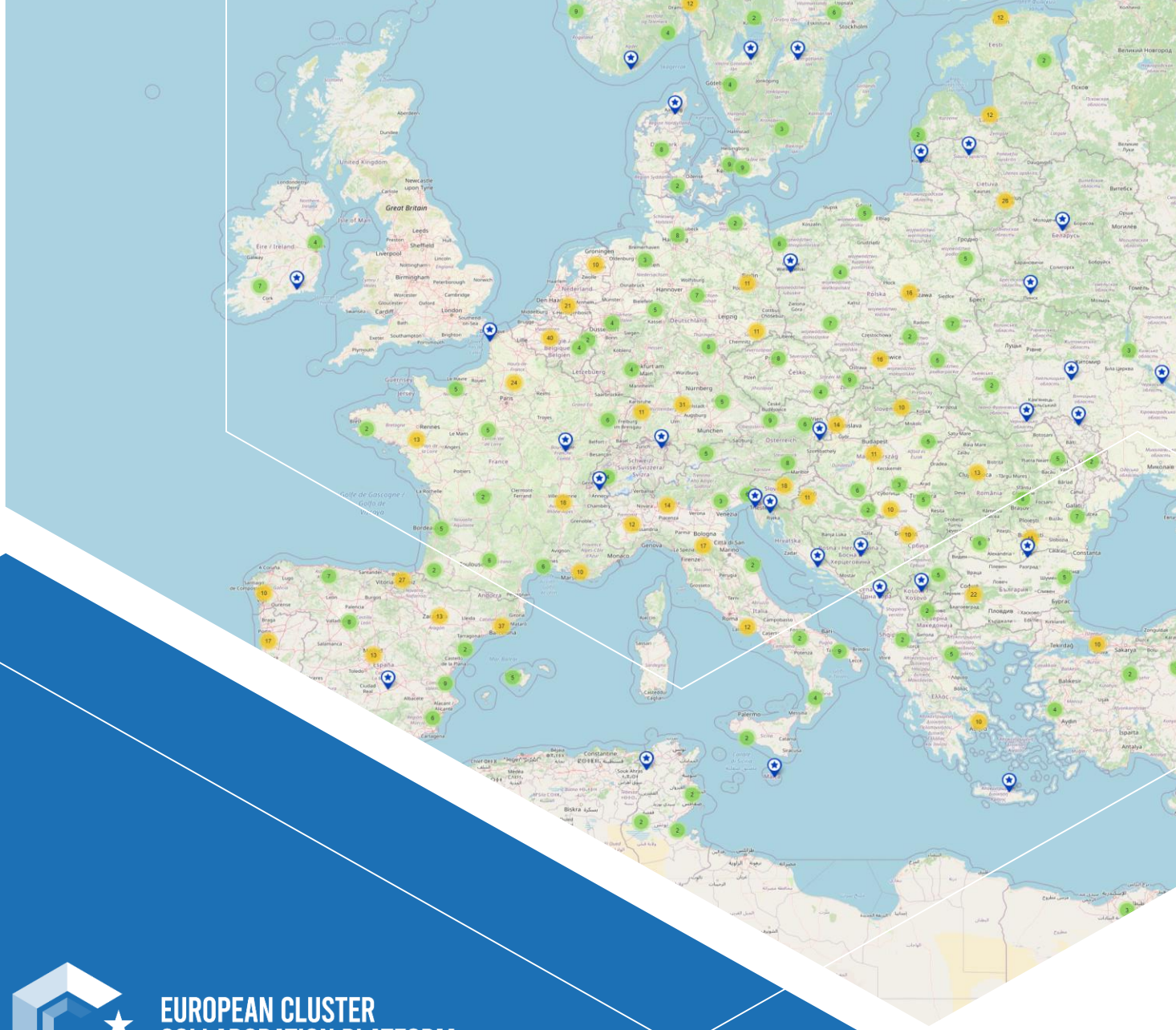

EUROPEAN CLUSTER COLLABORATION PLATFORM

European Cluster Panorama 2021

Leveraging clusters for resilient, green and digital regional economies

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as part of the **European Cluster Collaboration Platform** (ECCP) service contract.

The European Cluster Collaboration Platform (ECCP) is the European hub for industry clusters. It contains data on the characteristics of 8 different types of cluster actors that are currently able to profile themselves on the platform, alongside statistical data on sectors and industrial ecosystems for 201 regions.

Explore the ECCP at: https://clustercollaboration.eu/
Mapping tool: https://reporting.clustercollaboration.eu/
Policy toolkit: https://clustercollaboration.eu/policytoolkit

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European Cluster Panorama 2021

Leveraging clusters for resilient, green and digital regional economies

 The ECCP is run by a consortium of Ecorys (lead partner), Orkestra, SPI and VVA. This report was developed by Susana Franco (Orkestra), Asier Murciego (Orkestra), Juan Pablo Salado (Orkestra), Eduardo Sisti (Orkestra), and James Wilson (Orkestra).

