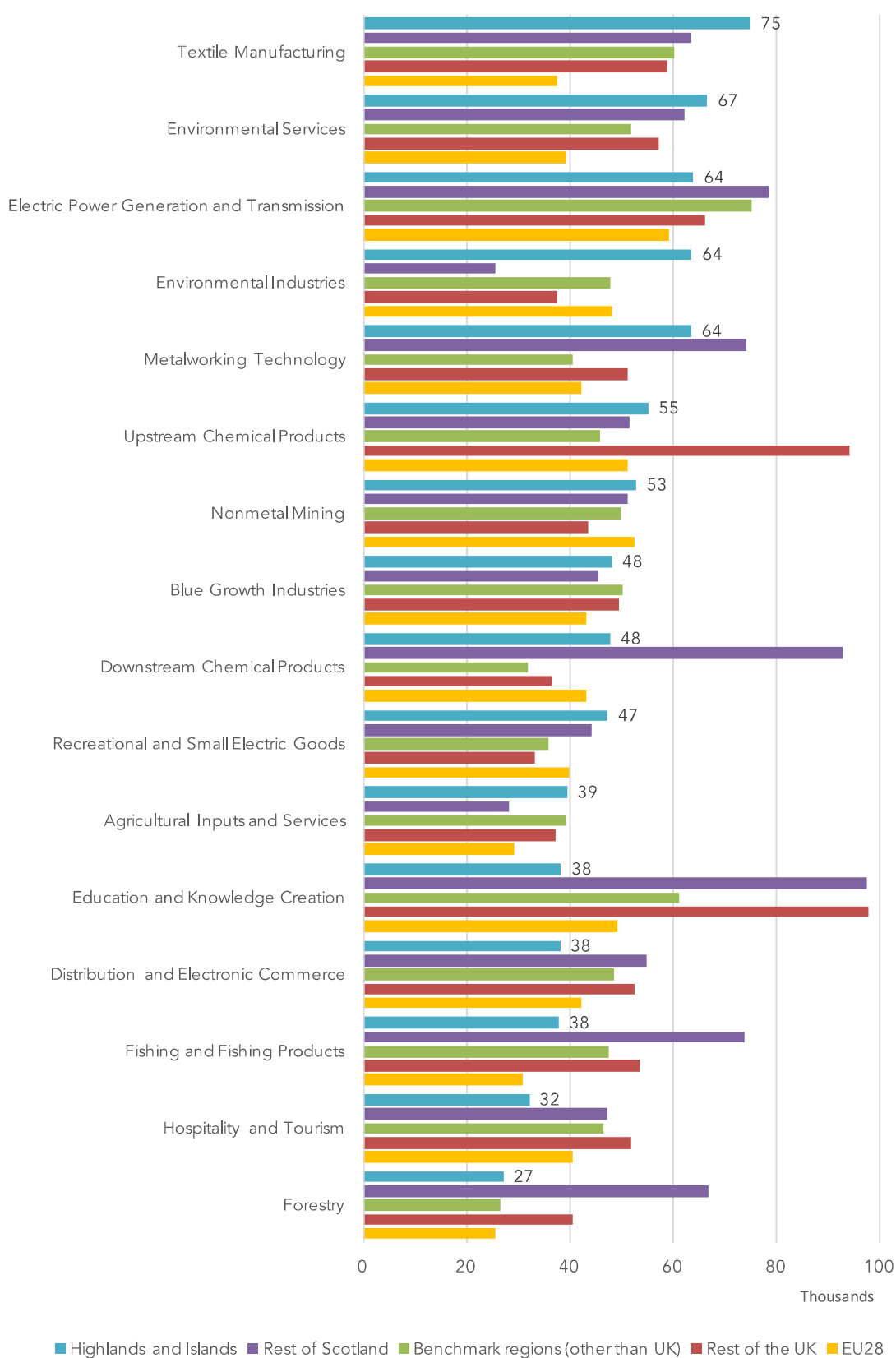
- Officials, managers, professionals, technicians ("Managers"): jobs usually employing abstract cognitive tasks (ISCO sections 0, 1, 2, 3),
- Clerical support workers ("Clerks"): jobs using routine cognitive tasks, usually in offices (ISCO group 4),
- Craft, trade, operators, assemblers ("Crafts"): routine manual jobs, usually on the factory floor (ISCO sections 6, 7, 8), and
- Service, sales, elementary ("Services"): basic non-routine manual jobs like sales or cleaning (ISCO sections 5 and 9).

**Figure 10 Employment growth in Highlands and Islands specialisation clusters and other regional benchmarks, 2010-2014**



Source: authors, based on European Cluster Observatory data 2016

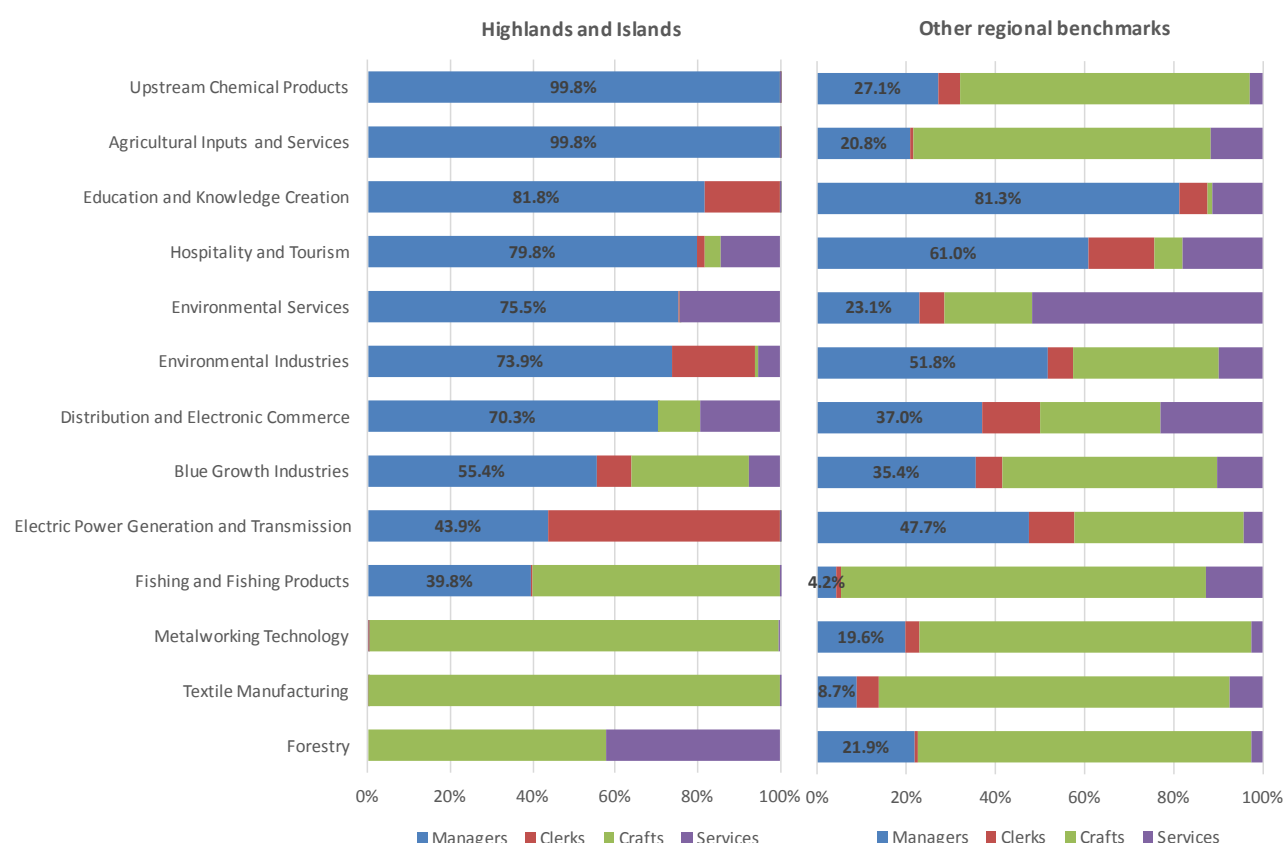
**Figure 11 Annual average payroll per head in the Highlands and Islands and benchmark regions' selected clusters, 2014**



Source: authors, based on European Cluster Observatory data 2016

**Error! Not a valid bookmark self-reference.** shows the relative sophistication of workers in the Highlands and Islands specialisation clusters for which data is available<sup>13</sup> compared to the sophistication of workers in the selected benchmarks. Workers' sophistication is relatively high in most of the specialisation clusters except for the metalworking technology cluster, textile manufacturing and forestry, for which the largest share of workers correspond to routine manual jobs ("crafts"), compared to a greater share of managers and clerks in the benchmark regions.

**Figure 12 Relative sophistication of workers in specialisation clusters, 2010-2014**



Source: authors, based on European Cluster Observatory data 2016

## 2.4 Cluster productivity compared to benchmark regions

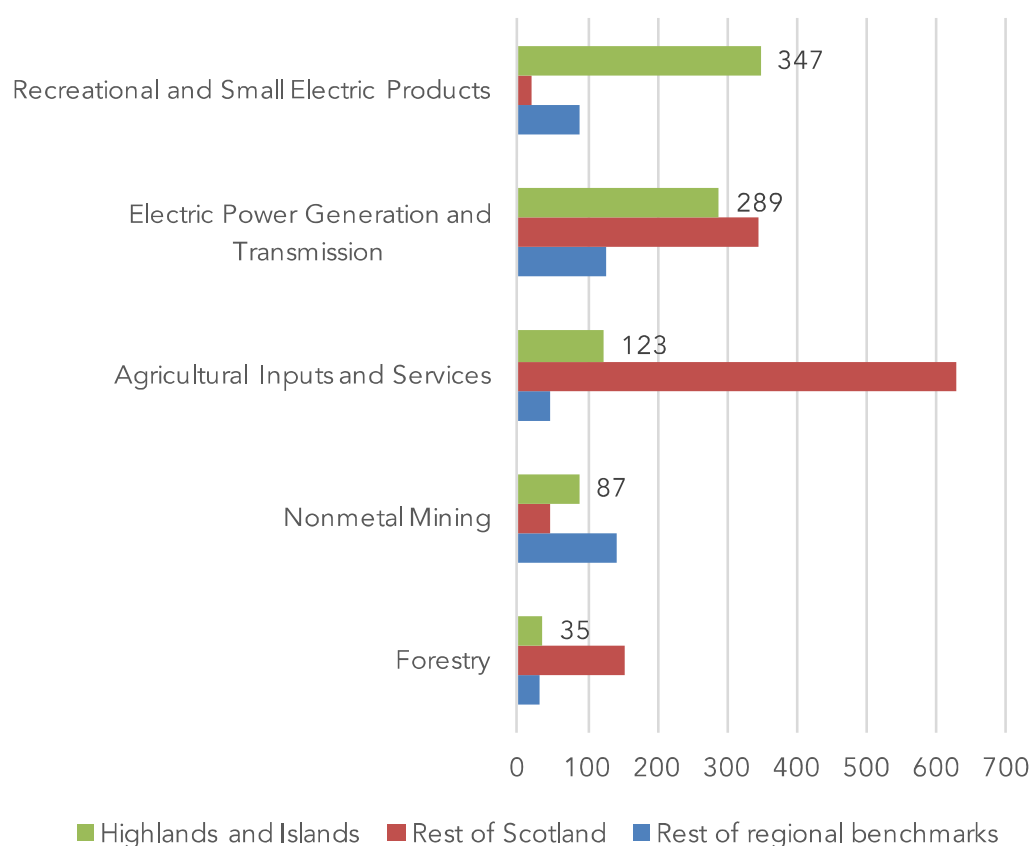
Productivity is an important indicator for measuring cluster performance. Firm productivity will influence the enhanced productivity of agglomeration in clusters. It is also expected that the effects of clustering will have different effects for different levels of firms' size. We have built a labour productivity measure for each of the Highlands and Islands specialisation clusters by dividing the GVA of the cluster by its total employment for the year 2014, or GVA per filled job. This measure follows a similar methodology to the one used by the Office of National Statistics (ONS) for calculating regional and sub-regional

<sup>13</sup> Data is not available for 3 H&I specialisation clusters: upstream chemical products, non-metal mining and recreational and small electric goods.

productivity in the UK<sup>14</sup>, with the main difference that the one presented here is calculated at cluster category level. This indicator shows how much value is being created in each cluster per employee, and it is a more precise measure of productivity as for instance productivity proxies such as wages and salaries.

We have grouped the Highlands and Islands specialisation clusters in three categories: high productivity clusters, low productivity clusters and emerging industries. We present labour productivity graphs by cluster category in Figure 13, Figure 14 and Figure 15. The productivity of each cluster is compared for the Highlands and Islands, the rest of Scotland and the average of the regional benchmarks.

**Figure 13 High productivity clusters among selected benchmarks, GVA per filled job in 2014**



Source: authors, based on European Cluster Observatory data 2016

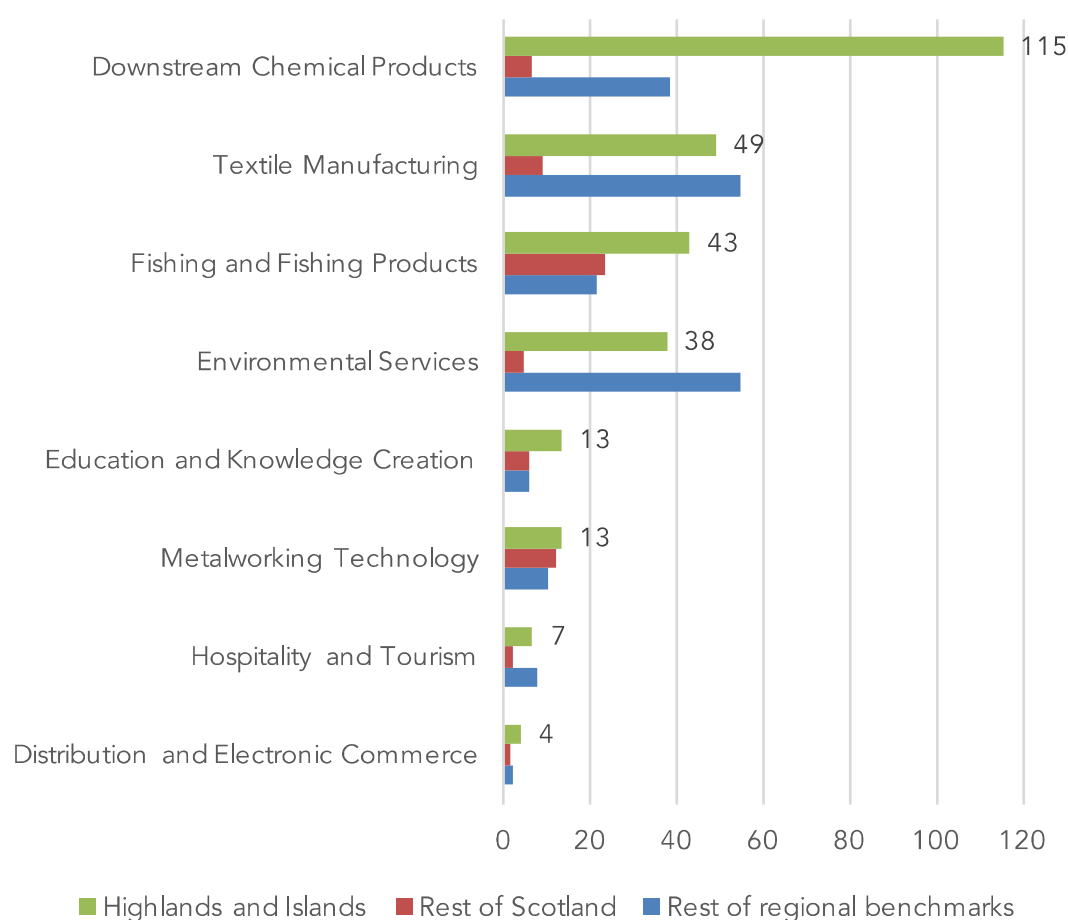
There are five high productivity clusters: agricultural inputs and services, electric power generation and transmission, forestry, non-metal mining and recreational and small electric products (Figure 13). The Highlands and Islands underperforms relative to the rest of Scotland in electric power generation and transmission, agricultural inputs and services and forestry, but outperforms the average productivity of the regional benchmarks in the same cluster categories. The Highlands and Islands is the most productive relative to the rest of Scotland and the benchmarks in the recreational and small electric products cluster.

<sup>14</sup>

See: <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/labourproductivity/articles/regionalandsubregionalproductivityintheuk/jan2017>

There are eight low productivity clusters among the identified specialisation clusters, or those with an average productivity below 69 GVA per employee (Figure 14). The most productive clusters among these are downstream chemical products, textile manufacturing and environmental services. Relative to the regional benchmarks and the rest of Scotland, the Highlands and Islands has higher labour productivity in all low productivity clusters of specialisation except for textile manufacturing, environmental services and hospitality and tourism, in which the rest of the regional benchmarks are more productive (but not the rest of Scotland).

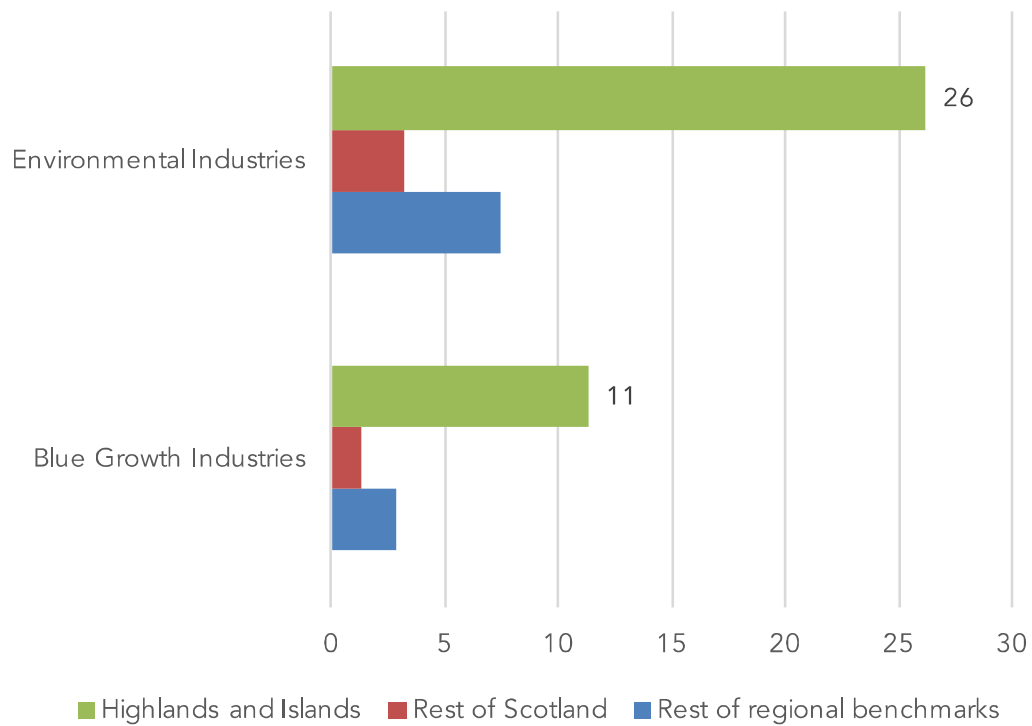
**Figure 14 Low productivity clusters among selected benchmarks, GVA per filled jobs in 2014**



Source: authors, based on European Cluster Observatory data 2016

Finally, Figure 15 presents the cluster productivity of environmental industries and blue growth industries, considered as emerging industries. In these two industries, the productivity of the Highlands and Islands is the highest compared to the rest of Scotland and the average of the regional benchmarks. It also ranks in top 3 for both, when compared to individual regional comparators, just after Hedmark og Oppland (NO02) and Mellersta Norrland (SE32).

**Figure 15 Productivity in emerging industries in the Highlands and Islands and selected benchmarks, GVA per filled jobs in 2014**



Source: authors, based on European Cluster Observatory data 2016



### 3. RESEARCH AND INNOVATION INVESTMENT AND TECHNOLOGICAL AND SCIENTIFIC SPECIALISATION

#### 3.1 R&D and innovation activity in Highlands and Islands business clusters

Business expenditure on R&D (BERD) and innovation activity is one key factor that helps explain above average performance and growth in value added and productivity. Overall there was an upward trend in the Highlands and Islands region over the last decade in absolute expenditure by the business sector on R&D, with a peak in absolute expenditure in 2011 at approximately £53m (Eurostat).