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Strengthening the European economy through collaboration

Executive Summary

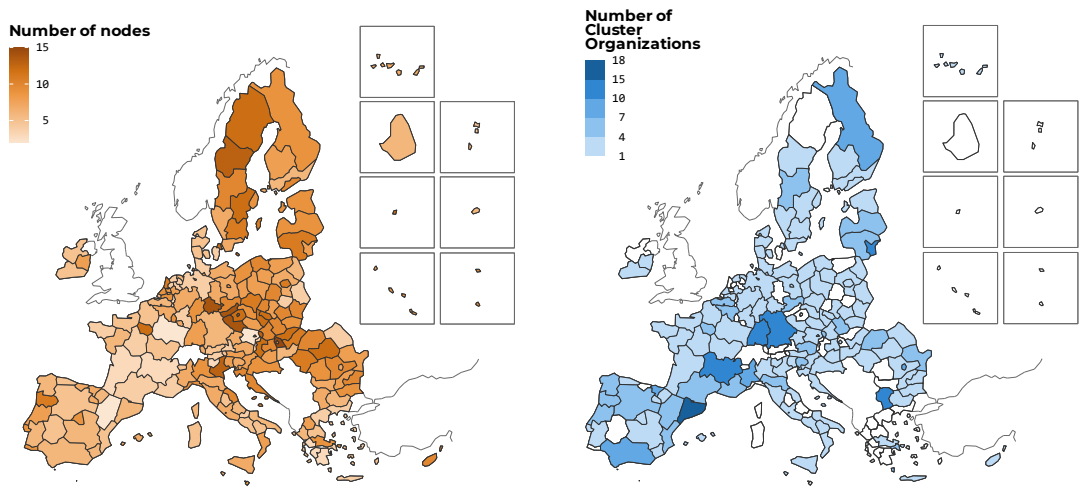
The COVID-19 pandemic has shone a spotlight on the roles that clusters are playing in fostering regional resilience. In the immediate response to the pandemic, they have provided a vital collaborative bridge between business and policy makers in regions across Europe. This has helped cope with supply chain disruptions and develop new production capacities such as in the manufacturing of Personal Protective Equipment (PPE). Moreover, regional cluster dynamics have been amplified at EU level by leveraging the European Cluster Collaboration Platform (ECCP) and European Cluster Alliance (ECA), for example organising matchmaking events on vaccine production and regular meetings to share strategic intelligence for example on microelectronics, raw materials or wood.

Building a robust recovery from the crisis will require sophisticated collaboration across the triple helix of business, research and government, both within and between clusters. The focus of this *European Cluster Panorama* report is the presence of clusters in Europe and the roles they play in fostering resilient, green and digital industrial ecosystems. It is based on comprehensive new data that can be navigated through the ECCP's mapping tool.[1] A key novelty is that it brings together, for the first time, statistical data on the regional clustering of economic activity in 88 standard sectors from Eurostat and 14 industrial ecosystems as indicated in the updating of EU industrial strategy,[2] with detailed data on the presence and key characteristics of cluster organisations.

Clustering is a key feature of the European economy

Across 201 EU-27 regions, there are 1501 sector specialisation nodes with a share of at least 1% of regional employment, and these account for almost 25% of total EU-27 employment. There are also over 1000 cluster organisations in the EU-27, whose membership on average is made up of 70% SMEs, 10% large firms and 8% research organisations.

Distribution of region-relevant sector specialisation nodes and cluster organisations in EU-27

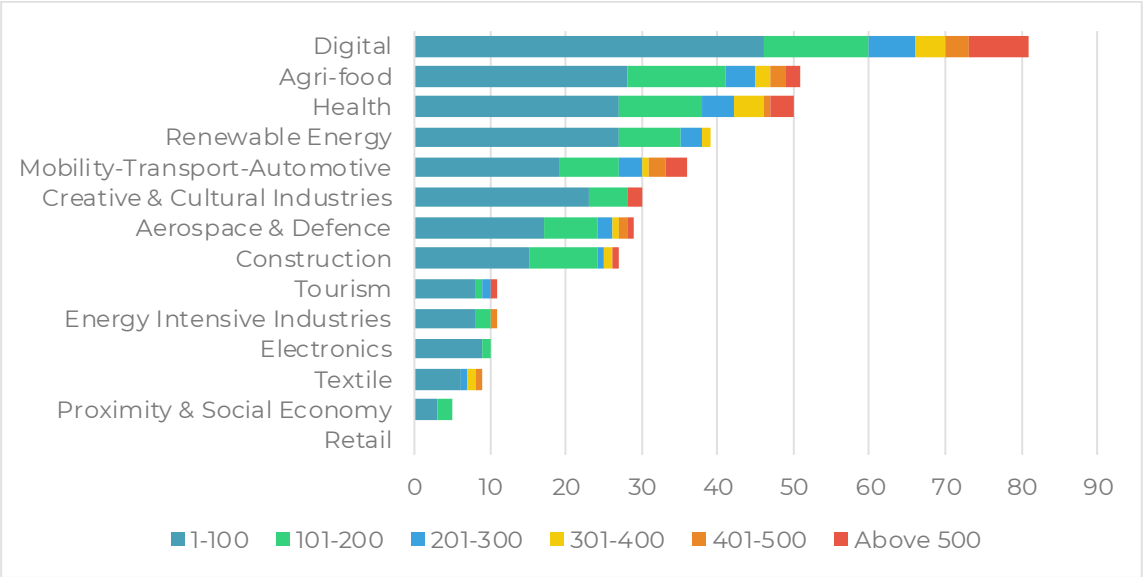


Source: Based on data from Eurostat and national statistics offices and ECCP profile data (sample of 468 cluster organisations with updated profiles on 29/11/2021).