However, since 2012 the total BERD figure has declined to only £32m (Eurostat) in 2014. The Highlands and Islands share of Scottish BERD remained relatively stable, on average 5.7% from 2005-14, however the absolute decline in the last few years led the share to decline to only 3.5% in 2014. Data for BERD by sub-region is available from the Scottish Government BERD tables. Unfortunately, annual data is only complete for Highland (except 2009) and Moray, as for other sub-regions the values are considered “disclosive”. Nevertheless, it is possible to make some estimates based on the Eurostat annual figure for BERD (national currency table) and by calculating an average figure for each sub-region.

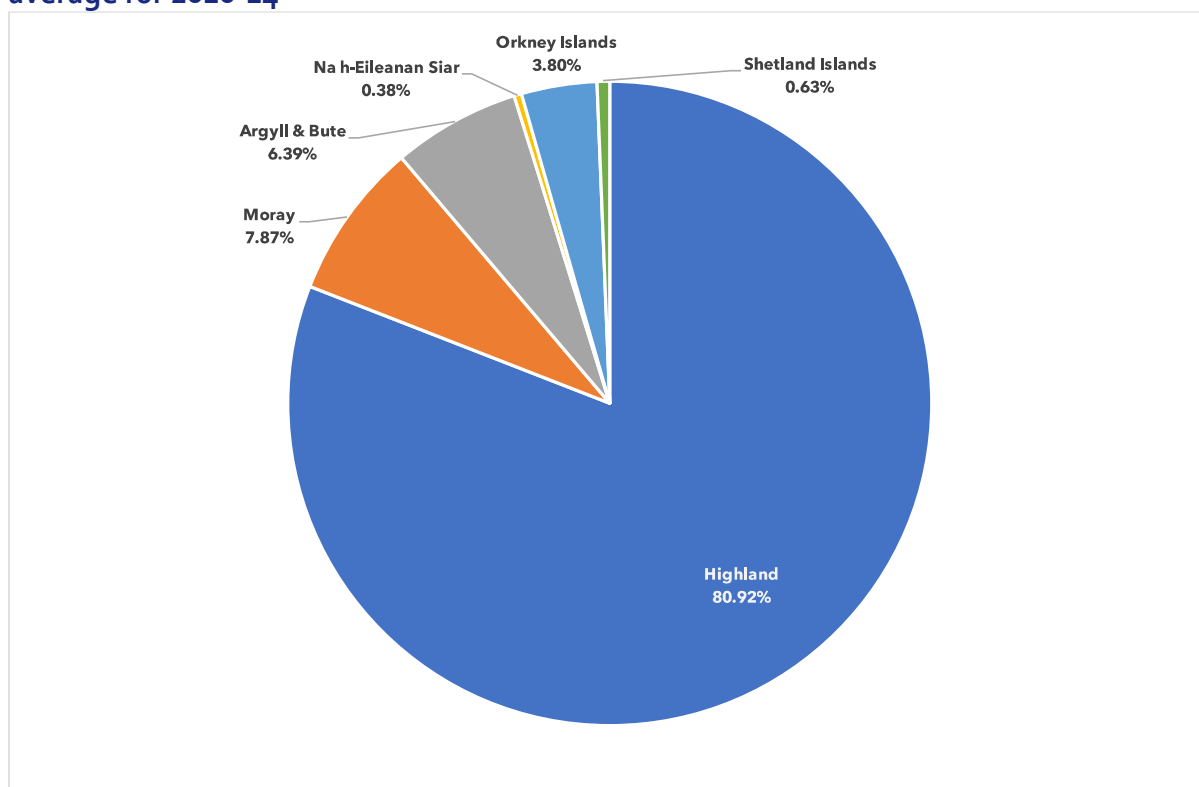
**Figure 16: Trends for business expenditure on R&D in the Highlands and Islands**

(Sub)-region	2010 (£000)	2011 (£000)	2012 (£000)	2013 (£000)	2014 (£000)	2015 (£000)	Share of Scotland 2015	2015 per capita
Highland	£29,192	£44,023	£36,470	£32,054	£28,178	£27,117	3.11%	£116
Moray	£3,385	£3,751	£3,464	£3,693	£2,239	£1,873	0.22%	£20
Argyll & Bute	£2,423	£2,948	..	..	..	£1,479	0.17%	£17
Na h-Eileanan Siar	..	..	..	..	..	£161	0.02%	£6
Orkney Islands	£1,712	£1,078	£2,001	..	..	..		
Shetland Islands	£249	£342	£199	..	..	..		
Total H&I	£36,961	£52,142	£42,134	£35,747	£30,417	£30,630		
H&I Eurostat	£38,000	£53,000	£43,900	£38,700	£32,000			
Difference	£1,039	£858	£1,766	£2,953	£1,583			

Source: Authors based on Scottish Government, BERD tables 2015, Eurostat.

Nb: .. = disclosive value

**Figure 17 : Share of estimated total business R&D expenditure by sub-region, annual average for 2010-14**



Source: Authors based on Scottish Government, BERD tables 2015

On this basis, average annual BERD during the period 2010-14 is estimated to be approximately £34m for Highland region, £3.3m in Moray, below £2.5m in Argyll & Bute, approximately £1.5m in Orkney and less than a quarter of a million each in Shetland and the Western Isles. The sum of the sub-regional averages (£41.9m) is slightly higher than the Eurostat average annual figure for the Highlands and Islands region (£41.1m) but the estimate appears robust within a reasonable margin of error.

Compared to the benchmark regions (as well as other Scottish regions and Scotland as a whole), the Highlands and Islands is in a group of three 'laggard' regions along with Estonia and South-Western Scotland with a per capita BERD ranging from 97-105 on average during the period 2005-14. All other regions had a much higher per capita BERD (Eurostat data). Only Nord-Norge had a lower BERD to GDP ratio than the Highlands and Islands in 2013.

Overall gross expenditure on R&D (GERD) in the Highlands and Islands has grown by 2% on an annual average basis during 2009-14 compared to 3.3% on average in the benchmarks (not including other Scottish regions). However, this is essentially due to a growth in higher education R&D (HERD) whereas BERD growth rates have been slightly negative and Government expenditure on R&D (GOVERD) growth rates declined significantly.

As can be seen in figure 18, several benchmark regions achieved significant BERD growth rates during the period including Trøndelag, Vestlandet, Estonia, Nord-Norge and Norra Mellansverige. Scotland's BERD grew strongly as well, notably due to a jump in BERD in 2014 for both Eastern and North-Eastern Scotland.

**Figure 18: R&D expenditure Highlands and Islands compared to benchmarks**

Indicator	2009-14 – Average Annual Growth Rate				2013	2013
	BERD	GOVERD	HERD	GERD	BERD €/hab.	BERD % GDP
Trøndelag	8.0%	1.2%	4.5%	6.2%	€ 1,473.1	2.72
Länsi-Suomi	-2.0%	-0.2%	1.3%	-1.2%	€ 806.8	2.4
Border, Midland and Western	1.1%	-2.0%	-0.7%	0.2%	€ 318.9	1.24
Northern Ireland (UK)	4.7%	1.7%	-2.2%	2.5%	€ 285.7	1.18
Norra Mellansverige	7.0%	-1.0%	6.2%	6.5%	€ 406.7	1.1
Average benchmarks	3.0%	2.9%	4.2%	3.3%	€ 410.8	1.07
Eastern Scotland	10.4%	-7.0%	5.5%	5.3%	€ 239.4	0.83
Eesti	7.2%	7.7%	8.8%	7.8%	€ 117.9	0.82
Vestlandet	7.6%	2.1%	6.7%	6.0%	€ 377.5	0.61
Scotland	8.3%	-0.9%	5.1%	5.6%	€ 176.5	0.60
Mellersta Norrland	2.4%	8.8%	6.5%	4.0%	€ 195.3	0.49
North Eastern Scotland	22.9%	15.0%	-3.4%	11.3%	€ 237.6	0.49
Hedmark og Oppland	12.4%	9.9%	10.4%	11.5%	€ 205.6	0.48
South Western Scotland	-0.7%	-11.2%	7.6%	3.3%	€ 124.8	0.48
Nordjylland	-1.2%	13.6%	7.5%	4.7%	€ 161.5	0.41
Highlands and Islands	-0.6%	-12.7%	5.0%	2.0%	€ 97.7	0.36
Nord-Norge	7.1%	8.6%	5.4%	6.4%	€ 169.6	0.33

Source : Eurostat (rd\_e\_gerdreg dataset, euro values, extracted April 2017). Calculations authors. Missing values for certain regions for 2014 were replaced by 2013 figures.

To further explore Highlands and Islands business R&D and innovation performance, a request was made to the Scottish Government for data on business expenditure on R&D (BERD) and innovation from the UK (Community) Innovation Survey for the Highlands and Islands and per specialised cluster. Data was provided covering the period from 2013 to 2015. Concerning the BERD survey data, unfortunately, for both the growth sectors and the specialisation clusters a high number of values for R&D expenditure and employment were declared disclosive.

From 2013-2015, approximately 9-10% of businesses performing R&D in Scotland's growth sectors are based in the Highland's & Islands local authority areas. However, the share is **roughly double for the food & drink and sustainable tourism** (tourism-related industries) sectors. Data for expenditure and employment on R&D by sector is much patchier. Overall, the Highlands and Islands has a share of Growth Sector BERD that varied between 5-6% of the Scottish total from 2013-2015. The share of expenditure is much lower than the share of R&D active firms for the food and drink sector suggesting that smaller R&D projects are being carried out in the region than elsewhere in Scotland. A tiny share (less than 1%) of financial and business R&D is being carried out in the region and the creative industry sector share is also lower than the average share of the Highlands and Islands in Scottish BERD. On the other hand, the life science sector appears to be roughly proportional to the share of R&D active firms and above the share of the Highlands and Islands in Scottish BERD.

Taking account of the total Highlands and Islands BERD from 2013 to 2015, the estimates made above for the sub-regions and the average share for all growth sectors of the Highlands and Islands in Scottish BERD, the residual values (the total for growth sectors minus disclosed values) allow a 'guess-estimate' to be made for energy and tourism that suggests a figure of somewhere in the region of £2.5-3 million for energy sector per year and roughly £200k by the tourism sector.

The data on R&D employment is similarly patchy but it suggests that on average R&D productivity (total BERD divided by total employment) is relatively high in the region, which accounts for only about 3.5% of Scottish Growth Sector R&D employment. This could be due to a higher share of BERD being allocated to development/prototype equipment (e.g. in the renewable energy sector) or relatively higher salaries for R&D staff in the Highlands and Islands compared to the average for Scotland (the former is a more probable hypothesis).

The data becomes even scarcer when broken down by specialisation cluster. The total number of firms performing R&D in the selected clusters ranges from 95 in 2013 to 110 in 2014 and 2015. This represents roughly 9.4% of the Scottish total for the same clusters, compared to an average share for the Highlands and Islands R&D performing businesses (all sectors) of roughly 8.6% for the same period. Rather surprisingly the share of the specialisation clusters in Scottish BERD is much lower than the Highlands and Islands average share for all sectors at only 1.2% over the period 2013-15. R&D employment in the Highlands and Islands specialisation clusters ranged between 97 and 136 over the three-year period or an average of 2% of the Scottish total for these clusters.

The data at cluster level points to possible reasons for the surprisingly low share of the specialisation clusters with no R&D performing firms recorded for electrical power generation and transmission or upstream chemicals which would be sectors in which R&D intensity could be expected to be higher than average. In terms of the clusters with recorded R&D performing firms, fishing and fishing products and hospitality and tourism as well as recreational and small electric goods stand out with shares of total Scottish R&D performing firms in the same sector of between 15-20% for the latter two clusters and up to 40% of all Scottish R&D performing firms for fishing and fish products.

**Figure 19: Business R&D for selected clusters and emerging industries (£000)**

Category	2013	2014	2015
Cluster SIC codes total	4,640	6,773	7,081
Other SIC codes total	33,715	26,836	25,570
H&I all sectors total	38,356	33,608	32,651
Education and Knowledge Creation		4,383	3,108
as % of cluster total		64.7%	43.9%
as % of H&I total		13.0%	9.5%
Environmental Industries		4,910	3,720
as % of cluster total		72.5%	52.5%
as % of H&I total		14.6%	11.4%
Blue Growth Industries	2,119		3,458
as % of cluster total	45.7%		48.8%
as % of H&I total	5.5%		10.6%

Source: Scottish Government, calculation authors

Unfortunately, the data for BERD at cluster level is almost all declared as disclosive values in the Highlands and Islands region. The table below summarises the data available for one specialisation cluster and the two emerging industries for the period 2013-15 (the totals of the three 'clusters' sum to more than 100% as there is significant overlap in certain SIC codes). Overall, we conclude that the BERD data at cluster level appears 'unreliable' as it seems unlikely that the share of these three 'clusters' in total Highlands and Islands BERD is so low (or the absolute expenditure for say blue growth industries is so low). One explanation could be that R&D expenditure is being recorded at the headquarters of firms with operations in the Highlands and Islands but head offices elsewhere in Scotland or the rest of the UK.

**Figure 20: Innovation activity in the Highlands and Islands growth sectors, 2012-14**

Growth Sector	Highlands & Islands		Scotland	
Indicator	Number of enterprises (with 10+ employees)	Share of innovation active enterprises	Number of enterprises (with 10+ employees)	Share of innovation active enterprises
1. Food & Drink	15	*	270	84.2%
2. Financial and Business Services	75	*	1420	59.2%
3. Life Sciences	5	*	100	59.5%
4. Energy (including Renewables)	0	*	295	50.2%
5. Sustainable Tourism (Tourism-related industries)	465	*	3480	45.4%
6. Creative Industries (including Digital)	45	*	720	56.0%
All	610	81.9%	6285	51.8%

Source: UK Innovation Survey 2015, ONS and Scottish Government. Notes: For number of enterprises column, the number of businesses are rounded to the nearest 5. Totals may not sum due to rounding. For share of enterprises (with 10+ employees) that were innovation active in the 2012-2014 period columns: \* - Disclosive cell. Sample size - all enterprises (with 10+ employees) - Highlands & Islands (Growth Sector Codes - 31) Scotland (Growth Sector Codes - 447)

The data from the CIS (UK Innovation Survey) 2015 is similarly bedevilled with disclosive values. However, the data suggests that **the share of innovation active enterprises in the growth sectors and specialisation clusters in the Highlands and Islands is higher than the Scottish average.**

At cluster and emerging industry level, almost no values are available, except for distribution and electronic commerce which has a rate of innovation activity of 66.6% in the Highlands and Islands compared to 61.5% in Scotland and Blue Growth industries where the Highlands and Islands has 55.9% of innovation active firms compared to 51.8% in Scotland.

**Figure 21: Innovation activity in the Highlands and Islands clusters, 2012-14**

Indicator	Number of enterprises (with 10+ employees)			Share of enterprises that were innovation active	
Cluster Category	Highlands & Islands	Scotland	H&I Share	Highlands & Islands	Scotland
<b>Cluster SIC Code</b>	<b>680</b>	<b>4120</b>	<b>16.5%</b>	<b>81.7%</b>	<b>60.9%</b>
Distribution and Electronic Commerce	105	1005	10.4%	66.6%	61.5%
Education and Knowledge Creation	5	65	7.7%	*	61.9%
Electric Power Generation and Transmission	0	15	0.0%	*	*
Environmental Services	0	25	0.0%	*	*
Fishing and Fishing Products	15	30	50.0%	*	*
Hospitality and Tourism	440	1240	35.5%	*	73.4%
Metalworking Technology	15	255	5.9%	*	55.3%
Non-metal Mining	5	20	25.0%	*	*
Recreational and Small Electric Goods	0	35	0.0%	*	*
Textile Manufacturing	15	120	12.5%	*	36.8%
Upstream Chemical Products	0	10	0.0%	*	*
Environmental Industries	45	910	4.9%	*	58.3%
Blue Growth Industries	120	1360	8.8%	55.9%	51.8%
<b>Other</b>	<b>920</b>	<b>11350</b>	<b>8.1%</b>	<b>49.9%</b>	<b>46.6%</b>
<b>All</b>	<b>1600</b>	<b>15470</b>	<b>10.3%</b>	<b>63.4%</b>	<b>50.4%</b>

Source: UK Innovation Survey 2015, ONS and Scottish Government. Notes: For number of enterprises, 1. The number of businesses are rounded to the nearest 5; 2. Totals may not sum due to rounding. For share of innovative enterprises \* - Disclosive cell. The sample size was Highlands & Islands: Cluster Codes - 48, Other Codes - 81; Scotland Cluster : Codes - 564, Other Codes - 1,052

The CIS **does not cover several key clusters for the Highlands and Islands economy**, including agricultural inputs and services, downstream chemical products and forestry as well as marine fishing, freshwater fishing, a range of tourism related activities and certain educational support services and activities

Given the patchy information on R&D and innovation activity available from standard statistical sources, we examine in chapter 4, the flow of public funding to specific sectors and clusters for investment, R&D and innovation to develop a more detailed understanding of business innovation activity.

### 3.2 Technological specialisation (patenting)

Given the data available on R&D and innovation activity, this section explores one type of output or result from (business) R&D, namely patenting. It is worth underlining that patenting is one specific form of intellectual property protection that is not always the best or most cost-effective IPR strategy for all sectors. For instance, in textiles industrial design, copyright and trademarks tend to be preferred<sup>15</sup>; whereas in biotech (life sciences) patenting will be a key defence mechanism.

To explore technological specialisation, we analysed patenting activities using the OECD Regpat database. The Database covers data on patent applications to the European Patent Office (EPO), the US Patent and Trademark Office (USPTO), patent applications filed under the Patent Co-operation Treaty (PCT) that designate the EPO, as well as Triadic patent

<sup>15</sup> See: [http://www.wipo.int/wipo\\_magazine/en/2005/03/article\\_0009.html](http://www.wipo.int/wipo_magazine/en/2005/03/article_0009.html)

families. Data mainly derives from the latest version of the EPO's Worldwide Patent Statistical Database (PATSTAT)<sup>16</sup>.

**Figure 22 Patent applicants from the Highlands and Islands, 2005-2014**

Applicant	# of patent applications
Lifescan Scotland Limited	133
Accunostics Limited	2
AWS Ocean Energy Limited	2
Island Marine Systems Limited	2
Scotrenewables (Marine Power) Limited	2
Aitchison, Donald, Alexander	1
Angus Jamieson Consulting Limited	1
Aquapharm Bio-Discovery Limited	1
Carbon Black System Ltd.	1
Catenary Testing Limited	1
CCMJ SYSTEMS LTD	1
Dynamic Insulation Solutions Limited	1
FVG Limited	1
Gordon Diesel Services Limited	1
Gowland, Dennis Stephen	1
Greenheat Systems Limited	1
Highland Biosciences Limited	1
Highland Innovation Centre Limited	1
Inverness Medical Limited	1
IVMD UK LIMITED	1
Johnson, Kenneth Gordon	1
Jopejo Limited	1
KP Technology Ltd.	1
Mowat Technical & Design Services Ltd	1
Ross, Gordon Mackay	1
Sintes, Hugh Corum	1
Suresensors LTD	1
The Scottish Association for Marine Science	1
UHI Millennium Institute	1
<b>Total</b>	<b>165</b>

Source: authors, based on OECD Regpat database

Simple counts on the number of patent applications submitted shows a total of **165 patent applications from the Highlands and Islands in the period 2005-2014**. The number of single applicants over the period is only 29, showing a **strong concentration of patenting**

<sup>16</sup> See: <http://www.oecd.org/sti/inno/oecdpatentdatabases.htm>

**activities in the region.** Moreover, 81% of out the total patents were submitted by a single applicant: **Lifescan Scotland Limited**<sup>17</sup>.

IPC codes of patent applications provide a hierarchical system for the classification of patents and utility models to the technology area to which they pertain. Using the IPC codes, it is possible to identify the technological know-how of a region. As one patent application may contain more than one IPC code, we can identify cross-technological patenting activities. Figure 23 presents the most frequently used technologies in Highlands and Islands patent applications. The most frequent technology used is the **investigation and analysis of materials**, a technology that is related to four different clusters: medical devices, information technology and analytical instruments, digital industries, and environmental industries. This is followed by the **analysis of biological materials**, which is linked to the medical devices and the digital industries clusters.