[1] See: https://reporting.clustercollaboration.eu/.
[2] See: https://ec.europa.eu/commission/presscorner/detail/en/IP_21_1884

Both sector specialisation nodes and cluster organisations are heavily concentrated in traded activities and especially in manufacturing industry. EU-27 cluster organisations are mostly active in the Digital, Agri-food, Health, Renewable Energy and Mobility/Transport/Automotive industrial ecosystems. They provide a wide range of services, above all related to the core transversal function of facilitating collaboration between members. They support research, development and innovation, matchmaking, access to funding, internationalisation, communication, access to the European internal market, location branding and IPR management. Cluster organisations are also largely professionalised, with a high proportion (68%) having some form of quality label.

EU-27 cluster organisations by industrial ecosystem (and size profile)



Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

Clusters are supporting resilience, green and digital transition

The presence of clusters in regions is correlated with stronger innovation behaviour, economic performance and employment outcomes. This is consistent with the rationale for cluster policy – and with the primary focus of cluster organisations – to enhance firm-level innovation and competitiveness, boosting resilience.

Over 80% of EU-27 cluster organisations support companies in digital transition and over 60% in green transition, highlighting the transversal nature of greening and digitalisation across all sectors and industrial ecosystems. This is reflected in the services provided by cluster organisations, their collaboration interests and the S3 priority areas and technology fields in which they are working.

A new typology of regions based on their specialisation in industrial ecosystems provides further evidence of the transversal role of cluster organisations in digital transition. Cluster organisations that associate themselves with the Digital ecosystem are strongly present in almost all types of regions, emphasising strong awareness of the opportunities from digital transition across the full spectrum of regions and ecosystems.

Regarding green transition, while analysis reveals challenges in achieving both strong economic outcomes and environmental performance, it also highlights awareness of the roles that cluster

organisations can play in achieving green transition by driving forward learning and change among their members.

In this context, clusters provide a unique collaborate bridge with European SMEs, and a key policy challenge is to capitalise further on the collaborative power of Europe's wide array of cluster organisations. This is a message not only for 'cluster policy makers' that are used to working with cluster organisations, but also for cluster managers and a much broader spectrum of policy makers and business support organisations working in the domains of innovation, skills, environment, etc. that are critical for ongoing resilience and transition. An ECCP cluster policy toolkit has been launched to support this challenge by helping to identify inspiring and relevant policy experiences.[3]

[3] See: https://clustercollaboration.eu/in-focus/policy-acceleration/policy-toolkit

01

Introduction

1. Introduction

Industrial clusters are groups of firms, related economic actors, and institutions that are located near each other and have reached a sufficient scale to develop specialised expertise, services, resources, suppliers, and skills.[4] They are the building blocks of national and regional economies and thus a key focal point for economic development policies.

The geographical clustering of economic activities occurs due to a series of competitiveness advantages deriving from proximity that were first identified by Alfred Marshall in what he labelled 'industrial districts', and around a hundred years later were conceptualised as 'clusters' by Michael Porter.[5] Over the last thirty years support for clusters has become a pillar of most national and regional competitiveness policies, and cluster organisations are active today in almost all European regions. They play key intermediary roles that link together SMEs, research organisations, training providers, policy makers and other relevant organisations around the challenges and opportunities faced by specific sectors, value chains and other configurations of economic activities.

Over the last two years, the COVID-19 pandemic has shone a spotlight on the roles that clusters, and cluster organisations, are playing in fostering regional resilience. In the immediate response to the pandemic, they have provided a vital collaborative bridge between business, in particular SMEs, and policy makers in regions across Europe. This has helped cope with supply chain disruptions and develop new production capacities, for example in the manufacturing of Personal Protective Equipment (PPE). Moreover, these dynamics have been amplified by the European Commission's leveraging of the European Cluster Collaboration Platform (ECCP), for example hosting a COVID-19 forum and organising match-making events on vaccine production,[6] and by the regular morning discussions of the *European Alliance Against Coronavirus*, organised by the European Cluster Alliance (ECA).[7] In the longer term, building a resilient recovery from the crisis requires awareness of and response to the underlying dynamics of industrial transition, which are well-captured in the collaborative dynamics within clusters.