**Figure 23 IPC technologies of patent applications by Highlands and Islands inventors**

IPC code	Number of patents using technology	Description	NACE Code	Related Clusters
G01N	181	Investigation or analysing materials by determining their chemical or physical properties (measuring or testing processes other than immunoassay, involving enzymes or micro-organisms)	Manufacture of Computer, Electronic and Optical Products [26]; Manufacture of Instruments and Appliances for Measuring, Testing and Navigation; Watches and Clocks [26.5]	Medical Devices; Information Technology and Analytical Instruments; Digital Industries; Environmental Industries
A61B	124	Diagnosis, surgery, identification (analysing biological material)	Manufacture of Medical and Dental Instruments and Supplies [32.5]; Other Manufacturing [32]	Medical Devices; Digital Industries
C12Q	42	Measuring or testing processes involving enzymes or micro-organisms	Manufacture of Basic Pharmaceutical Products and Pharmaceutical Preparations [21]	Biopharmaceuticals
G06F	24	Electric Digital Data Processing (computers in which a part of the computation is effected hydraulically or pneumatically, optically; computer systems based on specific computational models)	Manufacture of Computer, Electronic and Optical Products [26]; Manufacture of computers and peripheral equipment [26.2]	Information Technology and Analytical Instruments; Digital Industries
C09D	12	Coating Compositions (paints, varnishes or lacquers, filling pastes, chemical paints or ink removers, inks)	Manufacture of Chemicals and Chemical Products [20]; Manufacture of Paints, Varnishes and Similar Coatings, Printing Ink and Mastics [20.3]	Biopharmaceuticals; Downstream Chemical Products

Source: authors, based on based on OECD Regpat database

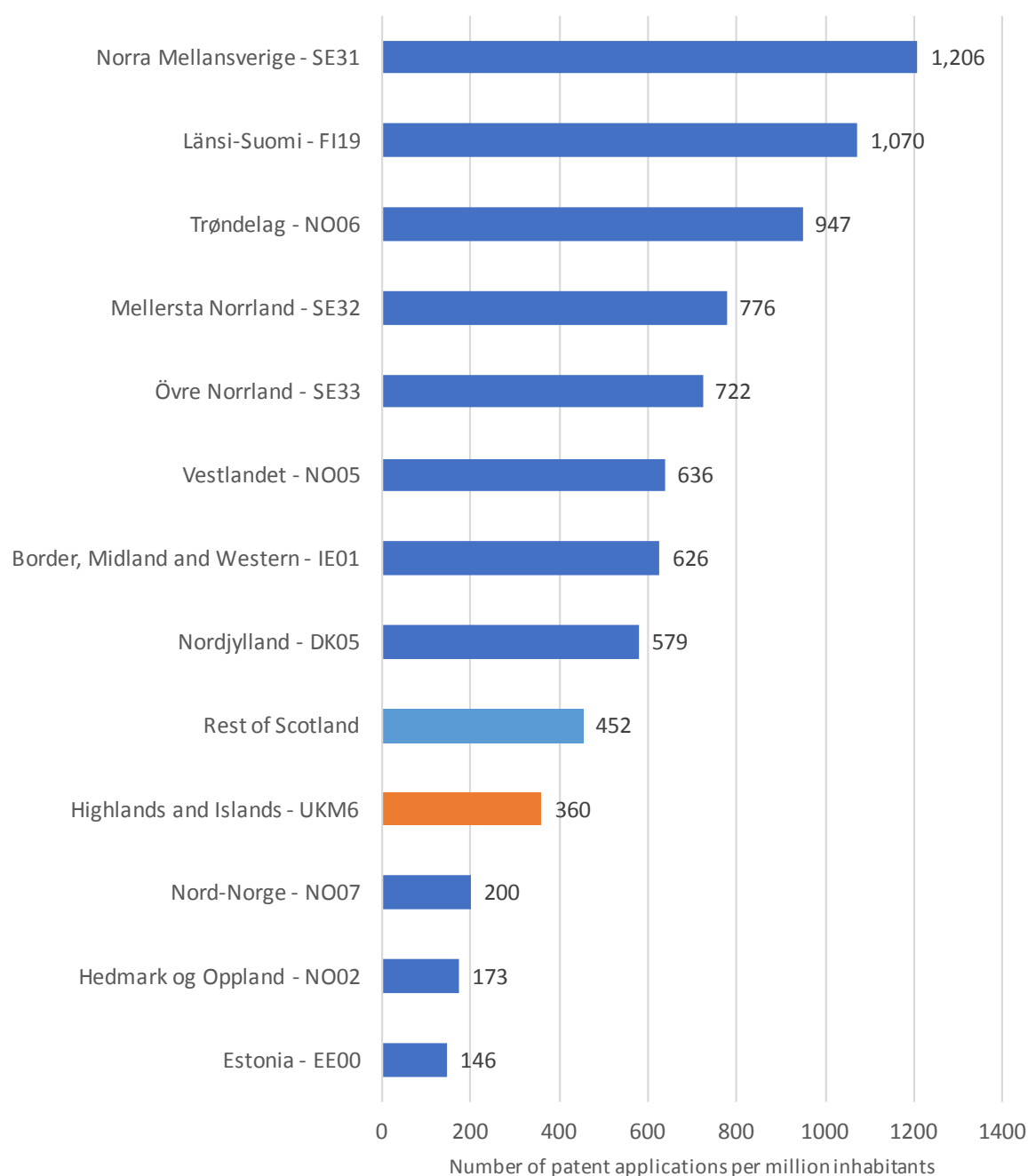
Aside from **environmental industries and downstream chemical products**, the technologies developed by inventors in the Highlands and Islands do not correspond directly to regional employment specialisation clusters. The technologies developed in the Highlands and Islands are, rather, at the intersection between information technologies, medical devices, environmental industries, digital industries and biopharmaceuticals.

In terms of the knowledge being created in the Highlands and Islands through patenting activities, Figure 24 presents the number of patent applications per million inhabitants compared to the regional benchmarks in the period 2005-2014. The Highlands and Islands underperforms the benchmarks, including the rest of Scotland with only 360 patent applications in a 10-year period per million inhabitants.

<sup>17</sup> <http://www.lifescan-scotland.co.uk/about/lifescan-scotland>



**Figure 24 Patent applications per million inhabitants in the Highlands and Islands and regional benchmarks, 2005-2014**



Source: authors, based on REGPAT

Figure 25 presents all patent applications for the period 2005-2014 for the Highlands and Islands and the selected comparators as shares of all patent applications in the period. In the Highlands and Islands, about half of all patent applications were in the manufacture of instruments and appliances for measuring (49.7%); followed by the manufacture of medical and surgical equipment (10.9%); and the manufacture of pharmaceuticals, medicinal chemicals and botanical products (5.4%).

Only the share of instruments manufacturing is significantly higher in the Highlands and Islands relative to the comparators, with Northern Ireland following with only 14.3% of all patent applications in the region in this industrial sector. The share of patents in pharmaceuticals is comparable to the levels in Estonia, Nordjylland (DK), Trøndelag (NO), and the rest of Scotland.

Figure 26 presents the share of patent applications filed in the Highlands and Islands and the benchmarks by technology field. More than two thirds (77%) of all patent applications in the Highlands and Islands were in four technology areas: measurement (25%); analysis of biological materials (24%); medical technology (18%) and biotechnology (10%). These **four areas are relatively important compared to the benchmark regions**: only Border, Midland and Western (IE01) has similar shares of patent filed in Medical Technology; while Nord-Norge (NO07) and Estonia have similar shares in biotechnology.

Figure 25 Patent applications by industrial sector, Highlands and Islands and selected benchmarks in 2005-2014, share of total

Industrial sector based on NACE Rev 1.1	Highlands and Islands - UKM6	Nordjylland - DK05	Estonia - EE00	Länsi-Suomi - FI19	Border, Midland and Western - IE01	Hedmark og Oppland - NO02	Vestlandet - NO05	Trøndelag - NO06	Nord-Norge - NO07	Norra Mellansverige - SE31	Mellersta Norrland - SE32	Övre Norrland - SE33	Rest of Scotland - (UKM-UKM6)	Northern Ireland (UK) - UKNo
Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment - 33.2	49,7%	3,4%	14,7%	4,8%	3,9%	5,9%	7,8%	14,1%	0,4%	3,6%	4,4%	5,8%	10,8%	15,3%
Manufacture of medical and surgical equipment and orthopaedic appliances - 33.1	10,9%	3,7%	20,1%	2,9%	19,9%	3,9%	12,2%	8,8%	49,6%	0,3%	5,6%	13,9%	17,1%	16,4%
Manufacture of pharmaceuticals, medicinal chemicals and botanical products - 24.4	5,4%	5,0%	5,7%	2,3%	9,5%	2,9%	1,9%	5,4%	0,4%	0,7%	0,6%	3,2%	5,1%	2,2%
Manufacture of office machinery and computers - 30	3,1%	4,7%	1,7%	5,1%	1,6%	1,0%	7,3%	4,5%	2,2%	3,3%	6,5%	2,9%	4,5%	2,5%
Manufacture of engines and turbines, except aircraft, vehicle and cycle engines - 29.1	1,7%	3,5%	8,2%	4,4%	4,8%	3,9%	8,0%	8,2%	5,8%	1,1%	2,0%	5,1%	6,1%	2,2%
Manufacture of basic chemicals - 24.1	1,4%	1,3%	1,4%	2,5%	2,2%	3,9%	1,7%	1,7%	1,3%	0,9%	4,0%	1,8%	1,1%	1,3%
Manufacture of agricultural and forestry machinery - 29.3	1,4%	6,3%	4,8%	12,4%	1,6%	7,8%	12,7%	7,6%	3,1%	24,1%	11,1%	8,3%	12,3%	4,5%
Manufacture of other special purpose machinery - 29.5	1,4%	2,6%	3,1%	2,6%	1,5%	2,0%	1,4%	4,2%	0,4%	1,1%	1,2%	3,6%	4,0%	1,3%
Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy - 32.2	0,6%	6,7%	2,3%	3,2%	2,7%	4,9%	5,1%	1,7%	1,8%	2,7%	1,6%	2,4%	4,4%	4,7%
Manufacture of rubber and plastic products - 25	0,6%	7,3%	2,0%	3,1%	3,0%	2,9%	2,9%	1,6%	2,2%	5,9%	4,8%	3,8%	2,3%	6,6%
Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy - 28	0,6%	0,9%	0,3%	2,8%	0,2%	2,0%	8,1%	2,5%	2,2%	2,5%	1,2%	0,8%	2,3%	2,4%
Manufacture of other transport equipment - 35	0,6%	2,8%	1,1%	0,8%	1,1%	22,5%	3,2%	1,8%	0,4%	1,3%	6,0%	1,9%	1,6%	1,3%
Manufacture of furniture; manufacturing n.e.c. - 36	0,6%	10,4%	4,0%	10,5%	4,5%	5,9%	6,6%	9,1%	4,0%	5,8%	7,3%	9,9%	3,8%	4,7%
Manufacture of other general purpose machinery - 29.2	0,3%	0,6%	0,3%	0,9%	0,1%	0,0%	0,1%	0,3%	0,0%	1,7%	7,5%	0,6%	0,2%	0,0%

Industrial sector based on NACE Rev 1.1	Highlands and Islands - UKM6	Nordjylland - DKo5	Estonia - EEo0	Länsi-Suomi - FI19	Border, Midland and Western - IEo1	Hedmark og Oppland - NOo2	Vestlandet - NOo5	Trøndelag - NOo6	Nord-Norge - NOo7	Norra Mellansverige - SE31	Mellersta Norrland - SE32	Övre Norrland - SE33	Rest of Scotland - (UKM6)	Northern Ireland (UK) - UKNo
Manufacture of pulp, paper and paper products - 21	0,3%	5,6%	2,8%	5,7%	6,5%	3,9%	2,0%	2,2%	0,4%	2,8%	2,0%	3,2%	0,9%	3,9%
Manufacture of other non-metallic mineral products - 26	0,3%	1,7%	0,6%	5,6%	0,7%	1,0%	1,4%	2,2%	1,3%	22,3%	3,6%	2,4%	1,2%	0,5%
Manufacture of machine tools - 29.4	0,3%	0,2%	1,4%	0,9%	0,1%	1,0%	0,2%	1,3%	0,0%	0,3%	0,0%	0,7%	0,2%	0,4%
Manufacture of industrial process control equipment - 33.3	0,0%	1,3%	2,8%	0,1%	0,4%	1,0%	3,9%	0,7%	12,5%	0,1%	0,6%	2,1%	0,4%	0,7%

Source: authors, based on REGPAT

Figure 26 Patent applications by technology field, Highlands and Islands and selected benchmarks in 2005-2014, share of total

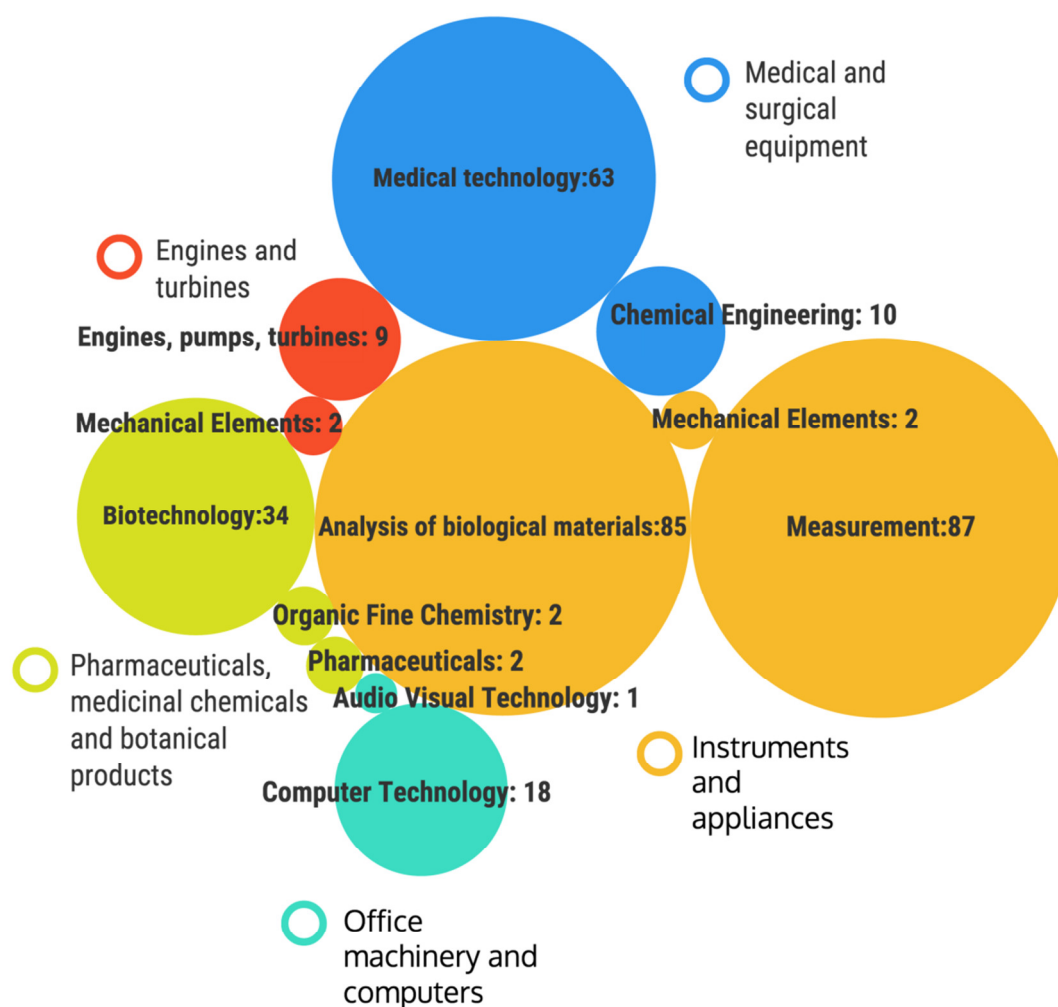
Technology Area	Highlands and Islands - UKM6	Nordjylland - DK05	Estonia - EE00	Länsi-Suomi - FI19	Border, Midland and Western - IE01	Hedmark og Oppland - NO02	Vestlandet - NO05	Trøndelag - NO06	Nord-Norge - NO07	Norra Mellansverige - SE31	Mellersta Norrland - SE32	Övre Norrland - SE33	Rest of Scotland - (UKM-UKM6)	Northern Ireland (UK) - UKNo
Measurement	25,1%	2,4%	8,8%	4,2%	2,8%	5,9%	6,9%	14,6%	0,4%	2,8%	3,4%	5,1%	7,7%	9,3%
Analysis of biological materials	24,3%	1,1%	5,9%	1,4%	1,3%	1,0%	2,9%	3,9%	0,0%	1,2%	1,0%	1,3%	4,2%	6,6%
Medical technology	18,0%	9,9%	4,2%	2,8%	16,8%	8,8%	1,3%	2,8%	1,8%	1,8%	3,6%	6,4%	7,0%	4,9%
Biotechnology	9,7%	2,8%	7,1%	1,1%	4,5%	2,0%	3,8%	3,2%	8,5%	0,3%	6,2%	5,1%	5,5%	6,6%
Computer technology	5,1%	4,5%	4,0%	1,7%	7,6%	2,0%	1,0%	4,5%	0,4%	0,2%	0,4%	2,8%	3,6%	1,4%
Chemical engineering	3,1%	2,8%	3,7%	3,7%	2,4%	2,9%	4,4%	6,8%	1,3%	9,2%	4,0%	5,7%	3,7%	3,8%
Engines, pumps, turbines	2,6%	6,5%	2,0%	10,5%	1,6%	2,9%	5,8%	3,8%	2,2%	1,7%	2,6%	0,4%	3,5%	3,1%
Basic materials chemistry	1,4%	1,1%	4,5%	3,1%	1,1%	4,9%	2,9%	0,9%	2,7%	0,7%	0,2%	2,9%	2,4%	0,0%
Handling	1,4%	5,0%	2,5%	5,6%	1,9%	4,9%	3,8%	2,0%	2,2%	2,8%	2,6%	6,0%	2,2%	2,6%
Other special machines	1,4%	6,3%	2,5%	6,4%	5,1%	5,9%	3,5%	2,8%	3,6%	1,9%	6,3%	3,9%	2,4%	2,9%

Source: authors, based on REGPAT

By combining the elements presented in the previous two graphs, Figure 27 illustrates Highlands and Islands' patents by main industrial sector and technology field. The industrial sectors are represented with different colours in the graph, while the technology fields are summarised in the bubbles. The bubble size corresponds to the number of patents using the technology in a given sector.

The results suggest interesting cross-industrial and cross-technology areas where patenting activities occur. A large part of the patents filed in the instruments and appliances sector, correspond to the analysis of biological materials (85); while most in the pharmaceutical sector correspond to the use of biotechnology (34). A total of 10 patents in the medical and surgical equipment sector use chemical engineering technologies.

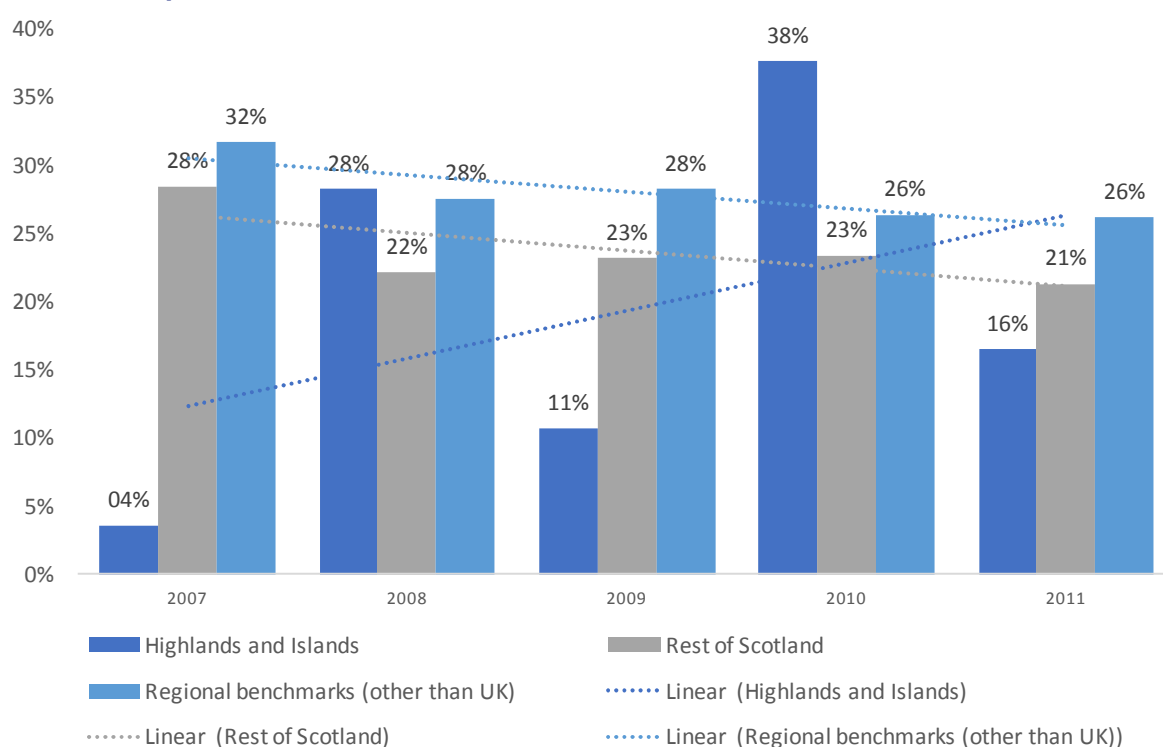
**Figure 27 Highlands and Islands patents by main industrial sector and technology field, 2005-2014**



Source: authors, based on REGPAT

Figure 28 presents cross-technological patenting activities in the Highlands and Islands and the regional benchmarks. Cross-technological patents are those patents that are classified under two or more technological areas as a proportion of the total number of patents filed by inventors in the region. For instance, out of all patent applications from the Highlands and Islands in 2007, 4% of all were cross-technological or involving at least two technological areas (28% in 2008, 11% in 2009, etc.). Cross-technological patenting reveal where sectors overlap and may create new opportunities for innovation. Despite the relatively low levels of patenting activities, the Highlands and Islands is exploiting opportunities across technologies and sectors, with a positive trend over the period analysed, compared to a negative trend observed among the regional benchmarks.