While the pandemic itself is having asymmetric effects across different clusters and industrial ecosystems, there are longer-term sources of industrial transition that interact with the policy responses to the pandemic. In particular, the dual digital and green transitions are widely recognised to be the key drivers of current and future industrial change, as reflected in their identification as the two key levers of the *Updated Industrial Strategy*, in the framework of the *New Green Deal*.[8] To these drivers we can add the growing concern with economic and social resilience, both in the explicit context of disruptions caused by the COVID-19 pandemic and in the more general context of challenges to the multilateral international system highlighted in the 2021 *Strategic Foresight Report*.[9]

As a key focal point for place-based and activity-specific collaboration, cluster organisations and cluster policies play a catalytic role in shaping industrial transitions and building resilience. This has been clearly recognised in the adoption by the *European Expert Group on Clusters* of a set of 15 recommendations for how the activities of clusters should be refocused to lead the green transition,

[4] See: https://clustercollaboration.eu/cluster-definitions.
[5] See: Marshall (1890); Porter (1990).
[6] See: https://clustercollaboration.eu/content/covid-19-vaccines-upscale-production-matchmaking-event.
[7] See: https://clustersalliance.eu/events/eaac-morning-discussions/.
[8] See: European Commission (2019, 2021a).
[9] See: European Commission (2021b).

accelerate the digital transition, and build resilience.[10] Putting these recommendations into practice effectively will require reliable strategic information on the panorama of clusters in Europe: Where are clusters and cluster organisations located? How are they evolving? How are they linked to the digital and green transitions, and to different dimensions of regional economic performance?

The ECCP brings together detailed mapping of cluster organisations and other key actors in the cluster community with statistical mapping that has until recently been provided by the European Observatory of Clusters and Industrial Change (EOCIC). An interactive mapping tool enables users to explore statistical data and cluster actor profiles across 201 European regions, 88 sectors and 14 industrial ecosystems.[11] As such, it provides a unique and dynamic hub for strategic intelligence and analysis on clusters and cluster policy, from which this 2021 edition of the *European Cluster Panorama* report provides a snapshot.

Statistical cluster mapping: Antecedents

Early research on clusters in the 1990s focused on case studies such as Silicon Valley or London's finance hub, and quantitative studies based on *ad hoc* cluster definitions and usually limited to specific sectors or locations began to emerge later. In 2003, Michael Porter developed a harmonised approach that sought to facilitate comparable statistical mapping of clusters by developing non-overlapping cluster categories based on co-location patterns in economic activity. This approach was used for the launch of the *European Cluster Observatory* in 2007, and was later refined to establish the 51 cluster categories that have been used over recent years to classify cluster organisations on the ECCP and as the basis for the development of previous *European Cluster Panorama* reports.[12] Additionally, the 2014 European Cluster Panorama introduced 10 categories of overlapping *emerging industries*, aiming to capture the areas where cross-sectoral linkages were most likely to materialise.[13]

As with most statistical analyses of socioeconomic phenomena, the cluster-mapping scenario in Europe has been shaped by the combination of interest in understanding different elements of the performance of clusters and the data possibilities for doing so. In this regard, while the methodologies employed to date have provided an increasingly nuanced picture of the European cluster landscape, they also have some well-acknowledged shortcomings related to the activity boundaries of clusters, the regional boundaries of clusters and the mixing of indicators that reflect cluster presence with those that reflect cluster strength. Cluster boundaries are changing fast because of green and digital industrial transitions, and new policy priorities have emerged reflecting the importance of resilient industrial ecosystems post-COVID. These also highlight the relevance of non-traded sectors alongside the traded clusters subject to most analysis until now,[14] and there is more generally a desire to bring the statistical analysis associated with clusters in line with other European statistical analyses and Eurostat classifications. Following a detailed reflection process, therefore, this has prompted a change in the approach to both cluster actor mapping and statistical cluster mapping under the newly launched ECCP.

[10] See: https://clustercollaboration.eu/content/recommendations-cluster-policies-boost-resilience-and-foster-green-and-digital.
[11] See: https://reporting.clustercollaboration.eu/.
[12] For detail on this approach see Porter (2003) and Delgado *et al.* (2016). For the most recent *European Cluster Panorama* reports, see Naumanen (2019) and Hollanders and Merkelbach (2020).
[13] See Ketels and Protsiv (2014).
[14] Traded activities are those such as agriculture and manufacturing industry whose outputs can be traded internationally, beyond the regions where they are located. Non-traded activities are those such as education, health, arts, and retail whose outputs are predominantly locally rendered services and thus tend not to be traded outside of the regions where they are located.

ECCP cluster mapping: A new approach

Cluster mapping, whether statistically or in terms of cluster organisations or other cluster actors, requires the identification of units of analysis on two dimensions: (i) economic activity; and (ii) territory.

The most significant change in the new ECCP concerns the economic activity dimension. The ECCP now asks cluster organisations that profile themselves on the platform to identify their economic activity according to 88 standardised sectoral categories (NACE 2-digit), which include both traded and non-traded activities, and the 14 industrial ecosystem categories defined by the European Commission.[15] The statistical analysis has been adjusted in line with this so that a common statistical and actor-based vision of the panorama of clusters in Europe can be achieved.

A more subtle change has also taken place in the territorial dimension, which now delimits regions according to what is considered the most appropriate administrative unit from a cluster policy perspective in each country. For most countries this corresponds with the NUTS2 level. However, NUTS1 regions are used for Belgium, Germany, and France, to correspond with the administrative level at which the remit for cluster policy implementation is strongest in these countries. This results in 201 regional units of analysis across the 27 EU Member States.