**Figure 28 Cross-technological patenting in Highlands and Islands and regional benchmarks, 2007-2011**



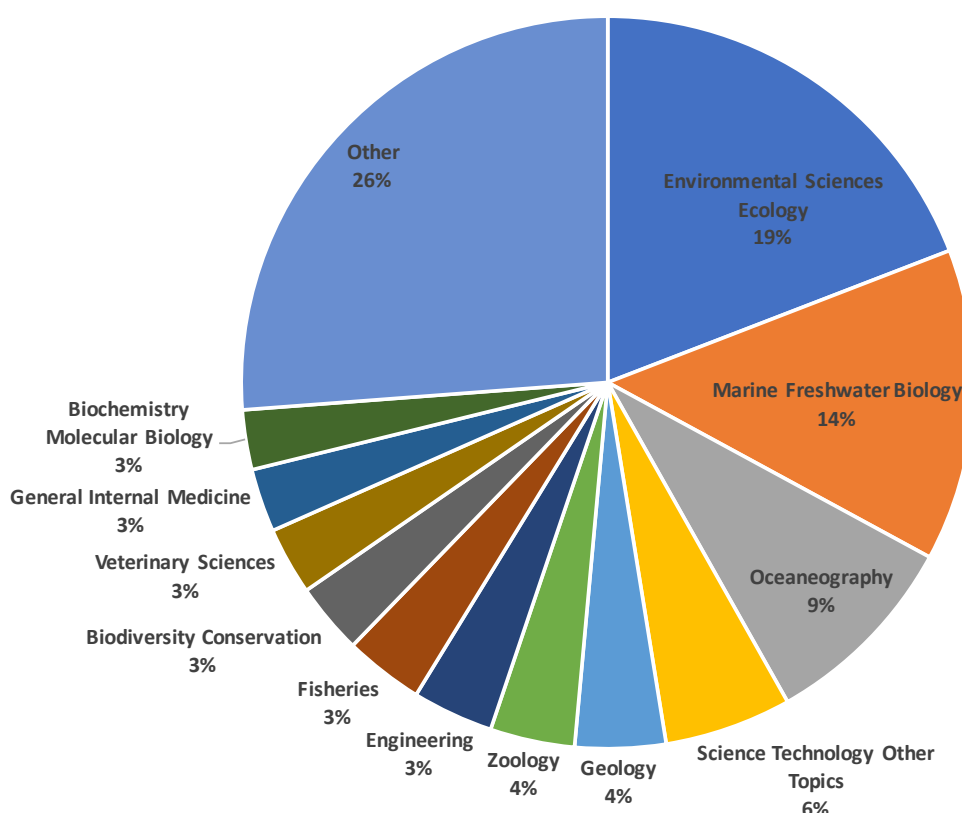
Source: European Cluster Observatory, Regional Ecosystem Scoreboard, based on PATSTAT

### 3.3 Scientific Production and Specialisation

This section examines the scientific production and scientific specialisation of the Highlands and Islands based on publication counts. We use data from the Web of Science with publications selected using postal code searches in the affiliation of the co-authors. A publication was included in the analysis if at least one of the co-authors listed had an affiliation in the Highlands and Islands.

Figure 29 presents the main research areas of scientific publications produced in the Highlands and Islands in the period 2013-2017. Three research areas account for about 42% of all scientific production in the Highlands and Islands: Environmental Sciences Ecology, Marine Freshwater Biology and Oceanography. About 87% of these publications are produced by researchers with affiliations to only four organisations: the University of the Highlands and Islands (49%); the University of Aberdeen (15.2%); the NERC National Environment Research Council (13.5%); and the NERC National Oceanography Centre (9.2%). The importance of the non- Highlands and Islands based organisations as main collaborators for research outputs for scientists in the Highlands and Islands underlines the linkages within Scotland and the rest of the UK.

**Figure 29 Scientific publications in the Highlands and Islands by research area (areas with more than 10 publications in the period), 2013-2017**



Source: Web of Science, calculations authors

In terms of the agencies funding the research that results in publications, the largest funder is the EU, either as an outcome of a FP6, FP7 or H2020 project, European Research Council Grants, or through EU Structural Funds. EU funded publications account for 12.5% of the



total; followed by the Natural Environment Research Council (NERC) (11.6%); the Scottish Government (4.5%); the Scottish Funding Council (3.3%); and Scottish Natural Heritage (2.4%).

While there is not a direct link between scientific activity (and even excellence) and economic activity, the Highlands and Islands relative strengths in terms of scientific specialisation do highlight whether there is a potential knowledge base relevant to existing or emerging regional clusters. Scientific specialisation is assessed based on a statistical (bibliometric) analysis of peer reviewed publications (Web of Science). A scientific specialisation index is calculated to assess the Highlands and Islands research output compared to the rest of Scotland. An index score above 20 indicates that the Highlands and Islands is highly specialised compared to the rest of Scotland; while a value between -20 and +20 indicates a subject area average relative to the rest of Scotland.

The Highlands and Islands is highly specialised in Oceanography research relative to the rest of Scotland (Figure 30). All other research areas in which the Highlands and Islands has generated outputs in the last five years are average relative to the specialisation of the rest of Scotland. Marine freshwater biology research also performs well and is close to being a high specialisation area of the Highlands and Islands.

**Figure 30 Academic research specialisation of the Highlands and Islands based on publication counts, 2013-2017**

Research Area	H&I	Rest of Scotland	Share of H&I	Share of Rest of Scotland	H&I/Scotland Specialisation
Environmental Sciences Ecology	225	4119	25,5%	4,9%	5,24
Marine Freshwater Biology	162	879	18,4%	1,0%	17,68
Oceanography	105	455	11,9%	0,5%	22,14
Science Technology Other Topics	66	4686	7,5%	5,5%	1,35
Geology	47	1818	5,3%	2,2%	2,48
Zoology	44	915	5,0%	1,1%	4,61
Engineering	42	4441	4,8%	5,3%	0,91
Fisheries	41	416	4,7%	0,5%	9,46
Biodiversity Conservation	37	512	4,2%	0,6%	6,93
Veterinary Sciences	35	1458	4,0%	1,7%	2,30
General Internal Medicine	33	3294	3,7%	3,9%	0,96
Biochemistry Molecular Biology	31	3323	3,5%	3,9%	0,90
Energy Fuels	30	928	3,4%	1,1%	3,10
Plant Sciences	26	1008	3,0%	1,2%	2,47
International Relations	25	329	2,8%	0,4%	7,29
Public Environmental Occupational Health	20	1722	2,3%	2,0%	1,11
Biotechnology Applied Microbiology	19	1158	2,2%	1,4%	1,57
Evolutionary Biology	19	847	2,2%	1,0%	2,15
Agriculture	18	1039	2,0%	1,2%	1,66
Chemistry	17	4260	1,9%	5,0%	0,38
Water Resources	17	510	1,9%	0,6%	3,20
Meteorology Atmospheric Sciences	16	476	1,8%	0,6%	3,23
Archaeology	15	295	1,7%	0,3%	4,88
Health Care Sciences Services	14	1053	1,6%	1,2%	1,28
Physical Geography	13	482	1,5%	0,6%	2,59
Life Sciences Biomedicine Other Topics	12	1005	1,4%	1,2%	1,15
Neurosciences Neurology	12	3479	1,4%	4,1%	0,33
Paleontology	12	178	1,4%	0,2%	6,47
Pharmacology Pharmacy	12	1624	1,4%	1,9%	0,71
History Philosophy of Science	11	286	1,2%	0,3%	3,69

Source: Web of Science, calculations authors

The results suggest that academic research is partially disconnected/mismatched with business performance and excellence. Only the Blue Growth industries rank well in terms of cluster productivity and have a corresponding scientific specialisation in the region.

## 4. MAPPING PUBLIC SUPPORT FOR BUSINESS DEVELOPMENT

This section summarises the findings from an analysis of business support (in the form of grant funding or the monetary equivalent for advice) to businesses located in the Highlands and Islands Enterprise (HIE) zone. The analysis is based on the following sources:

- Data from the HIE management system on supported companies
- SMART (R&D) awards (dataset received from Scottish Enterprise)
- Interface Scotland Innovation Vouchers and follow on voucher awards
- Scottish Government Regional Selective Data grants
- Innovate UK awards (various programmes)
- EU research and innovation funding (Framework Programme 7 and Horizon 2020).

Figure 31 details the period covered by the datasets and the number of awards made.

The HIE 'HMS' dataset (as at end January 2017) was cleaned and edited. This notably concerned reviewing business activity codes (SIC) as well as postcode data (details for individual companies were checked with the UK Company House database) to allocate companies as precisely as possible by sector and sub-sector and sub-region of the Highlands and Islands. The HMS dataset is the most detailed providing additional information on the companies and covering both financial and non-financial assistance provided by HIE and includes a range of other variables that have been used to categorise and analyse the dataset. However, with respect to the overall objective of this study, the relatively imprecise use of SIC codes in the HMS dataset makes it difficult to assign supported companies to the identified specialisation clusters. It is recommended that HIE finds a more robust method to correctly 'tag' firms by sector/SIC code as this would facilitate future analysis of the sectoral structure of support provided. The same applies for the 'key sector' categorisation which on occasions we found 'counter-intuitive'.

**Figure 31: Funding bodies, funding period, companies and value of support**

Funding body	Period	Number of companies	Value of support
<b>HIE</b>	Support provided since financial year (1st April to 31st March) 2009-10 to 25 January 2017.	1044 companies for which a value for grant-in-aid (GIA) or advice cost is recorded.	£162,099,517
<b>Scottish Government RSA</b>	Grants awarded between financial years 2010/11 and 2014/2015	10 firms received funding (12 grants in total).	£9,655,000
<b>SMART Feasibility &amp; Development</b>	Grants awarded from September 2011 to 2016	19 firms received funding (21 grants).	£1,764,260
<b>Interface Scotland</b>	Innovation Vouchers & follow-on vouchers awarded from 2011 to January 2017	134 grants of which 127 innovation vouchers (38 funded by HIE and 89 by SFC) plus 7 Follow-on vouchers (HIE funded)	SFC £435,420 HIE £303,773
<b>Innovate UK</b>	Grants awarded from 2006-7 to 2016-17	74 grants awarded to 42 organisations. Only 7 grants were awarded prior to FY 2009-10.	£5,360,365
<b>EU R&amp;D funding</b>	2007-13 Framework Programme 7 (FP7) 2014-16 Horizon 2020	31 organisations awarded funding in 56 FP7 and 15 Horizon 2020	£15,191,839 £12,075,182

Source: authors based on datasets

The other datasets provide mainly information on the recipient company/organisation, postcode, award amount, grant paid and in some cases capital expenditure. For innovation vouchers the high education institute partner providing services was also identified.

The funding and advice provided by HIE (including HIE funded innovation vouchers) accounts for 76% (approximately £162.4m) of all support. Other funders accounted for £23.9m in funding of which EU R&D funding programme grants (12.8% of total funding), RSA grants (4.5%) and Innovate UK (2.5%). The Scottish innovation programmes (Smart and Interface Scotland vouchers) account for a total of 4.2% of total funding. Of course, a like for like comparison cannot be made between investment/general business support (most HIE support and all RSA funding) and innovation/product development type funding (from Innovate UK, Smart, SFC/HIE innovation vouchers and EU R&D programmes).

**Figure 32: Funding per funder/programme**

Funder	Funding awarded/advice value
HIE from HMS data	£162,099,517
HIE funded innovation vouchers	£303,773
Scottish Government RSA	£9,655,000
Smart Feasibility & Development	£8,186,564
SFC Innovation vouchers	£435,420
Innovate UK	£5,360,365
EU R&D funding	
FP7 (€18,481,556) *.822	£15,191,839
H2020 (€15,441,409) *.782	£12,075,182
<b>Total</b>	<b>£213,307,660</b>

Source: authors based on datasets

The data available suggests that about £35m or 17% of the total funding allocated since 2009 has been in favour of 'innovation'. To this total, should be added the GIA value for innovation type support provided directly by HIE and R&D tax credits<sup>18</sup> claimed to HMRC by companies located in the region. For the former, almost all (98%) HIE funding has been allocated through direct financial support for which it was not possible to identify directly the 'innovative' nature.

Data on tax credits suggests that there has been a healthy growth in the number of claims per year (from 15 to 40 per annum over seven years), however, HMRC disclosure rules do not allow them to provide the amount claimed as the total is less than £5m per year.

<sup>18</sup> <https://www.gov.uk/guidance/corporation-tax-research-and-development-rd-relief#further-information>

**Figure 33: Highland and Islands claims analysis of number and cost of R&D tax credit claims, 2008-09 to 2014-15**

Year	Number of claims	Amount claimed
2008-09	15	*
2009-10	10	*
2010-11	15	*
2011-12	25	*
2012-13	35	*
2013-14	40	*
2014-15	40	*

Source: HM Revenue & Customs, Data received 2 May 2017

Notes:

\* Value suppressed as cell count less than £5m

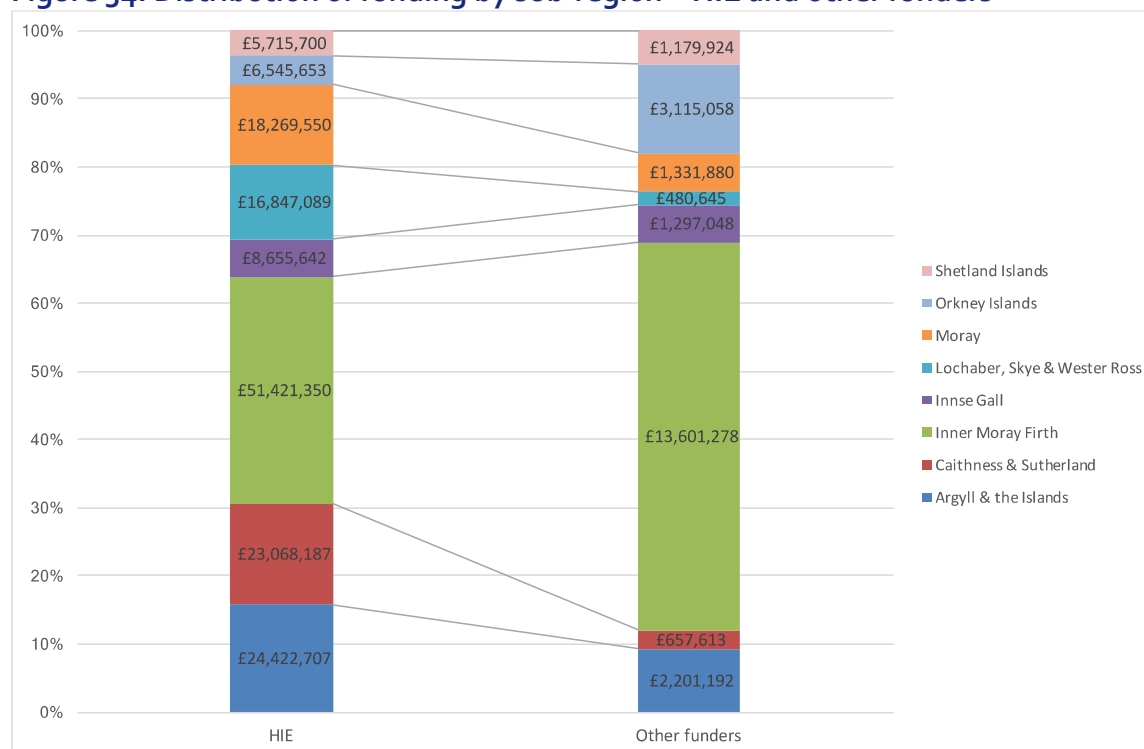
1. Regional allocation is based on the postcode of the company's registered address, which might not correspond to where the R&D activity takes place, so caution must be exercised when interpreting these figures.
2. Figures exclude claims where region is not known.
3. Numbers are rounded to the nearest 5 and amounts are rounded to the nearest £5m. Totals may not sum due to rounding.
4. Statistics in this table are consistent with HMRC's policies on dominance and disclosure.

The total public support (over six years) for 'innovation' captured in the datasets is equivalent to the declared annual business expenditure on R&D (BERD) for the region (£34.8m per year on average during the period 2013-15)<sup>19</sup>. Given that a share of HIE general financial support is likely to be 'innovation-orientated', this figure is likely to be an under-estimate as it does not capture 'non-technological innovation' (marketing, strategy, human resource organisation, etc.) or investment driven (e.g. digitalisation) support that has been delivered by HIE to client firms.

For each of the datasets, we analysed the distribution of support by HIE sub-region, by sector (key sectors and more detailed SIC codes). This allowed us to build up a 'heat map' of public investment since 2009 by sector/sub-sector and sub-region. Considering the geographical spread of the funding provided by HIE and other funders (Figure 34), the funding coming from other funders is more heavily skewed to companies located in the Inner Moray Firth (Inverness and surrounding districts) and Orkney Islands (although the diagram below excluded approximately £7m allocated by HIE through Wave Energy Scotland to organisations not located in the HIE area but which are likely to be focusing their activities in or on Orkney).

<sup>19</sup> Scottish Government, data provided on 5 March 2017

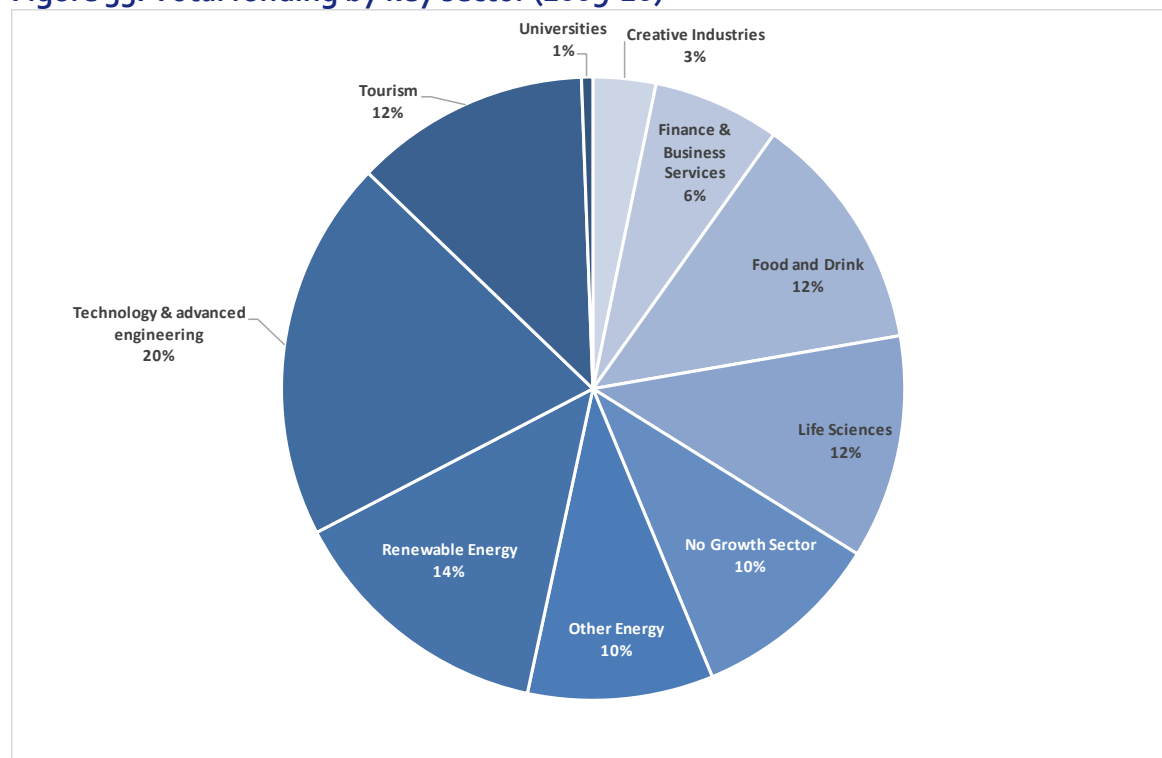
**Figure 34: Distribution of funding by sub-region – HIE and other funders**



Source: authors based on datasets

Excluding EU R&D funding (for which the data does not include sectoral classification codes), the breakdown of funding (Figure 35) is relatively balanced across the key sectors even if technology and advanced engineering (20% of total) and the energy (renewable and other forms) sectors (23.5%) have been a focus.