A key benefit of a harmonized approach is that analysis can blend indicators on full-time equivalent (FTE) employment, specialisation (based on FTE employment) and productivity (value added in Euros / employment) used to map clusters statistically, with indicators on number of cluster organisations (and various characteristics of those cluster organisations) that can be taken from the ECCP profiles of cluster actors. Table 1 summarises these indicators as a matrix of the two common units of analysis.

Table 1: Units of analysis and key indicators for ECCP cluster mapping

	Territorial unit of analysis 201 Regions (combination of NUTS2 and NUTS1)
Economic activity unit of analysis 88 Sectors (NACE 2-digit) + 14 Industrial Ecosystems	***Indicators*** • Employment • Specialisation (based on FTE employment) • Productivity (value added in Euros / FTE employment) • Number of cluster organisations • Key characteristics of cluster organisations (sector, industrial ecosystem, S3 priority area, technology field, number of members, services offered, collaboration interests, quality labelling, support for the key areas of internationalisation, greening, digitalisation, skills and social economy, specific expertise)

The statistical indicators on employment, specialisation and productivity have been calculated from official sources (Eurostat and National Statistical Offices) for the latest available year, homogenised and processed to ensure full coverage of the matrix of 201 regions and 88 sectors.[16] The cluster actor

[15] They also identify their activity with the list of Smart Specialisation Strategy (S3) areas developed by the European Commission's Joint Research Centre (JRC) and the list of technology fields established for international patent classification by the World Intellectual Property Organisation, and they have the option to specify more granular NACE 4-digit sectors.

[16] Annexes 1 and 2 contain lists of the 201 regions and 88 sectors with their codes. Annex 3 contains methodological detail on the statistical data collection process and definition of the indicators. While 2019 data was collected for several countries, significant gaps in the data for that year mean that we have used the more complete 2018 data for the analysis of this report.

data has been taken directly from the profiles of the EU-27 cluster organisations that have updated their profiles following the re-launch of the ECCP in February 2021.

The ECCP mapping tool allows users to interactively explore the cluster actor data and statistical data highlighted in Table 1, facilitating in depth analysis of a specific sector, industrial ecosystem, or region. Customised charts can be drawn from this data, and the data can also be downloaded. The aim of this *European Cluster Panorama* report is to provide analysis that gives both a general picture of the panorama of clusters and industrial ecosystems in Europe and that sheds light on the links between them and the development of resilient, green, and digital regional economies.

Focus and structure of this report

The specific focus of this *European Cluster Panorama* is the presence of clusters in Europe and the roles they are playing in fostering resilient, green, and digital regional economies. It undertakes a baseline mapping of the concentration of economic activity across 201 regions (at NUTS1 or NUTS2 level)[17] in EU-27 countries, based on NACE 2-digit sector[18] data for employment and value added. This data is also aggregated to reflect the 14 pan-European industrial ecosystems identified by the European Commission as being critical to the transformation pathways that will shape the recovery.[19] The presence of cluster organisations is integrated into analysis of regional specialisation in sectors and ecosystems to provide a comprehensive picture of the current European cluster panorama, alongside a new typology of regions based on specialisation profiles. This provides the basis for analyses exploring the contribution of clusters to green and digital transition, and the relationships between specialisation and different dimensions of regional performance.

The report is structured as follows:

- Chapter 2 uses data from ECCP cluster actor profiles to provide a detailed characterisation of European cluster organisations.
- Chapter 3 provides an integrated analysis of the panorama of clusters and industrial ecosystems in Europe. From analysis of the overall distribution of European employment, it analyses regional nodes of specialisation in sectors and industrial ecosystems alongside the presence of cluster organisations.
- Chapter 4 provides a tailored analysis that explores the specific roles of clusters and cluster organisations in the green and digital transitions.
- Chapter 5 introduces a new typology of European regions based on their specialisation profiles in industrial ecosystems. The purpose is to provide a common denominator to help identify similar regions in terms of employment structure and thereby support reflections on the relevance of different policy instruments.
- Chapter 6 explores the relationships between specialisation in sectors and industrial ecosystems and a series of indicators of regional competitiveness performance, including those related to green and digital transition.
- Chapter 7 concludes by summarising the principal facts, figures and messages arising from the analysis and reflecting on some key issues shaping the ongoing evolution of the European cluster panorama.

[17] See: https://ec.europa.eu/eurostat/web/nuts/background
[18] See: https://ec.europa.eu/eurostat/web/nace-rev2.
[19] See: European Commission (2021c).

02

Characterisation of European cluster organisations

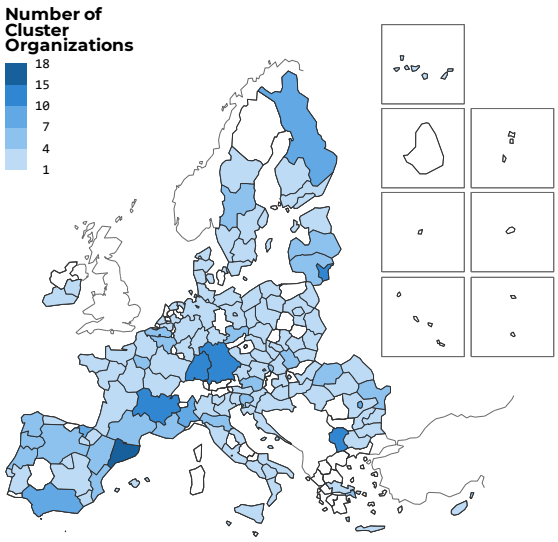
2. Characterisation of European cluster organisations