**Figure 35: Total funding by key sector (2009-16)**

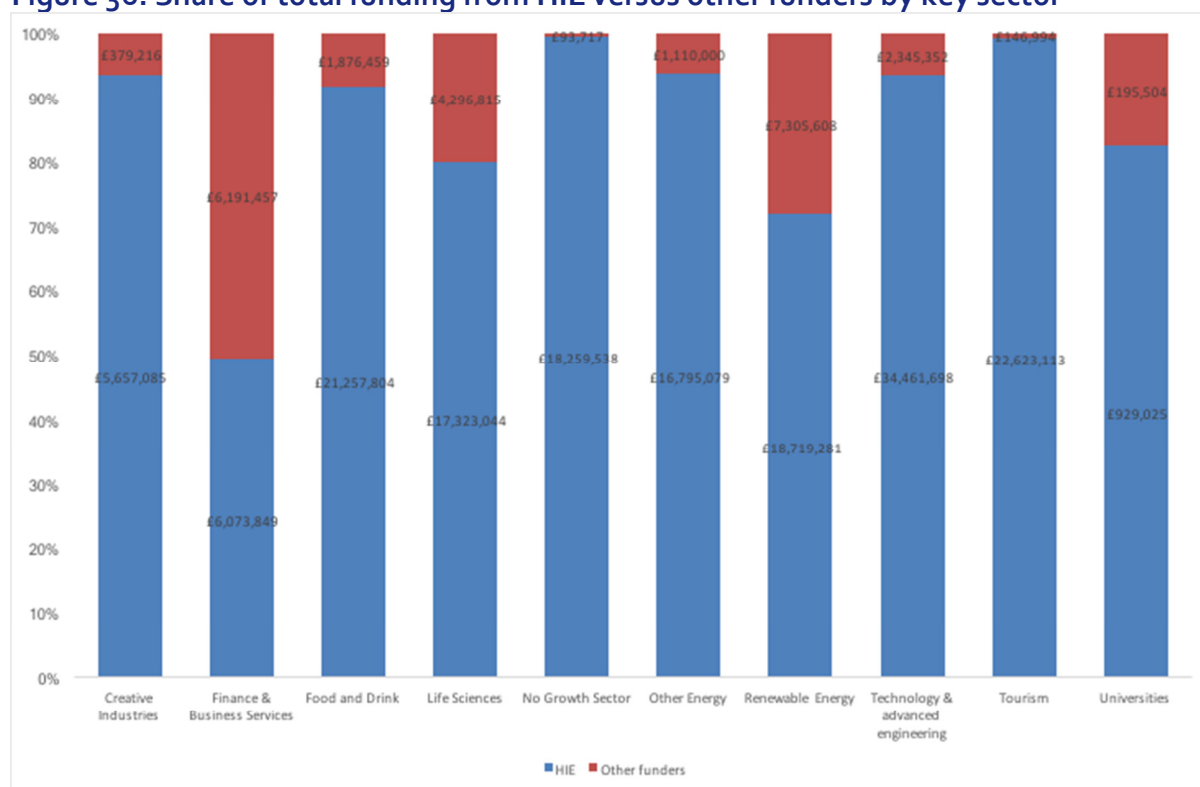


Source: authors based on datasets

However, there is a striking difference in public investment patterns when comparing HIE support to that from other funding bodies (Figure 36). While on average HIE support accounts for 87% of total funding, the figure is much higher in creative industries, food and drink, other energy, technology and advanced engineering and tourism. In finance and business services, a single large RSA grant skews the data and leads to a roughly 50/50 split between HIE and other funders. However, it is worth noting that food and drink companies have made relatively greater use of the Interface Scotland Innovation Vouchers (36% of total) and Innovate UK (12%) and have not benefited at all from Smart or RSA grants.

Other funders have channelled a relatively larger share to life sciences, renewable energy and universities. If EU R&D funding is brought into the equation then there is a **clear focus from 'extra-regional' funding bodies towards renewable energy** (wave & tidal developments in the Pentland Firth/Orkney zone) followed by **marine (life) science** (essentially SAMS and the related spin-off Glycomar Ltd).

**Figure 36: Share of total funding from HIE versus other funders by key sector**



Source: authors based on datasets

HIE's interventions are critical for sectors that are typically considered as 'less high-tech' (or more accurately tend to carry out non-technological forms of innovation) such as the creative industries, food and drink and tourism sectors. HIE support for the technology and advanced engineering sector is coherent with the cross-cutting need for engineering and specialist technology advice that underpin other sectors such as food and drink, extractive industries, (renewable) energy, etc.

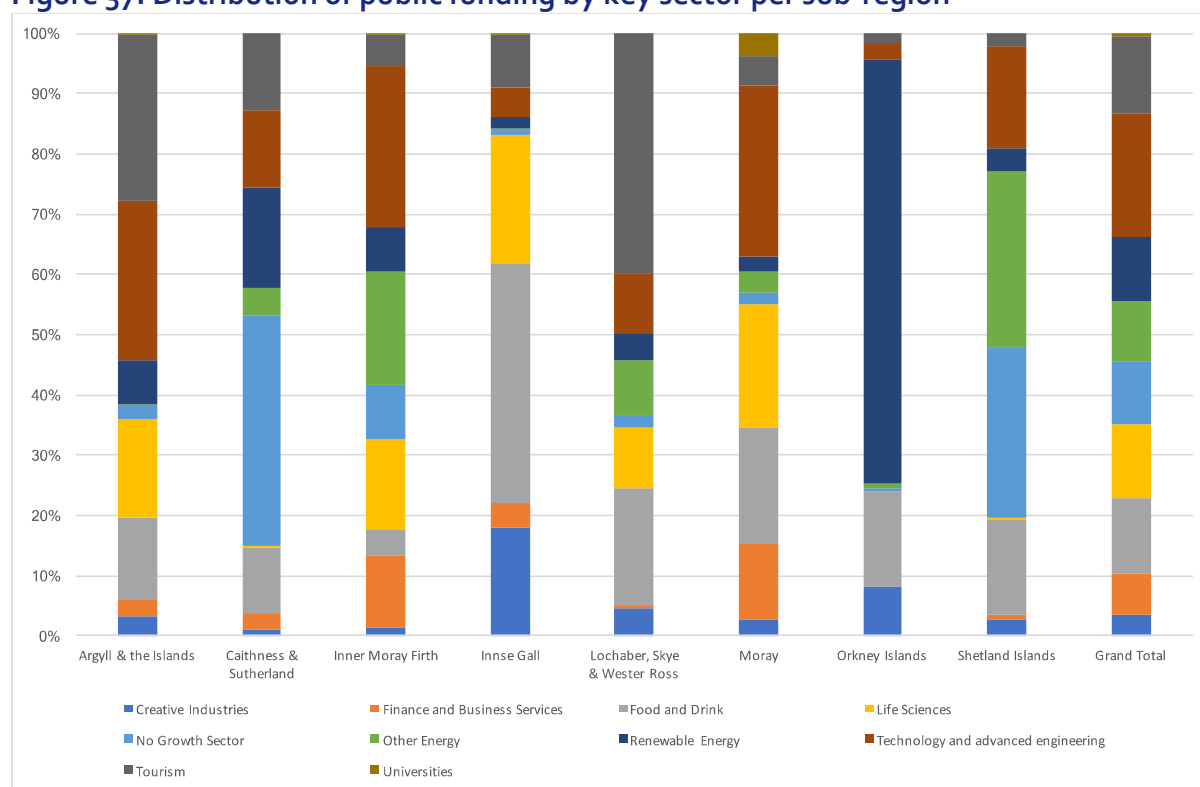
It is noteworthy that 11% of HIE support is provided to companies that are classified as 'No growth sector', although this group captures a wide range of sub-sectors, the investment was focused on 3-4 port and airport upgrading projects (Scrabster Harbour, Port of Cromarty Firth, Lerwick Port Authority and Inverness Airport Business Park). These

'enabling' investments can be viewed as critical for a wide range of other sectors (renewable energy, aquaculture, etc.).

The concentration of public funding by key sector (see Figure 37) varies markedly across the sub-regions:

- Tourism investment leads the field in Argyll & the Islands (27.5% of total investment) and particularly in Lochaber Skye & Wester Ross (40%).
- Technology and advanced engineering lead in the Inner Moray Firth (26.7%) and Moray (28.4%).
- Food and drink accounts for 39.7% of public support to businesses in Innse Gall
- Not surprisingly, public investment into Orkney is heavily skewed toward renewable energy (70%)<sup>20</sup>.
- Other energy and related maritime transport (ports) investments have soaked up over half the funding allocated to the Shetland Islands.
- Caithness & Sutherland has witnessed a high share of investment into non-growth sector fields (notably the above-mentioned port developments) followed by renewable energy.

**Figure 37: Distribution of public funding by key sector per sub-region**



Source: authors based on datasets

<sup>20</sup> a figure that is probably even higher as projects funded through Wave Energy Scotland are not assigned to Orkney as the funding is awarded to organisations not located in the region).



Considering the distribution from a sectoral concentration perspective:

- Close to 30% of creative industry funding has been secured by Innse Gall businesses (at least half of which is related to the Harris Tweed 'cluster').
- 64% of finance & business sector support has gone to the Inner Moray Firth, this area also secured 45% of life science and 68% of other energy investments.
- 62% of tourism funding has been shared between Argyll & the Islands and Lochaber, Skye and Wester Ross.
- Half of university funding has gone to Moray (the Blair Steading development of Glasgow School of Art) and a further 32% to Argyll & the Islands (SAMS).
- Public support for renewable energy is focused on Orkney (over a quarter of total funding, not including WES projects) with the Inner Moray Firth and Caithness & Sutherlands also receiving significant support.
- Food and drink is one of the few sectors where the funding is broadly distributed – no single sub-region clearly dominating.

The data allows a further disaggregation of the mapping at sub-sector level (using SIC codes) (see tables on following pages). The more detailed breakdown provides a different perspective on the focus of support with three sectors concentrating a third of funding: professional, scientific and technical activities, manufacture of base metals and fabricated metal products and transport, storage and communication.

A previously 'invisible' activity (captured under the key sector technology and advanced engineering) namely the manufacture of wood and wood products is ranked fourth in terms of funding and food and drink is fifth. These top five sectors absorbed 51% of total funding.

The next five sectors reflect the importance of tourism and energy in the Highland's and Islands' economy linked to the fishing (aquaculture) sector which is also in the top 10 recipients of funding. Real estate, renting and business activities complete the top 10. The other 19 SIC sectors were awarded 21% of funding with four manufacturing sectors (chemicals, electrical and optical equipment, medical instruments and non-classified manufacturing) receiving 11.8% of total funding.

**Figure 38 : Distribution of public funding by sector (SIC) and funding body (2009-16)**

Sectors (SIC)	HIE-HMS	HIE (vouchers)	Innovate UK	Scot.Gov	SMART	SFC (vouchers)	Total
Professional, scientific & technical activities	£18,380,070	£49,762	£2,186,467		£2,211,895	£47,171	£22,875,365
Manf - Base metals and fabricated metal products	£21,820,163		£-		£100,000		£21,920,163
Transport, storage and communication	£18,467,001	£9,983	£-	£1,100,000		£10,000	£19,586,984
Manf - Wood and wood products	£14,971,697					£5,000	£14,976,697
Manf - Food, beverages and tobacco	£13,718,144	£63,838	£131,173	£40,000		£79,893	£14,033,048
Real estate, renting and business activities	£7,473,211	£10,000		£5,850,000		£5,000	£13,338,211
Hotels and Restaurants	£12,833,457					£4,200	£12,837,657
Fishing	£8,214,838	£54,920	£564,583	£490,000	£200,000	£24,890	£9,549,231
Electricity, gas and water supply	£3,913,808		£419,118		£5,137,077	£4,983	£9,474,986
Recreational, cultural and sporting activities	£8,064,308	£55,907		£100,000	£166,212	£130,345	£8,516,772
Manf - Chemical products and man-made fibres	£4,196,724		£570,893	£1,700,000			£6,467,617
Manf - Electrical and optical equipment	£4,960,501		£1,078,632		£217,421		£6,256,554
Manf - Not elsewhere classified	£4,135,531		£263,706	£375,000		£14,920	£4,789,157
Manf - medical & dental instruments & supplies	£4,381,964						£4,381,964
Other community, social and personal services	£3,323,601	£19,983	£81,012			£39,731	£3,464,327
Education, Training and Employment	£2,912,147				£77,475	£4,820	£2,994,442
Manf - Machinery and equipment not elsewhere class	£2,823,365	£4,950				£5,000	£2,833,315
Manf - Textiles and textile products	£2,173,004	£4,950				£5,000	£2,182,955
Wholesale & retail trade; Inc. repair services	£1,931,695						£1,931,695
Construction	£1,390,287	£14,493	£24,000		£76,484	£9,980	£1,515,243
Mining and quarrying	£406,019						£406,019
Manf - Other non-metallic mineral products	£382,572	£5,000	£5,000				£392,572
Financial intermediation	£362,609						£362,609
Manf - Transport equipment	£291,564						£291,564
Agriculture, hunting & forestry	£190,851	£4,986	£15,000			£39,488	£250,325
Manf - Leather and leather products	£165,711						£165,711
Manf - Rubber and plastic products	£82,279	£5,000	£20,781				£108,060
Manf - Pulp, paper, publishing and printing	£71,541						£71,541
Health and social work	£60,859					£5,000	£65,859
<b>Total</b>	<b>£162,099,517</b>	<b>£303,773</b>	<b>£5,360,365</b>	<b>£9,655,000</b>	<b>£8,186,564</b>	<b>£435,420</b>	<b>£186,040,639</b>

Source: authors based on datasets

**Figure 39: Funding by key sector and SIC sector**

Key Sector SIC sector	Creative Industries	Finance & Business Services	Food & Drink	Life Sciences	No Growth Sector	Other Energy	Renewable Energy	Tech. & adv. engineering	Tourism	Universities
Professional, scientific & technical activities	£162,555	£858,584	£694,107	£7,577,606	£77,320	£278,472	£11,864,403	£1,209,145	£5,980	£147,193
Manf - Base metals and fabricated metal products	£419,899				£3,000	£12,501,585	£202,475	£8,793,204		
Transport, storage and communication	£68,441	£18,743			£14,740,190	£1,824,011	£675,100	£1,046,334	£1,214,166	
Wood and wood products	£30,890				£78,770	£368,200		£14,498,837		
Food, beverages and tobacco			£13,955,444							£77,604
Real estate, renting and business activities	£79,122	£10,122,201		£725,424	£566,769	£640,500	£512,758	£273,652	£417,785	
Hotels and Restaurants			£126,308						£12,711,349	
Fishing			£7,559,220	£57,435	£12,850		£1,310,183	£572,654		£36,888
Electricity, gas and water supply						£31,049	£9,443,936			
Recreational, cultural and sporting activities	£709,743				£11,050				£7,795,979	
Manf - Chemical products and man-made fibres				£3,114,996		£22,575		£3,330,046		
Manf - Electrical and optical equipment	£26,691			£3,651,782		£337,214	£183,075	£2,057,792		
Manf - Not elsewhere classified	£823,296		£128,999	£1,587,361	£541,583	£39,800	£501,848	£1,166,270		
Manf - medical & dental instruments & supplies				£4,381,964						
Other community, social and personal services	£843,185	£488,064		£16,800	£1,517,451		£16,986	£32,467	£468,363	£81,012
Education, Training and Employment	£7,052	£202,814		£105,000	£88,302	£1,562,232	£169,735	£77,475		£781,832
Manf - Machinery and equipment not elsewhere class	£5,677		£56,007	£840	£28,102	£178,530	£523,764	£2,040,394		

Key Sector SIC sector	Creative Industries	Finance & Business Services	Food & Drink	Life Sciences	No Growth Sector	Other Energy	Renewable Energy	Tech. & adv. engineering	Tourism	Universities
Manf - Textiles and textile products	£2,181,755				£1,200					
Wholesale & retail trade; Inc. repair services	£97,217	£22,464	£400,598		£106,741	£109,831	£212,653	£833,820	£148,370	
Construction	£10,886	£190,941			£391,883	£11,080	£407,972	£497,501	£4,980	
Mining and quarrying	£85,071				£39,868			£281,080		
Manf - Other non-metallic mineral products	£247,572			£145,000						
Financial intermediation		£361,495			£1,114					
Manf - Transport equipment				£192,401	£80,574			£18,589		
Agriculture, hunting & forestry			£190,599	£5,000	£51,591				£3,135	
Manf - Leather and leather products	£165,711									
Manf - Rubber and plastic products			£22,981		£7,288			£77,791		
Manf - Pulp, paper, publishing and printing	£71,541									
Health and social work				£58,250	£7,609					

Source: authors based on datasets

Crossing the key sectors with the detailed SIC classification (Figure 39) 'paints' another picture of the composition of the public investment.

- The important block of funding towards companies classified under the professional and scientific and technical activities code is focused on renewable energy (more than 50% of funding) followed by life science activities.
- Investments into companies classified as manufacturing base metals and fabricated metal products are essentially in the energy or the related technology and engineering sectors, but with a significant investment in creative industries.
- Transportation, storage and communication (as previously noted) is not linked to a specific growth sector. The bulk of investment is focused on port and airport infrastructures and services and is an enabling factor for other key sectors.
- Over 80% of manufacturing of the investment into manufacture of wood and wood products concern a single major capital investment project (NordBord Europe expansion), this is classified under technology and advanced engineering key sector. Most of the remaining investments concerns smaller sawmill operations, with a cross-over toward renewable energy (e.g. Balcas Ltd).
- Manufacturing of food beverages and tobacco is unsurprisingly almost entirely concentrated under the Food and Drink key sector; similarly, Hotels and restaurants equate almost directly with tourism; as does the recreational cultural and sporting activities sector (with some cross-over to creative industries).
- The fishing sector maps largely to the food and drink key sector; with however, a significant cross-over investment under renewable energy (due to an investment in multi-purpose vessels for the diversification of activities by a shellfish company). The high-tech side of the aquaculture industry is picked up by cross-over investments in technology and advanced engineering and life science key sectors.
- Electricity, gas and water supply equates almost 1-to-1 with the investments made in the renewable energy key sector.
- Real estate, renting and business funded projects dominates the finance and business service sector investment (70% allocated to three 'global business service' firms), followed by a series of investments into professional services (two companies, Dental Plan and Comcarde, account for almost all this activity). Similarly, funding classified under financial intermediation is essentially for one investment (Capita).

Looking at the same data from the perspective of the key sectors, it is striking that the activity captured under the **creative industry** sector is widely dispersed ranging from firms classified as active in metal manufacturing (jewellery) and related craft businesses under 'manufacturing not elsewhere classified', wood products and stoneware under manufacturing of non-metallic minerals. Textile sector investments (the Harris Tweed 'cluster', Johnstons of Elgin and a Skye based sheepskin business) are a main component (36%) of the creative industry sector. The diversity of investments in creative industries is exemplified by a series of projects in printed and electronic media and games, film, music and other recreational activities (falling under recreational, cultural and sporting, manufacturing not elsewhere classified and other community social and personal services SIC codes). A few of these projects are 'of scale' but most are smaller community or small-scale firms.

The investments in the technology and advanced engineering key sector (20% of total investment) are also highly diversified emphasising the critical underpinning role

engineering and technical services play across a range of business activities. It also raises a question about how best to delimit this 'cluster'.

A further analysis was done by extracting the top 10 companies by public funding (all sources except EU R&D funding) by key sector and calculated a 'concentration index' for each sector, namely the share of the top 10 in total funding for the sector. Funding/value of advice awarded in three sectors is heavily concentrated (above 80% awarded to top 10) namely: Finance & Business Services, Life Sciences and Other energy. Renewable energy and technology and advanced engineering sectors are relatively less concentrated (for the latter the result is skewed by one very large investment project). Funding is more spread out in the creative industries, tourism and particularly food and drink sectors.