This chapter provides a detailed characterisation of European cluster organisations, based on a sample of EU-27 cluster organisations with updated profiles on the ECCP. As of November 2021, there are a total of 1320 cluster organisations (EU and non-EU) profiled on the ECCP, alongside 133 European Cluster Partnerships,[20] 40 cluster networks (or meta-clusters), 21 National Cluster Associations, 5 policy institutions, 131 resource efficiency providers,[21] and 11 training providers.[22]

2.1 Cluster organisations in EU-27 countries

Among all the ECCP cluster actors, there are 1036 EU-27 cluster organisations that have registered profiles over the last decade. Following the ECCP website relaunch in February 2021, cluster organisations were invited to update their profiles to include, for the first time, up-to-date information on the NACE 2-digit sectors and industrial ecosystems in which they are working, alongside characteristics such as their roles in the green and digital transitions and a range of other more detailed questions. To enable analysis that is consistent with statistical data on sectors and industrial ecosystems, this report is based on the sample of EU-27 cluster organisations that had completed these updated profiles on the ECCP by 29/11/2021.[23] Map 1 shows the distribution of this sample across EU-27 regions.

Map 1: Regional distribution of EU-27 cluster organisations



Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

[20] The ECCP is the home of 4 types of European Cluster Partnerships: International (ESCP4i) Innovation (also known as cluster facilitated projects under Horizon 2020 INNOSUP-1, Excellence (ESCP4x); and Smart Specialisation (ESCPS3).

[21] Most of these providers come from the European Resource Efficiency Knowledge Centre (EREK) (https://clustercollaboration.eu/erek), which is hosted by the ECCP.

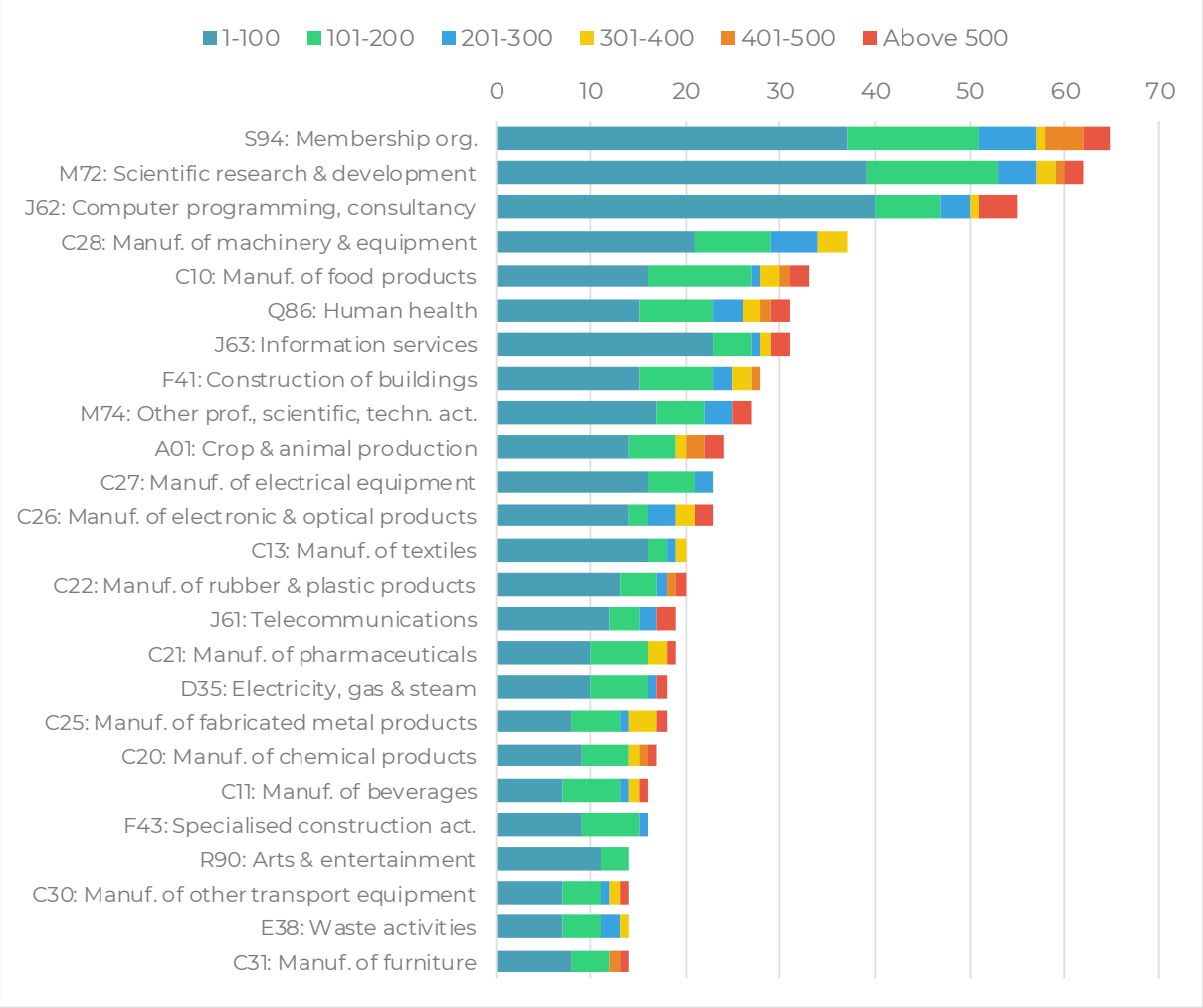
[22] All 8 types of cluster actor profile can be explored and analysed in detail using the ECCP interactive mapping tool: https://reporting.clustercollaboration.eu/.