**Figure 40: Share of top 10 beneficiaries and average public funding per key sector**

Creative Industries		Finance & Business Services		Food and Drink	
Company	Funding	Company	Funding	Company	Funding
Total Top 10	£ 3,193,169	Total Top 10	£ 10,838,256	Total Top 10	£ 8,801,245
Total Funding	£ 6,036,302	Total Funding	£ 12,265,306	Total Funding	£ 22,724,598
Concentration Index	52.9%	Concentration Index	88.4%	Concentration Index	38.7%
Total number of companies	152	Total number of companies	55	Total number of companies	242
Average per company	£ 39,713	Average per company	£ 223,006	Average per company	£ 93,903
Life Sciences		Other Energy		Renewable Energy	
Company	Funding	Company	Funding	Company	Funding
Total Top 10	£ 18,534,992	Total Top 10	£ 15,727,726	Total Top 10	£ 17,253,920
Total Funding	£ 22,029,524	Total Funding	£ 17,905,079	Total Funding	£ 26,024,889
Concentration Index	84.1%	Concentration Index	87.8%	Concentration Index	66.3%
Total number of companies	53	Total number of companies	48	Total number of companies	81
Average per company	£ 415,651	Average per company	£ 373,022	Average per company	£ 321,295
Technology & advanced engineering		Tourism		No Growth Sector	
Company	Funding	Company	Funding	Company	Funding
Total Top 10	£ 26,892,206	Total Top 10	£ 12,393,278	Total Top 10	£ 16,712,389
Total Funding	£ 36,807,049	Total Funding	£ 22,770,107	Total Funding	£ 18,353,255
Concentration Index	73.1%	Concentration Index	54.4%	Concentration Index	91.1%
Total number of companies	112	Total number of companies	227	Total number of companies	168
Average per company	£ 328,634	Average per company	£ 99,876	Average per company	£ 97,624

Source: authors based on datasets, not including EU R&D funding

The highest average public support per company is in the field of life sciences, followed by the two energy sub-sectors and advanced engineering and technology (again the average for the latter is skewed by a single large investment).

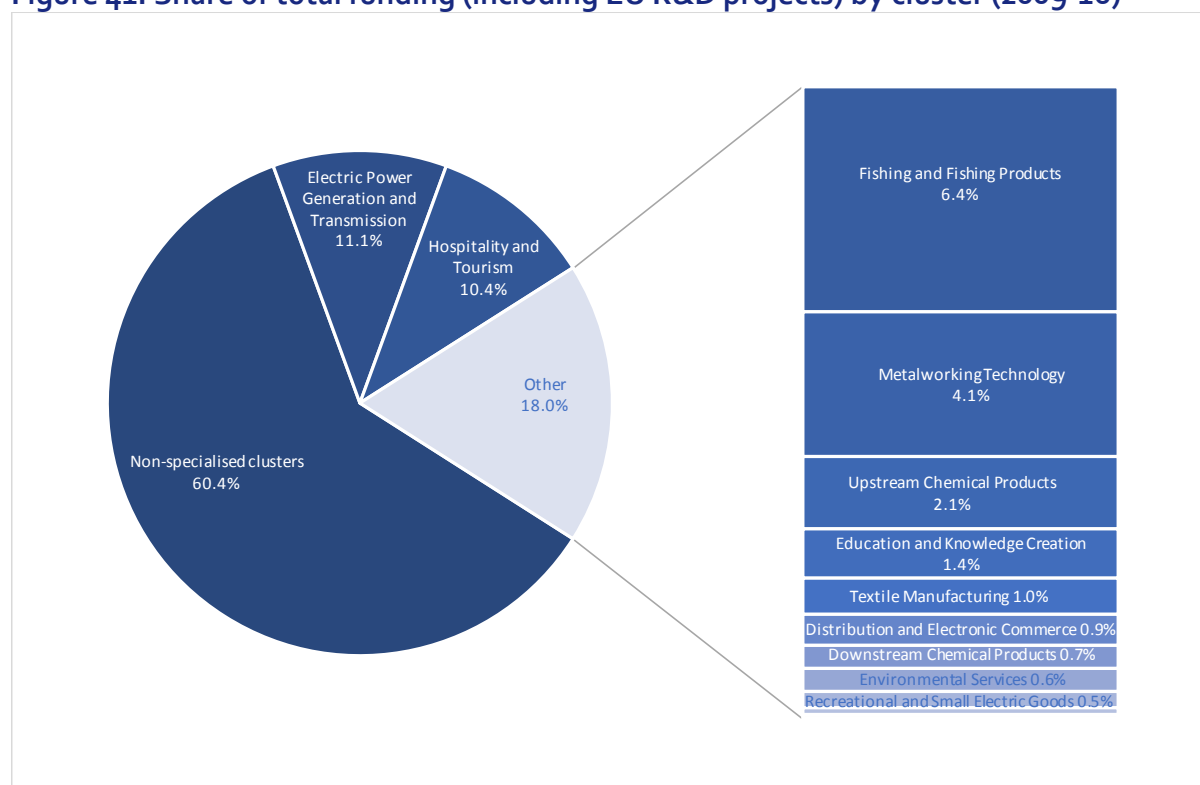
Due to insufficiently precise SIC code categorisations in the datasets, it proved more difficult to calculate the share of funding directed towards the specialisation clusters identified in the first stage of the analysis. However, we provide in Figure 41 and Figure 42 what we consider to be a reasonable approximation for most clusters.

The share of funding directed towards the specialised clusters is roughly 40% of the total of £213m provided by public agencies (including EU FP7 and Horizon 2020 projects) since 2009. Four specialised clusters absorbed just under a third of total funding, namely electric power generation and transmission, hospitality and tourism, fishing and fishing products and metalworking technology. Downstream and upstream chemical clusters followed with a combined 3% of funding.

By main funder, the share of the specialisation clusters differs significantly: ranging from 34.5% of Highlands and Islands Enterprise support, to just over 40% of other UK funding to 68.4% of EU R&D funding. Considering the two emerging industries in which the Highlands and Islands is specialised, blue growth industries received 17.5% of total funding but almost

44% of EU R&D funding; and environmental industries close to 23% of total funding and over 80% of EU R&D funding.

**Figure 41: Share of total funding (including EU R&D projects) by cluster (2009-16)**



Source: authors based on datasets

**Figure 42: Share of funding by cluster and emerging industry (2009-16)**

Clusters	HIE-HMS	Other UK funding	EU R&D funding	Total
Fishing and Fishing Products	£ 8,214,838	£ 1,334,393	£ 4,132,205	£ 13,681,436
Environmental Services	£ 1,067,849	£ 37,130	£ 234,817	£ 1,339,796
Metalworking Technology	£ 8,693,204	£ 100,000	£ -	£ 8,793,204
Forestry	£ 41,605	£ 9,986	£ -	£ 51,591
Upstream Chemical Products	£ 2,862,465	£ 1,520,893	£ -	£ 4,383,358
Agricultural Inputs and Services	£ 149,246	£ 49,488	£ -	£ 198,734
Electric Power Generation and Transmission	£ 3,913,808	£ 5,561,178	£ 14,286,270	£ 23,761,256
Nonmetal Mining	£ 406,019	£ -	£ -	£ 406,019
Hospitality and Tourism	£ 21,782,452	£ 456,664	£ -	£ 22,239,116
Education and Knowledge Creation	£ 2,912,147	£ 82,295		£ 2,994,442
Distribution and Electronic Commerce	£ 1,931,695	£ -	£ -	£ 1,931,695
Recreational and Small Electric Goods	£ 1,034,424	£ -	£ -	£ 1,034,424
Downstream Chemical Products	£ 699,359	£ 750,000	£ -	£ 1,449,359
Textile Manufacturing	£ 2,173,004	£ 9,950	£ -	£ 2,182,954
Total specialisation clusters	£ 55,882,115	£ 9,911,977	£ 18,653,292	£ 84,447,384
Total funding all SIC codes	£ 162,099,517	£ 23,941,122	£ 27,267,020	£ 213,307,659
Share of total funding	34.5%	41.4%	68.4%	39.6%
Emerging industries	HIE-HMS	Other UK funding	EU R&D funding	Total
<b>Blue Growth Industries</b>	£ 24,043,176	£ 1,354,376	£ 11,895,636	£ 37,293,188
Share of total funding	14.8%	5.7%	43.6%	17.5%
<b>Environmental Industries</b>	£ 20,250,735	£ 5,689,684	£ 22,284,518	£ 48,224,937
Share of total funding	12.5%	23.8%	81.7%	22.6%

Source: authors based on datasets

## 5. INTERNATIONAL LINKAGES OF HIGHLANDS AND ISLANDS GROWTH SECTORS AND SPECIALISATION CLUSTERS

### 5.1 Highlands and Islands exports by main sectors – an exploratory analysis

It was clear from interviews with HIE staff, that there was no disaggregated data on export performance of Highlands and Islands businesses. An initial survey had been conducted by HIE account managers to identify the broad sector in terms of main markets by country (or broad geographic area, e.g. "Scandinavia"). The study team made a request to the Scottish Government's business and enterprise statistics unit for regionalised data from the Export Statistics Scotland (ESS). However, the reply was that it is not possible to break the ESS data down for the Highlands and Islands area. In the future, the Scottish Government is seeking to obtain local level exported goods data from HMRC.

As available export statistics data at the level of the Highlands and Islands growth sectors and specialisation clusters are not readily available, we made use of several sources to arrive at an approximation of export activities. The Scottish Growth Sector statistics provide data on total exports by key sector and one rough way to estimate Highlands and Islands exports is to apportion exports using a key such as share of GVA of the Highlands and Islands region in the Scottish total (based on ONS regional GVA tables).

**Figure 43: Scottish Growth Sectors exports (2015) - hypothetical share for the Highlands and Islands**

£million	Exports to RUK		International exports	
	Scotland	H&I (8.3%)	Scotland	H&I (8.3%)
<b>Total</b>	49,835	4136	28,740	2385
<b>Food and Drink</b>	4,600	382	5,070	421
<b>Financial and Business Services</b>	10,170	844	2,585	215
<b>Life Sciences</b>	370	31	1,195	99
<b>Energy (including Renewables)</b>	10,810	897	5,105	424
<b>Sustainable Tourism (Tourism related Industries)</b>	555	46	320	27
<b>Creative Industries (including Digital)</b>	2,040	169	1,105	92
<b>Growth Sectors Total</b>	28,545	2369	15,380	1277

Source: Scottish Growth Sector Statistics (20 April 2017). Calculations H&I, authors.

However, this probably underestimates the Highlands and Islands performance for sectors in which the region has a higher share of output such as food and drink, energy or tourism. Based on the Scottish Annual Business Statistics, the food and drink sector accounts for 14.5% of Scottish GVA, similarly accommodation and food service activities account for 14.7% of the Scottish total.

A second source is a tool developed for the European Commission's Joint Research Centre which estimates regional trade flows based on a model that disaggregates national trade statistics at regional level<sup>21</sup>. The model identifies the top 10 main trading regions for each

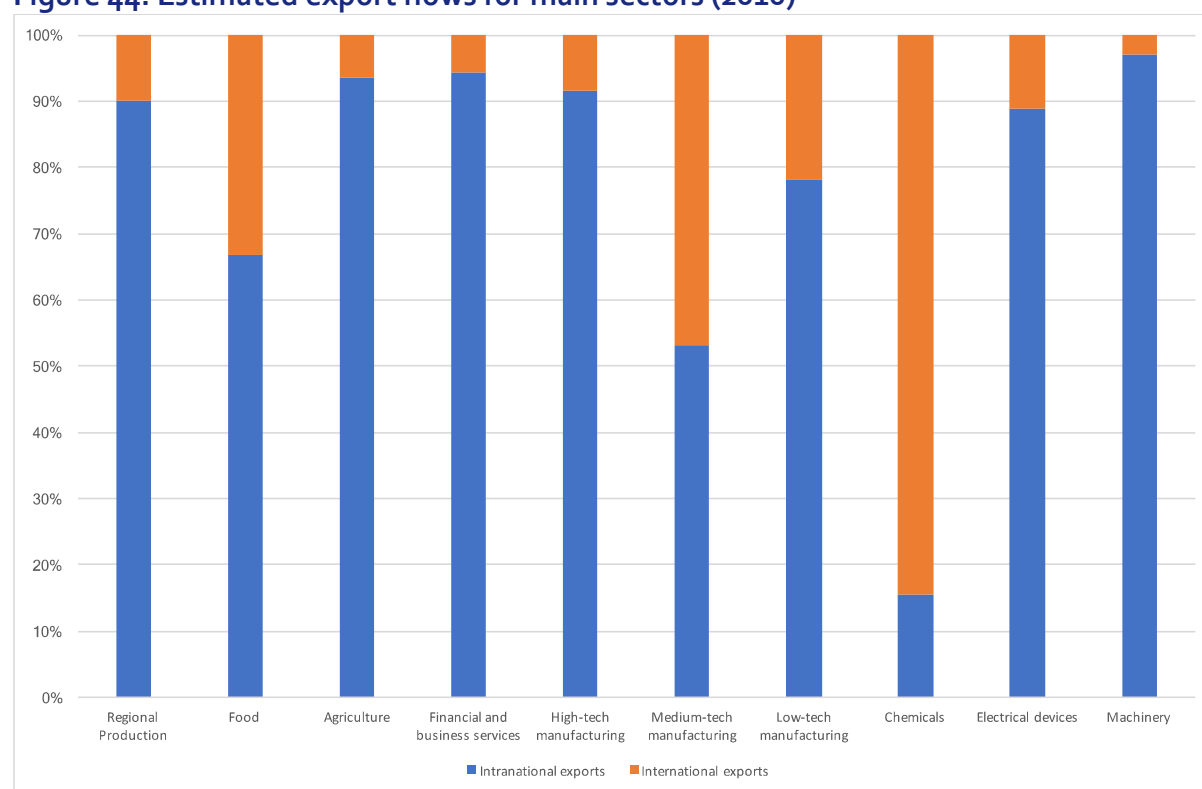
<sup>21</sup> See : <http://www.pbl.nl/en/publications/integration-and-convergence-in-regional-europe>



region and estimates export flows in 2010 both intra-national (within the UK in the case of the Highlands and Islands) and international. Figure 44 and Figure 45 summarise the data from the online tool at the JRC's S3 Platform website.

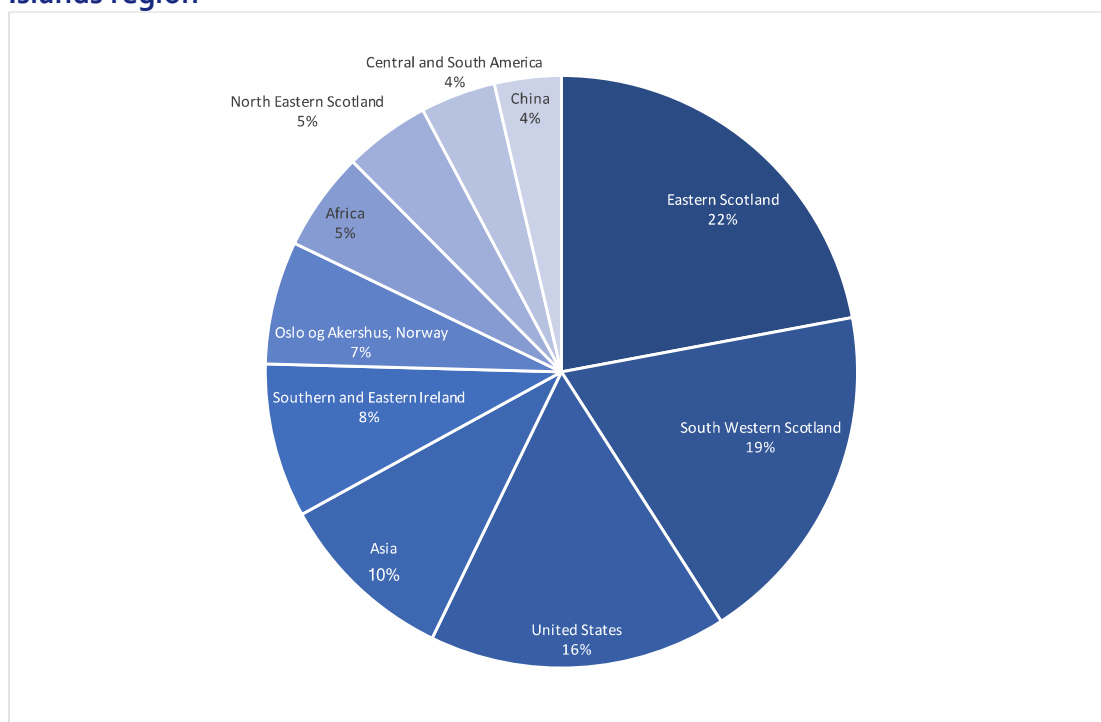
The relatively high share of food and drink, medium tech manufacturing and chemicals production being exported internationally appears consistent with other observations. The share of production going to other Scottish regions also appears consistent with likely internal exports of energy, forestry, food, intermediate products and goods. Overall, the JRC tool while providing an exploratory analysis is probably not a precise enough basis for analysing regional trade inter-linkages.

**Figure 44: Estimated export flows for main sectors (2010)**



Source: <http://s3platform.jrc.ec.europa.eu/s3-trade-tool/>; calculation authors

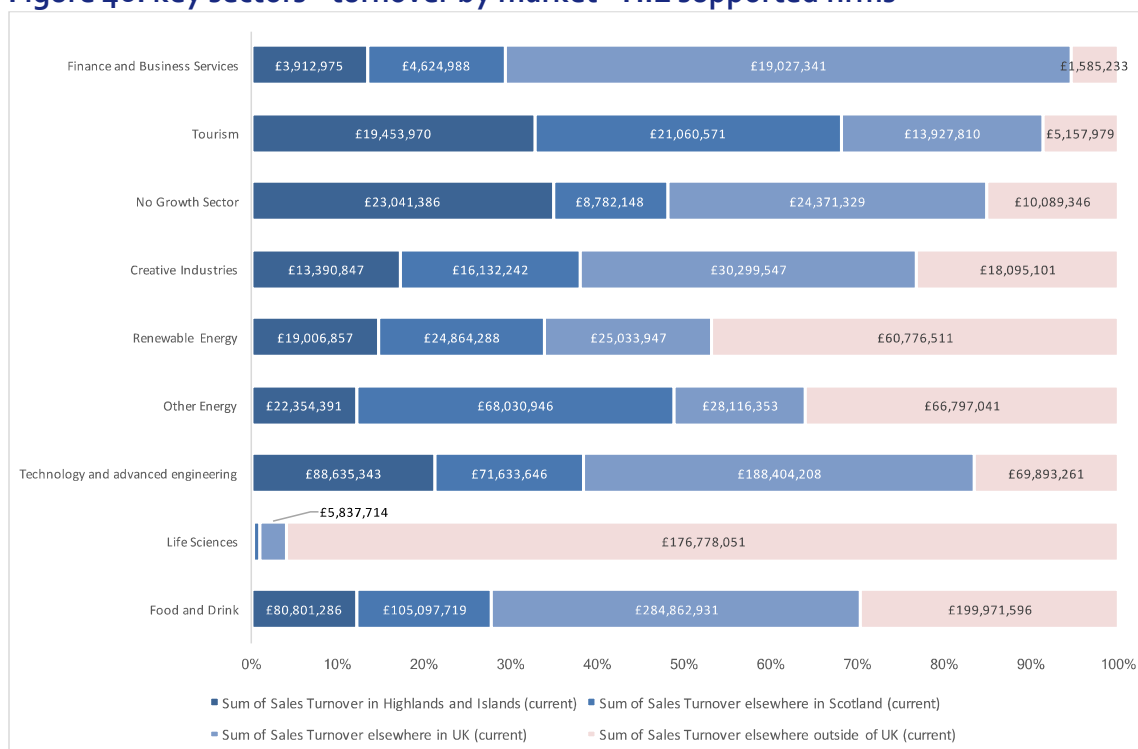
**Figure 45: Top 10 intra- and inter-national export destinations for the Highlands and Islands region**



Source: <http://s3platform.jrc.ec.europa.eu/s3-trade-tool>; calculation authors

A third source of data is the information gathered by HIE on supported firms derived from the HMS dataset. Figure 46 summarises the data available by key sector. As can be the most 'internationalised' sectors are life sciences, renewable energy, other energy, and food and drink.