[23] A list of the sample of 468 cluster organisations with updated ECCP profiles that are included in the analysis of this report is included in Annex 4 (organised by country and region) and Annex 5 (organised by industrial ecosystem). Annex 6 provides summary data for the analysis conducted in this chapter.

2.2 Economic activity profile of EU-27 cluster organisations

EU-27 cluster organisations are active in 73 of the 88 NACE 2-digit sectors, and there is a strong concentration in the top-25 sectors, which together account for more than 70% of references to sectors from cluster organisations in the sample. These 25 sectors are included in Figure 1, along with a breakdown by cluster organisation size (number of members). The top three categories stand out from the rest, both in terms of the number of cluster organisations working in these areas and the tendency towards larger memberships. Unsurprisingly, these are all transversal activities: *Activities of membership organisations (S94)*, *Scientific research and development (M72)*, and *Computer programming, consultancy, and related activities (J62)*. The most prevalent of the more specific activities are *Manufacture of machinery and equipment (C28)*, *Manufacture of food products* (C10), *Human health activities (Q86)* and *Information services (J63)*.

Figure 1: EU-27 cluster organisations by sector (and size profile)

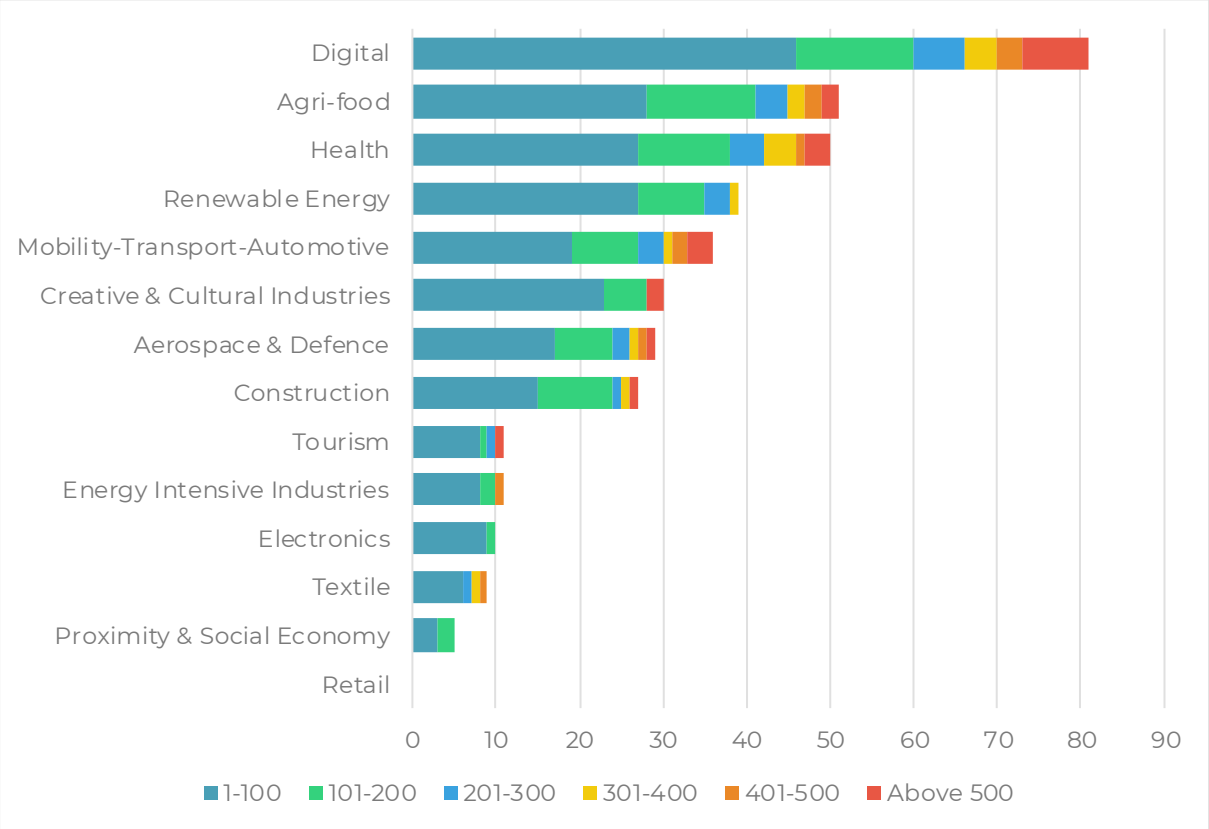


Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021; top-25 sectors included in Figure; summary data provided in Table A6.1 (Annex 6).