**Figure 46: key sectors - turnover by market - HIE supported firms**



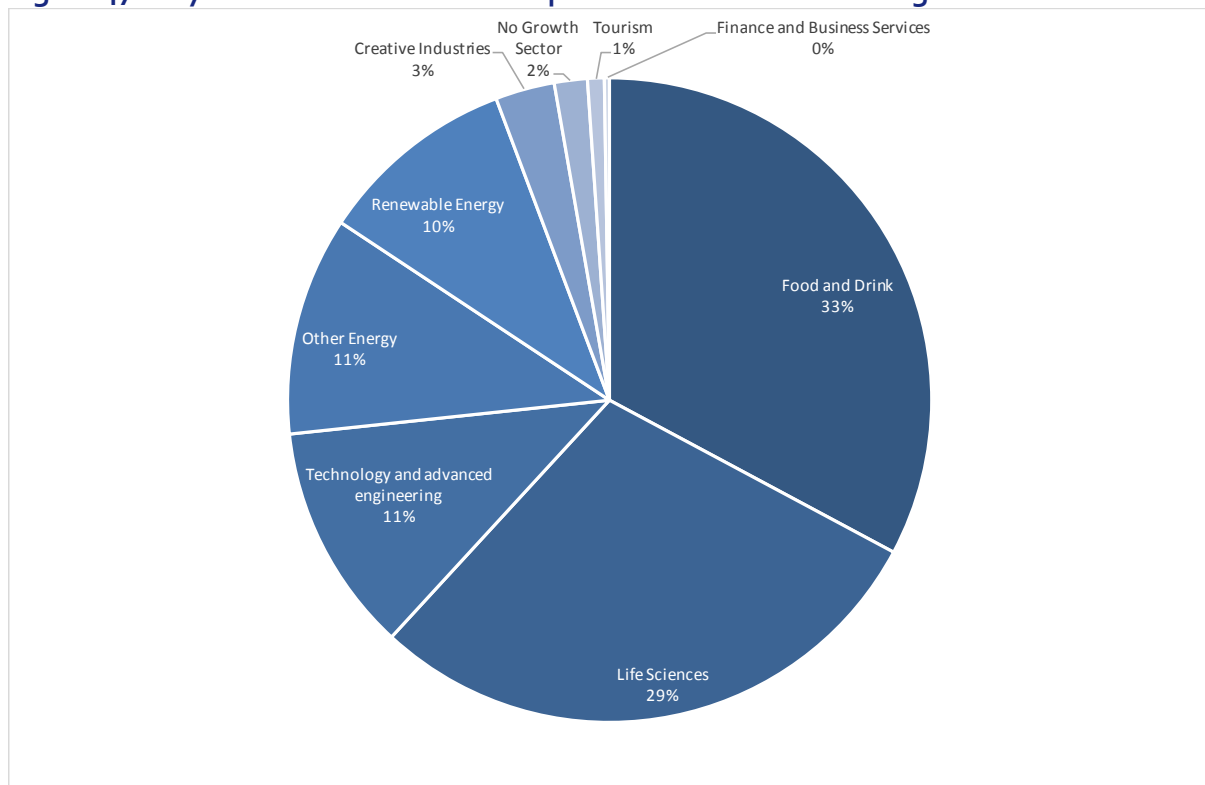
Source: HIE HMS database. Calculations authors.

In terms of the exported component of turnover, food and drink accounts for a third of the value captured in the dataset, followed by life sciences with 29% and then three other sectors with approximately 10-11% each (energy and technology and advanced engineering).

The same data broken down by SIC code suggests that food and drink exports are split roughly equally between fishing and food and drink manufacturing; while the single largest sector is medical, dental instruments and related supplies. The fourth largest SIC level sector is the manufacture of base metals and metal products – likely to capture part of the engineering sector in the region.

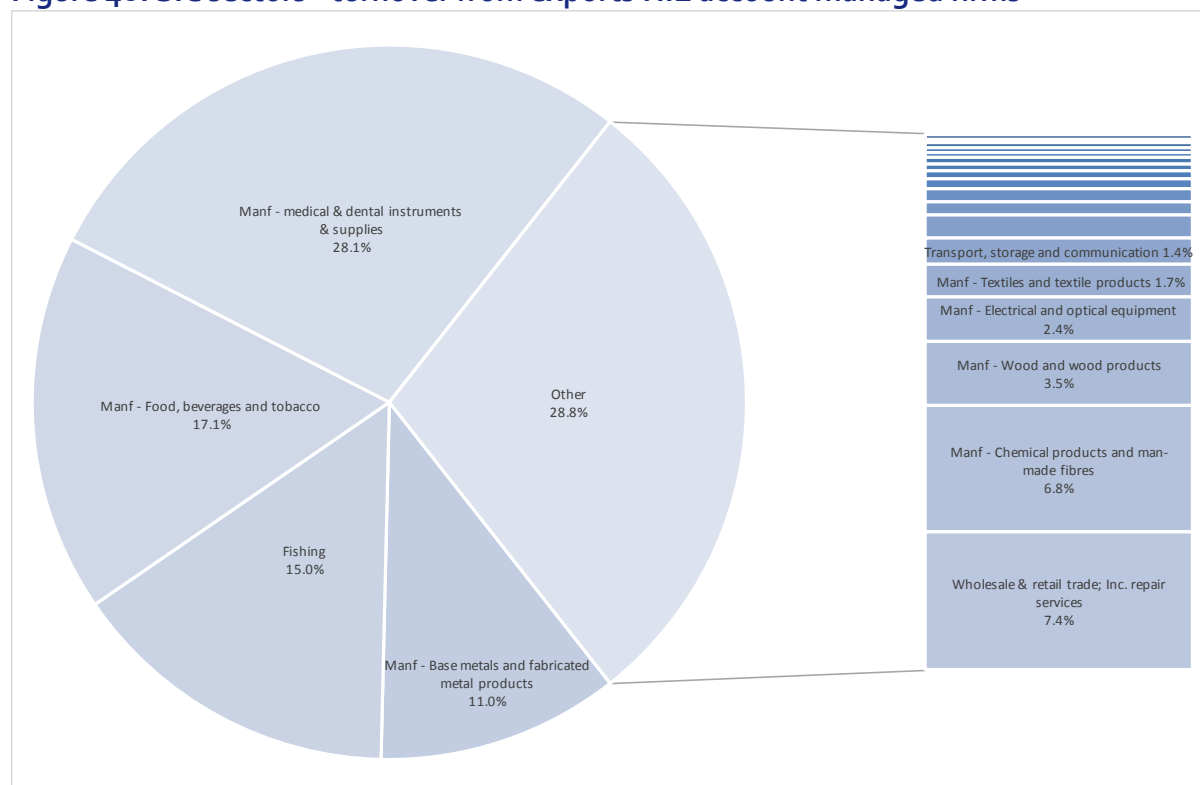
While this data should be treated with caution, as the HMS database does not systematically provide export data for all companies, it does provide an insight into the exporting trends of the main HIE client businesses.

**Figure 47: Key sectors turnover from exports of HIE account managed firms**



Source: HIE HMS database. Calculations authors.

**Figure 48: SIC sectors - turnover from exports HIE account managed firms**



Source: HIE HMS database. Calculations authors.

## 5.2 Highlands and Islands position in European research and innovation networks

In this section, we analyse the partnership network of organisations in the Highlands and Islands involved in the EU's research and innovation funding programmes: FP7 (2007-13) and H2020 (2014-20). In total 31 organisations received an EC contribution for a research or innovation project from 2007 to mid 2016, a total of €33.9m, of which four organisations secured 73% (or €24.6m): namely the Scottish Association for Marine Science (SAMS)<sup>22</sup>, Scotrenewables Tidal Power Limited<sup>23</sup>, Green Marine (UK) Ltd<sup>24</sup> and the University of the Highlands and Islands. Out of 56 FP7 and 15 H2020 projects awarded to organisations in the Highlands and Islands, a regional organisation coordinated 13 projects (six were led by SAMS). The table below summarises the participation by broad thematic field and underlines the dominant position of marine science and marine (tidal and wave) renewable energy, coherent with the activities of the four leading organisations. Other thematic fields are relatively marginal with food and digital health projects receiving some funding under FP7 and engineering and environmental projects winning support in Horizon 2020.

<sup>22</sup> <http://www.sams.ac.uk/sams-research>

<sup>23</sup> <http://www.scotrenewables.com/>

<sup>24</sup> <http://greenmarineuk.com/>

**Figure 49 : EU research & innovation programmes – EC contribution by field**

Field	FP7	% of total	H2020	% of total
Marine science	€ 7,209,903	39.0%	€ 2,348,965	15.2%
Energy	€ 5,863,272	31.7%	€ 12,105,704	78.4%
Aquaculture	€ 4,602,653	24.9%	€ 446,066	2.9%
Digital health	€ 486,741	2.6%	€ -	0.0%
Food	€ 318,987	1.7%	€ -	0.0%
Engineering	€ -	0.0%	€ 208,781	1.4%
Environment	€ -	0.0%	€ 300,278	1.9%
Business services	€ -	0.0%	€ 31,616	0.2%
<b>Total</b>	<b>€ 18,481,556</b>	<b>100.0%</b>	<b>€ 15,441,409</b>	<b>100.0%</b>

Source: e-corda database, calculations and classifications by authors

After only two years of Horizon 2020, regional organisations have already secured 83% of the funding awarded under FP7. This significant growth is due to funding for marine energy projects under Horizon 2020 compared to FP7. In contrast, funding for aquaculture projects is barely 10% of the FP7 total (this may be due to a lack of relevant calls under H2020).

Marine science projects essentially involve SAMS (plus three other organisations under FP7) and cover a range of projects from climate and arctic related research, marine ecosystem, blue mining, marine biofuels<sup>25</sup> to marine biotech. SAMS has also been involved in aquaculture and, to a limited extent, marine energy projects.

Under FP7, most funding for energy was awarded to the UHI for the MERIKA Marine Energy Research Innovation and Knowledge Accelerator) project<sup>26</sup>; while under Horizon 2020, three major projects received funding namely: CEFOW<sup>27</sup>, FloTEC<sup>28</sup> and BIG HIT<sup>29</sup>. These projects support organisations in the Orkney marine renewables cluster (Green Marine Ltd, European Marine Energy Centre, Scotrenewables Tidal Power Ltd and community partners in the Big Hit project).

In a second step, we ran a social network analysis to clarify where Highlands and Islands organisations are playing a nodal position in networks as well as mapping partners in other EU regions. Figure 50 shows the social network of the Highlands and Islands participation in FP7 projects. The nodes of the knowledge collaboration network (circles in the graph) are all participants in projects, and participants are linked with an edge (lines joining the circles) if they are partners in the same FP7 project. In blue are highlighted all participants from the Highlands and Islands. The size of the circles (nodes) is based on the *betweenness centrality* indicator. This indicator is widely used in Social network analyses to identify *knowledge hubs* in collaboration networks and it is highly informative as it reflects the number of shortest paths from all actors to all others that pass-through a given actor normalised by the total number of shortest paths in a network. In other words, the higher the number of shortest paths on which an actor appears, the higher its centrality in the network as it falls between all others to the greatest extent. The edges (lines) are also coloured depending on

<sup>25</sup> For instance : <http://www.macrofuels.eu/about-macrofuels>

<sup>26</sup> <https://www.uhi.ac.uk/en/merika> & [http://cordis.europa.eu/project/rcn/111362\\_en.html](http://cordis.europa.eu/project/rcn/111362_en.html)

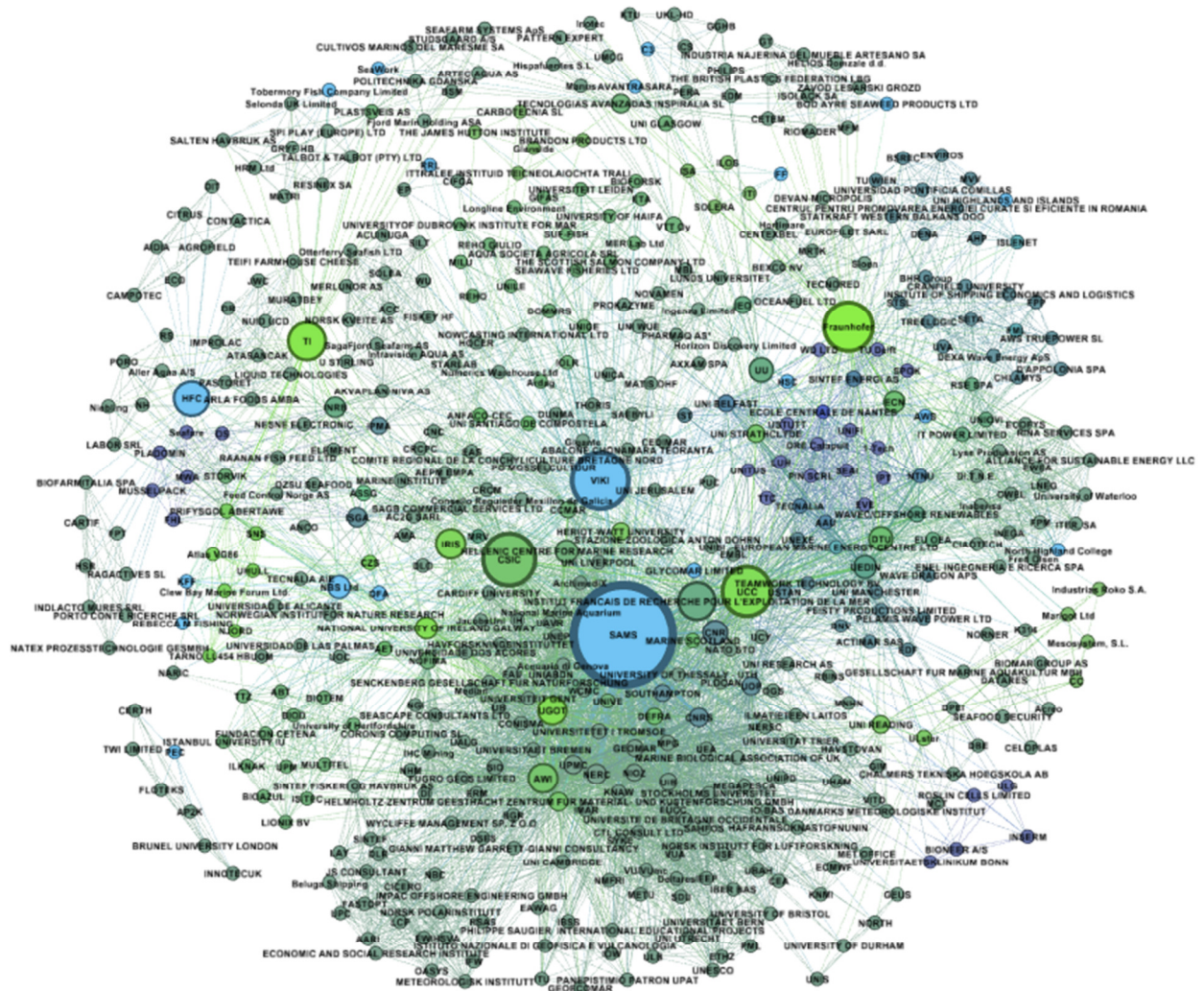
<sup>27</sup> [http://cordis.europa.eu/project/rcn/195136\\_en.html](http://cordis.europa.eu/project/rcn/195136_en.html)

<sup>28</sup> [http://cordis.europa.eu/project/rcn/199964\\_en.html](http://cordis.europa.eu/project/rcn/199964_en.html)

<sup>29</sup> [http://cordis.europa.eu/project/rcn/204424\\_en.html](http://cordis.europa.eu/project/rcn/204424_en.html)

who are direct 'neighbours' of each other (organisations that are structurally close to each other). All links coloured in blue represent the neighbourhood of Highlands and Islands participants, while the green links are the neighbours of all other (non- Highlands and Islands) participants.

**Figure 50 Network of Highlands and Islands partners in FP7 projects, 2007-13**



Source: authors, based on CORDA data

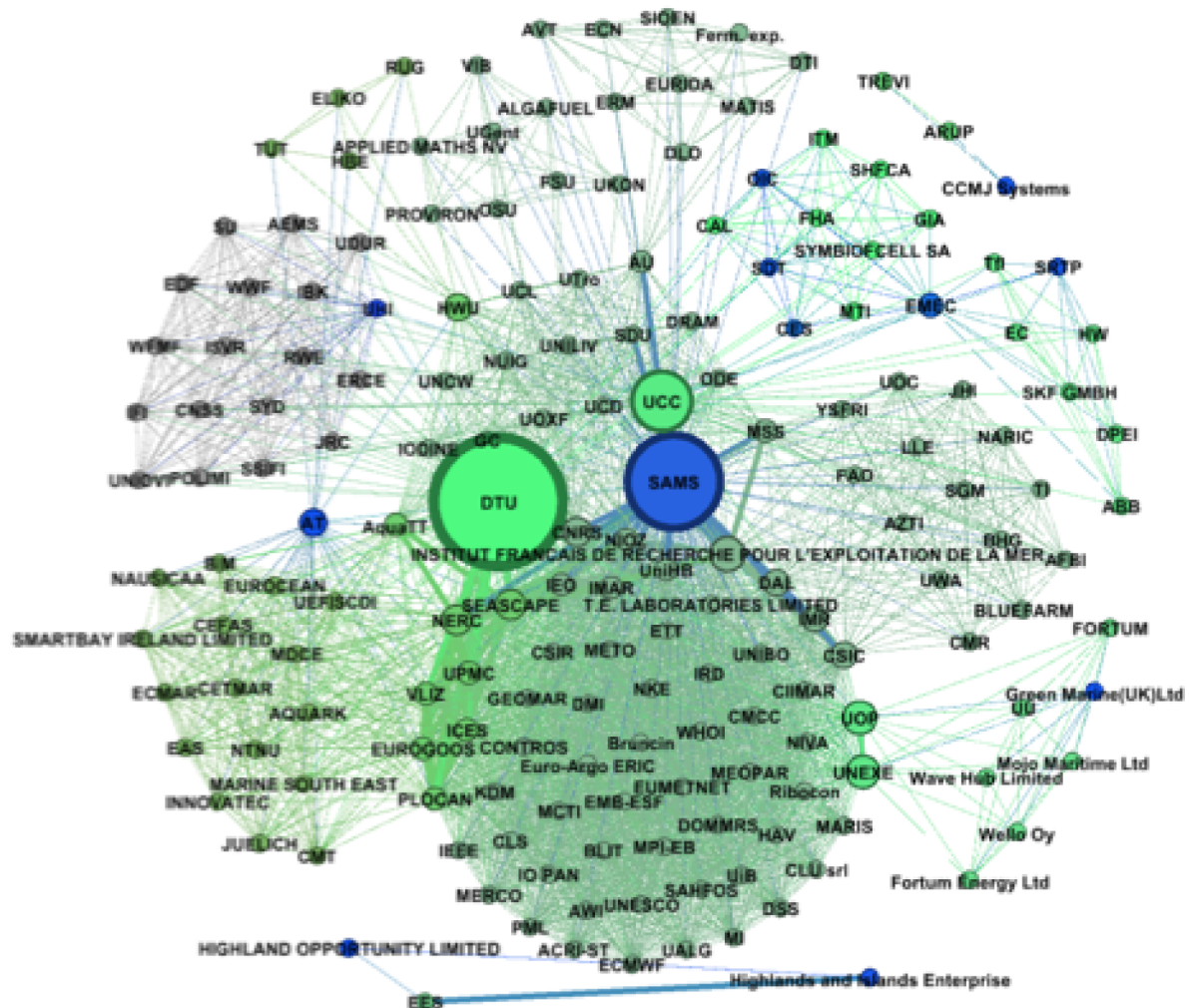
Of a total of 491 organisations in the network, 25 are from the Highlands and Islands. The top 5 most central organisations in the FP7 knowledge research network of the Highlands and Islands, based on the *betweenness centrality* indicator are:

1. The Scottish Association for Marine Science (SAMS) (H&I)
2. Viking Fish Farm Limited (H&I)
3. Consejo Superior de Investigaciones Científicas (CSIC) (ES)
4. Fraunhofer Gesellschaft (DE)
5. University College Cork (UCC) (IE)

The results suggest that the Highlands and Islands rely heavily on international connectivity and collaboration in European funded research.



Figure 51 Network of Highlands and Islands partners in H2020 projects, 2014-15



Source: authors, based on CORDA data

Figure 51 presents the social network of Highlands and Islands participation in H2020 projects during 2014-2015 - the Highlands and Islands participants in blue along with their European research partners in green. A total of 180 individual organisations are part of the research network, out of which 12 are from the Highlands and Islands. The most central actors acting as knowledge hubs in the research network are:

1. Danmarks Tekniske Universitet (DK)
2. The Scottish Association for Marine Science (SAMS) (H&I)
3. University College Cork (UCC) (IE)
4. Institut Français de Recherche pour l'exploitation de la Mer (FR)
5. Universities of Plymouth and Exeter (UK) (with the same centrality score)

Only UCC and SAMS are central actors in both the FP7 and H2020 networks. The importance of SAMS in leveraging EU research funds to the Highlands and Islands is incontestable.

## 6. FUTURE OPTIONS FOR HIGHLANDS AND ISLANDS CLUSTER POLICY

This study has explored the relative specialisation of the Highlands and Islands economy from several perspectives:

- Developing a comparative understanding of the composition and performance of the economy compared to the rest of the Scottish economy and selected European regions
- Identifying 'niche' in the economy that are growing faster or investing and innovating more intensively than average within the context of the 'growth sector' priorities
- Identifying business and research and innovation inter-linkages both within the region and with external partners (whether based in Scotland, the rest of the UK, the EU or further afield).

The study limitations are clearly that we worked from a mix of official statistics and grey/open datasets with varying degrees of 'granularity' (and 'missing/non-disclosed data') that can require qualitative or 'in-the-field' interpretation on occasions to make sense of the data results. For instance, we could not easily identify the pivotal companies that can help explain positioning or trends of all specialisation clusters (e.g. recreational and small electric goods).

Drawing policy conclusions and recommendations from the (data-driven) cluster mapping requires due caution. Indeed, the primary objective was not to produce a 'short-list' of clusters requiring policy intervention and the list of specialisation clusters should not be read as such. Our purpose was not, and is not, to advocate a policy intervention to create a "cluster organisation".

Indeed, it is only by crossing the different sources and contextualising the analysis that it makes sense to consider whether there are 'opportunities' in the Highlands and Islands economy for strengthening business-to-business cooperation. The development of a business cluster, defined as the geographic concentration of interdependent companies and their supporting institutions and organisations, requires entrepreneurial leadership rather than a top-down policy lead.

Within the Highlands and Islands region, there are currently no such cluster organisations. There are, however, elements in the current policy mix which are similar to cluster interventions related to the priority growth sectors (e.g. creative industries strategy and related actions such as the XpoNorth networks, aquaculture supply chain innovation project or the digital health care initiative, etc.).

Policy interventions to enhance 'clustering' may be more or less effective for different types of clusters (e.g. clusters with a larger number of smaller businesses versus a cluster with one or more major companies and their supply/value chain). Past studies on clusters in less populated places<sup>30</sup> also point to the broad diversity of supporting initiatives and forms that such 'clustering' may take (from a single lead company, from a developed set of skills in the region, as the result of a natural resource), hence there is not a 'one-size-fits' all model.

We adopt Rosenfeld's (2009) model of three classes of clusters to position clusters that emerge from the mapping exercise (see Figure 52). We have taken account of existing policy initiatives and strategies and we have reviewed sector road maps and other

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<sup>30</sup> See the Compendium of Clusters in Less Populated Places. Regional Technology Strategies (2009).



background studies. The proposed clusters are intended as a basis for further discussion by 'cluster stakeholders' and HIE management.

**Figure 52: 'strategic clusters' in the Highlands and Islands – a proposal**

Cluster category and selected clusters	Description and assessment
<b>Clusters of distinction</b>	<b><i>Quintessential clusters that both define and brand a local economy and particular place</i></b>
<b>Wave &amp; tidal energy</b>	Unique natural resource twinned with world-leading know-how and technology demonstration sites attracting significant UK and EU funds into region. The wave and tidal energy sector is already well structured in terms of sectoral associations, energy research and demonstration facilities and innovative funding mechanisms like WES. Geographically concentrated in the Orkney-Caithness area, the cluster may face challenges from the BREXIT outcome given the importance of EU funding and support to date.
<b>Aquaculture and marine products</b>	Significant scientific and business activities are concentrated in the region, although many firms are not locally owned. A number of strategic initiatives already in place but there is potential for stronger growth and to diversify production (e.g. seaweed cultivation and harvesting). The cluster benefits from the Scottish seafood brand internationally and Scottish wide initiatives such the SAIC. The cluster has also been a key recipient of EU funding and alternative funding sources may be required post-BREXIT.
<b>Engineering services for 'harsh environments'</b>	Building on the strong metalworking technology specialisation cluster, with notable interlinkages to offshore energy but also economy-wide applications. Clustering could help define the engineering skills needs of the region and brand and market the existing expertise in relevant international markets. Promoting joint demonstration, testing or consortia for larger projects may help scale up smaller engineering operations and increase R&D spend, etc.
<b>Clusters of competence</b>	<b><i>High concentration of companies, skills, and specialized support but lacking uniqueness and operating within a more diversified regional economy</i></b>
<b>Adventure tourism, including maritime</b>	The tourism sector is facing up to digitalisation and global market trends and seeking increase the value added it generates. Efforts to develop and structure 'adventure tourism' to exploit the natural environment of the region are underway. Initiatives such as North Coast 500 are helping to redefine the regional brand. In this respect, digital skills and specialised design and marketing expertise in the regional creative industry sector will need reinforced. The potential for increased maritime (e.g. yachts) tourism offers a cross-cluster linkage to a 'mini-cluster of boat-yards' and related engineering services that could foster the expansion of skilled and value-added services around the region.
<b>Premium food products</b>	Food and drink sector is critical for economy but there is a fragmented innovation effort with limited cross-sectoral linkages. This suggests a possible role for several larger firms to lead and structure larger and longer-term food innovation partnerships. There are clear cross-cluster linkages with (marine) bioscience but also tourism and hospitality businesses and creative industries (packaging design, digital marketing, etc.).
<b>Creative industries (textile and design)</b>	The Creative Industries sector in the H&I is diverse and HIE with regional partners has already put in place a Creative Industries Strategy for 2014-19 including a broad range of actions and initiatives (e.g. XpoNorth, creative industry networks for screen and broadcast, writing and publishing, craft fashion and textiles and music). The region has a traditional textile sector which is not homogenous in nature (ranging from traditional knitwear and tweed to more modern fabrics) and is geographically dispersed. Within the creative industries key sector, the textile and textile products sector has benefitted from over a third of total funding during the past 5 years. The cluster has also shown a trend towards being a relative specialisation of the region. Related (digital) design skills and know-how are located in the region and the recent development of the Creative Campus of Glasgow School of Art and a number of related projects to draw on and develop design skills.

Cluster category and selected clusters	Description and assessment
	Transforming and further increasing the added value that can be generated from textile and related designer goods based on the H&I culture and landscape is one possible focus for a future cluster initiative.
<b>Clusters of opportunity</b>	<b><i>Seeds of clusters of sufficient size and resources to portend growth, or declining clusters with the foresight and capacity to reinvent themselves</i></b>
<b>'Natural products'</b>	This cluster has been identified in past HIE strategy work and emerges clearly from the technological and scientific specialisation as well as being captured in the mapping data through companies in several of the specialisation clusters (upstream and downstream chemicals, environmental services, biotech under professional, scientific and technical activities, etc.). A challenge is that the significant investment into scientific activity on marine biosciences (SAMS, etc.) is not yet matched by the same scale of business growth. The cluster has a high potential for generating sustainable, high value-added jobs across the region. There are also clear linkages to the Scottish industrial biotechnology strategy.
<b>Forest-based industries</b>	The forestry sector is an important natural resource and the region has a range of companies operating in various related activities, including some larger and technology advanced companies in the wood processing chain. However, value added is lower than in other benchmark regions and more could be done to build cross-sectoral linkages with sustainable construction or natural products. A strategic initiative adopting a value chain perspective could help leverage the full economic value of the forest-based industries sector (including new bioenergy or industrial biotechnology products)
<b>Environmental services</b>	The region has a relatively important scientific output in environmental science and ecology and a growing environmental services sector. In addition, other relevant companies are captured under the SIC code for professional scientific and technical activities. Given global trends, the cluster is likely to be a source of growth in higher value-added niche but currently the companies active in this cluster are not well identified.
<b>Digital healthcare and devices clusters</b>	The technology profile of the region includes a significant concentration of know-how in medical technology, biotechnology, analysis of biological materials and related instruments. A range of public-private digital health initiatives are already being developed and the region hosts both a large international firm and a range of smaller tech-based firms. The potential for cluster growth is dependent on whether the smaller companies can 'scale-up' and grow internationally while retaining ownership locally.

## ANNEX 1: definition of clusters and emerging industries

Figure 53: Relationships between cluster categories and emerging industries

	Advanced Packaging	Biopharmaceuticals	Blue Growth Industries	Creative Industries	Digital Industries	Environmental Industries	Experience Industries	Logistical Services	Medical Devices	Mobility Technologies
Aerospace										100%
Agricultural						24%				
Appliances									80%	80%
Automotive	39%								5%	100%
Biopharmaceuticals		100%								
Business Services			21%	100%	25%	17%	26%	4%	1%	
Communications					100%			3%		
Construction	9%		5%			7%				3%
Distribution	1%	7%	12%		19%	3%	16%		7%	9%
Downstream Chemical		64%				23%				
Downstream Metal	53%		53%			53%			7%	53%
Education		19%	17%			19%				
Electric Power			100%			100%				
Environmental Services			61%			100%				
Fishing			100%							
Food Processing		2%								
Furniture	18%									
Hospitality and Tourism			7%				100%			
Information Technology					100%	29%	11%		81%	26%
Lighting and Electrical					42%				59%	82%
Marketing			33%	100%	20%		6%			
Medical Devices					87%				100%	
Metalworking	19%				19%				10%	57%
Music				100%						
Oil and Gas			27%			42%				
Paper and Packaging	100%	10%				10%				
Performing Arts							100%			
Plastics	70%				37%	47%				57%
Production Technology	12%		16%		25%	32%			38%	85%
Recreational Goods										8%
Transportation			73%			19%	14%	100%		
Upstream Chemical		77%				47%				
Upstream Metal						33%				53%
Video				100%						
Vulcanized Materials			24%			1%			6%	
Water Transportation			97%			20%	24%			
Wood Products						22%				

The numbers specify the share of each cluster category's employment involved in a given industry.

Source: Ketels and Protsiv, 2014

For the full set of definitions see the European Cluster Observatory Methodology and Findings Report for a Cluster Mapping of Related Sectors: <http://ec.europa.eu/DocsRoom/documents/16527/attachments/1/translations/en/renditions/pdf>

**Figure 54: Definition of specialisation clusters and emerging industries**

Label	Cluster name	NACE code	Industry Name
CC30-02	Agricultural Inputs and Services	01.61	Support activities for crop production
		01.62	Support activities for animal production
		01.63	Post-harvest crop activities
		01.64	Seed processing for propagation
		20.15	Manufacture of fertilisers and nitrogen compounds
CCXX-T03	Blue Growth Industries	03.12	Freshwater fishing
		09.10	Support activities for petroleum and natural gas extraction
		10.20	Processing and preserving of fish, crustaceans and molluscs
		22.19	Manufacture of other rubber products
		25.99	Manufacture of other fabricated metal products n.e.c.
		28.11	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
		28.22	Manufacture of lifting and handling equipment
		30.11	Building of ships and floating structures
		30.12	Building of pleasure and sporting boats
		33.15	Repair and maintenance of ships and boats
		35.11	Production of electricity
		35.12	Transmission of electricity
		36.00	Water collection, treatment and supply
		42.91	Construction of water projects
		46.14	Agents involved in the sale of machinery, industrial equipment, ships and aircraft
		49.41	Freight transport by road
		50.10	Sea and coastal passenger water transport
		50.20	Sea and coastal freight water transport
		50.30	Inland passenger water transport
		50.40	Inland freight water transport
		52.10	Warehousing and storage
		52.22	Service activities incidental to water transportation
		52.23	Service activities incidental to air transportation
		52.24	Cargo handling
		52.29	Other transportation support activities
		71.12	Engineering activities and related technical consultancy
		71.20	Technical testing and analysis
		72.19	Other research and experimental development on natural sciences and engineering
		73.11	Advertising agencies
		77.32	Renting and leasing of construction and civil engineering machinery and equipment
		77.34	Renting and leasing of water transport equipment
		79.11	Travel agency activities
CC30-10	Distribution and Electronic Commerce	46.11	Agents involved in the sale of agricultural raw materials, live animals, textile raw materials and semi-finished goods
		46.12	Agents involved in the sale of fuels, ores, metals and industrial chemicals
		46.13	Agents involved in the sale of timber and building materials
		46.14	Agents involved in the sale of machinery, industrial equipment, ships and aircraft
		46.15	Agents involved in the sale of furniture, household goods, hardware and ironmongery
		46.16	Agents involved in the sale of textiles, clothing, fur, footwear and

Label	Cluster name	NACE code	Industry Name
			leather goods
		46.17	Agents involved in the sale of food, beverages and tobacco-
		46.18	Agents specialised in the sale of other particular products
		46.19	Agents involved in the sale of a variety of goods
		46.21	Wholesale of grain, unmanufactured tobacco, seeds and animal feeds
		46.22	Wholesale of flowers and plants
		46.23	Wholesale of live animals
		46.24	Wholesale of hides, skins and leather
		46.31	Wholesale of fruit and vegetables
		46.32	Wholesale of meat and meat products
		46.34	Wholesale of beverages
		46.35	Wholesale of tobacco products
		46.38	Wholesale of other food, including fish, crustaceans and molluscs
		46.41	Wholesale of textiles
		46.42	Wholesale of clothing and footwear
		46.43	Wholesale of electrical household appliances
		46.44	Wholesale of china and glassware and cleaning materials
		46.45	Wholesale of perfume and cosmetics
		46.46	Wholesale of pharmaceutical goods
		46.47	Wholesale of furniture, carpets and lighting equipment
		46.48	Wholesale of watches and jewellery
		46.49	Wholesale of other household goods
		46.51	Wholesale of computers, computer peripheral equipment and software
		46.52	Wholesale of electronic and telecommunications equipment and parts
		46.61	Wholesale of agricultural machinery, equipment and sup- plies
		46.62	Wholesale of machine tools
		46.63	Wholesale of mining, construction and civil engineering machinery
		46.64	Wholesale of machinery for the textile industry and of sewing and knitting machines
		46.65	Wholesale of office furniture
		46.66	Wholesale of other office machinery and equipment
		46.69	Wholesale of other machinery and equipment
		46.71	Wholesale of solid, liquid and gaseous fuels and related products
		46.72	Wholesale of metals and metal ores
		46.76	Wholesale of other intermediate products
		47.91	Retail sale via mail order houses or via Internet
		52.10	Warehousing and storage
		77.31	Renting and leasing of agricultural machinery and equipment
		77.32	Renting and leasing of construction and civil engineering machinery and equipment
		77.33	Renting and leasing of office machinery and equipment (including computers)
		77.34	Renting and leasing of water transport equipment
		77.35	Renting and leasing of air transport equipment
		77.39	Renting and leasing of other machinery, equipment and tangible goods n.e.c.
		82.92	Packaging activities
CC30-11	Downstream Chemical Products	20.12	Manufacture of dyes and pigments
		20.30	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
		20.41	Manufacture of soap and detergents, cleaning and polishing preparations

Label	Cluster name	NACE code	Industry Name
		20.42	Manufacture of perfumes and toilet preparations
		20.51	Manufacture of explosives
		20.52	Manufacture of glues
		20.53	Manufacture of essential oils
		20.59	Manufacture of other chemical products n.e.c.
CC30-13	Education and Knowledge Creation	72.11	Research and experimental development on biotechnology
		72.19	Other research and experimental development on natural sciences and engineering
		72.20	Research and experimental development on social sciences and humanities
		85.41	Post-secondary non-tertiary education
		85.42	Tertiary education
		85.52	Cultural education
		85.59	Other education n.e.c.
		85.60	Educational support activities
		94.12	Activities of professional membership organisations
CC30-14	Electric Power Generation and Transmission	35.11	Production of electricity
		35.12	Transmission of electricity
CCXX-T05	Environmental Industries	06.20	Extraction of natural gas
		09.10	Support activities for petroleum and natural gas extraction
		16.21	Manufacture of veneer sheets and wood-based panels
		16.29	Manufacture of other products of wood manufacture of articles of cork, straw and plaiting materials
		17.22	Manufacture of household and sanitary goods and of toilet requisites
		20.14	Manufacture of other organic basic chemicals
		20.15	Manufacture of fertilisers and nitrogen compounds
		20.16	Manufacture of plastics in primary forms
		20.59	Manufacture of other chemical products n.e.c.
		22.29	Manufacture of other plastic products
		23.49	Manufacture of other ceramic products
		23.51	Manufacture of cement
		24.10	Manufacture of basic iron and steel and of ferro-alloys
		25.21	Manufacture of central heating radiators and boilers
		25.30	Manufacture of steam generators, except central heating hot water boilers
		25.99	Manufacture of other fabricated metal products n.e.c.
		26.51	Manufacture of instruments and appliances for measuring, testing and navigation
		28.11	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
		28.29	Manufacture of other general-purpose machinery n.e.c.
		28.99	Manufacture of other special-purpose machinery n.e.c.
		35.11	Production of electricity
		35.12	Transmission of electricity
		36.00	Water collection, treatment and supply
		38.12	Collection of hazardous waste
		38.22	Treatment and disposal of hazardous waste
		38.31	Dismantling of wrecks
		38.32	Recovery of sorted materials
		46.21	Wholesale of grain, unmanufactured tobacco, seeds and animal feeds
		46.22	Wholesale of flowers and plants
		49.50	Transport via pipeline

Label	Cluster name	NACE code	Industry Name
		52.22	Service activities incidental to water transportation
		52.29	Other transportation support activities
		71.12	Engineering activities and related technical consultancy
		72.11	Research and experimental development on biotechnology
		72.19	Other research and experimental development on natural sciences and engineering
CC30-15	Environmental Services	36.00	Water collection, treatment and supply
		38.12	Collection of hazardous waste
		38.22	Treatment and disposal of hazardous waste
		38.32	Recovery of sorted materials
CC30-17	Fishing and Fishing Products	03.11	Marine fishing
		03.12	Freshwater fishing
		10.20	Processing and preserving of fish, crustaceans and molluscs
CC30-20	Forestry	02.10	Silviculture and other forestry activities
		02.20	Logging
		02.30	Gathering of wild growing non-wood products
		02.40	Support services to forestry
CC30-22	Hospitality and Tourism	01.70	Hunting, trapping and related service activities
		55.10	Hotels and similar accommodation
		55.20	Holiday and other short-stay accommodation
		55.30	Camping grounds, recreational vehicle parks and trailer parks
		55.90	Other accommodation
		77.21	Renting and leasing of recreational and sports goods
		79.11	Travel agency activities
		79.12	Tour operator activities
		79.90	Other reservation service and related activities
		91.02	Museums activities
		91.03	Operation of historical sites and buildings and similar visitor attractions
		91.04	Botanical and zoological gardens and nature reserves activities
		92.00	Gambling and betting activities
		93.11	Operation of sports facilities
		93.12	Activities of sport clubs
		93.19	Other sports activities
		93.21	Activities of amusement parks and theme parks
		93.29	Other amusement and recreation activities
CC30-32	Metalworking Technology	23.91	Production of abrasive products
		25.11	Manufacture of metal structures and parts of structures
		25.12	Manufacture of doors and windows of metal
		25.61	Treatment and coating of metals
		25.62	Machining
		25.73	Manufacture of tools
		25.94	Manufacture of fasteners and screw machine products
		28.41	Manufacture of metal forming machinery
		28.91	Manufacture of machinery for metallurgy
CC30-34	Nonmetal Mining	08.11	Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate
		08.12	Operation of gravel and sand pits mining of clays and kaolin
		08.91	Mining of chemical and fertiliser minerals
		08.92	Extraction of peat
		08.93	Extraction of salt



Label	Cluster name	NACE code	Industry Name
		08.99	Other mining and quarrying n.e.c.
CC30-41	Recreational and Small Electric Goods	28.23	Manufacture of office machinery and equipment (except computers and peripheral equipment)
		30.91	Manufacture of motorcycles
		30.92	Manufacture of bicycles and invalid carriages
		32.20	Manufacture of musical instruments
		32.30	Manufacture of sports goods
		32.40	Manufacture of games and toys
		32.91	Manufacture of brooms and brushes
		32.99	Other manufacturing n.e.c.
CC30-42	Textile Manufacturing	13.10	Preparation and spinning of textile fibres
		13.20	Weaving of textiles
		13.30	Finishing of textiles
		13.91	Manufacture of knitted and crocheted fabrics
		13.92	Manufacture of made-up textile articles, except apparel
		13.93	Manufacture of carpets and rugs
		13.94	Manufacture of cordage, rope, twine and netting
		13.95	Manufacture of non-wovens and articles made from non-wovens, except apparel
		13.96	Manufacture of other technical and industrial textiles
		13.99	Manufacture of other textiles n.e.c.
		14.31	Manufacture of knitted and crocheted hosiery
		14.39	Manufacture of other knitted and crocheted apparel
		20.60	Manufacture of man-made fibres
CC30-46	Upstream Chemical Products	20.11	Manufacture of industrial gases
		20.13	Manufacture of other inorganic basic chemicals
		20.14	Manufacture of other organic basic chemicals
		20.17	Manufacture of synthetic rubber in primary forms
		20.20	Manufacture of pesticides and other agrochemical products