A similar analysis can be conducted for the 14 industrial ecosystems (Figure 2). Here the activities of EU-27 cluster organisations are spread more evenly, although there is a clear dominance of the digital ecosystem, within which 81 cluster organisations are situated, including 8 with more than 500 members. The *Agri-food* and *Health* ecosystems are the others with at least 50 cluster organisations.

At the other end of the scale the *Proximity and social economy* ecosystem stands out in terms of having very few cluster organisations that explicitly identify with working in these areas, and the *Retail* ecosystem has none.

Figure 2: EU-27 cluster organisations by industrial ecosystem (and size profile)

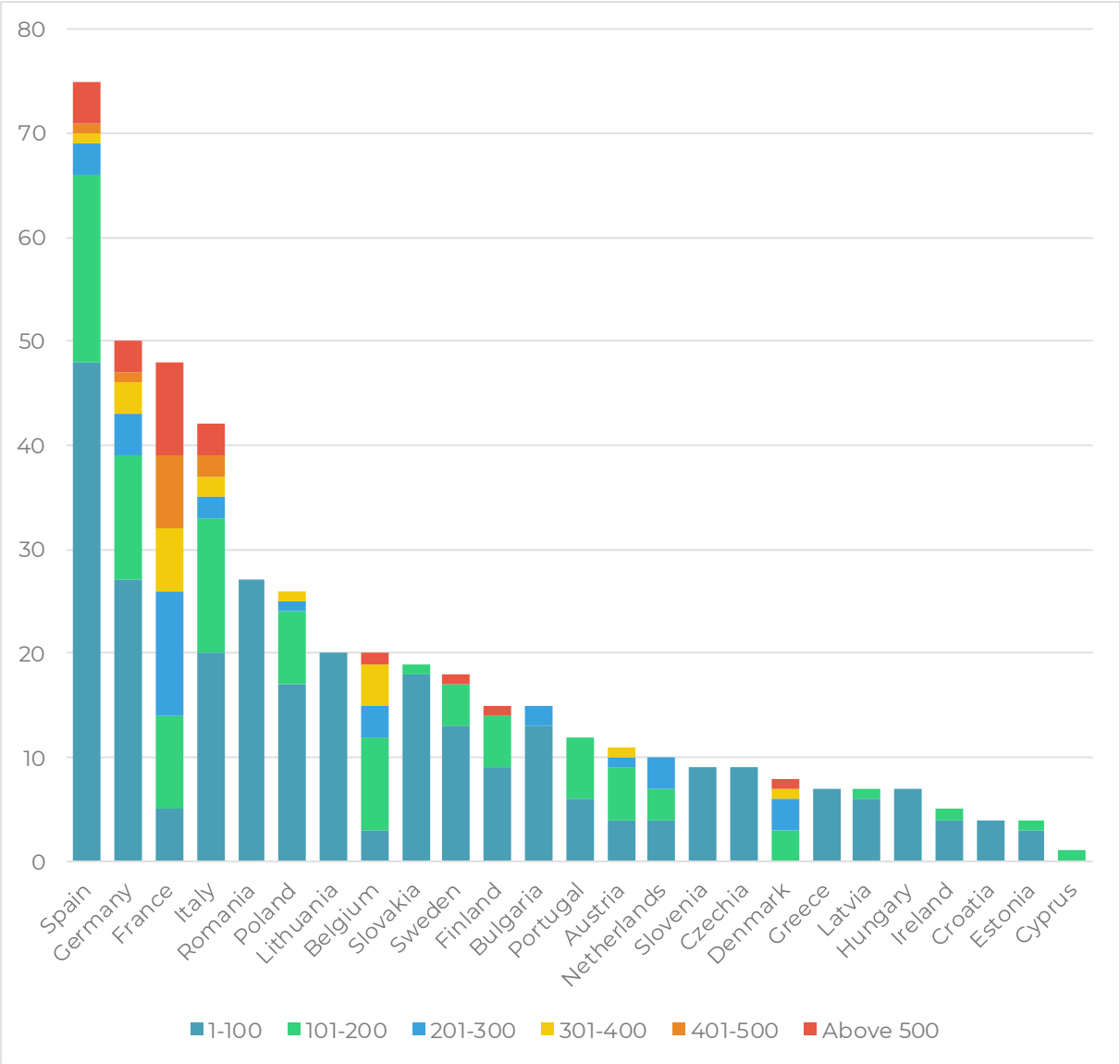


Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021; summary data provided in Table A6.2 (Annex 6).

2.3 Size and membership of EU-27 cluster organisations

Almost 60% of EU-27 cluster organisations have less than 100 members, and only around 7% have more than 400 members. However, there is considerable variation in the size of cluster organisations by country (Figure 3). Among the countries accounting for most cluster organisations, Spain, Italy, and Germany share a similar distribution to the average, while France has more cluster organisations in the larger categories. Belgium and Denmark too tend to have larger cluster organisations, while many countries in Central and Eastern Europe have exclusively smaller organisations (Romania, Lithuania, Bulgaria, Slovenia, Czech Republic, Hungary).

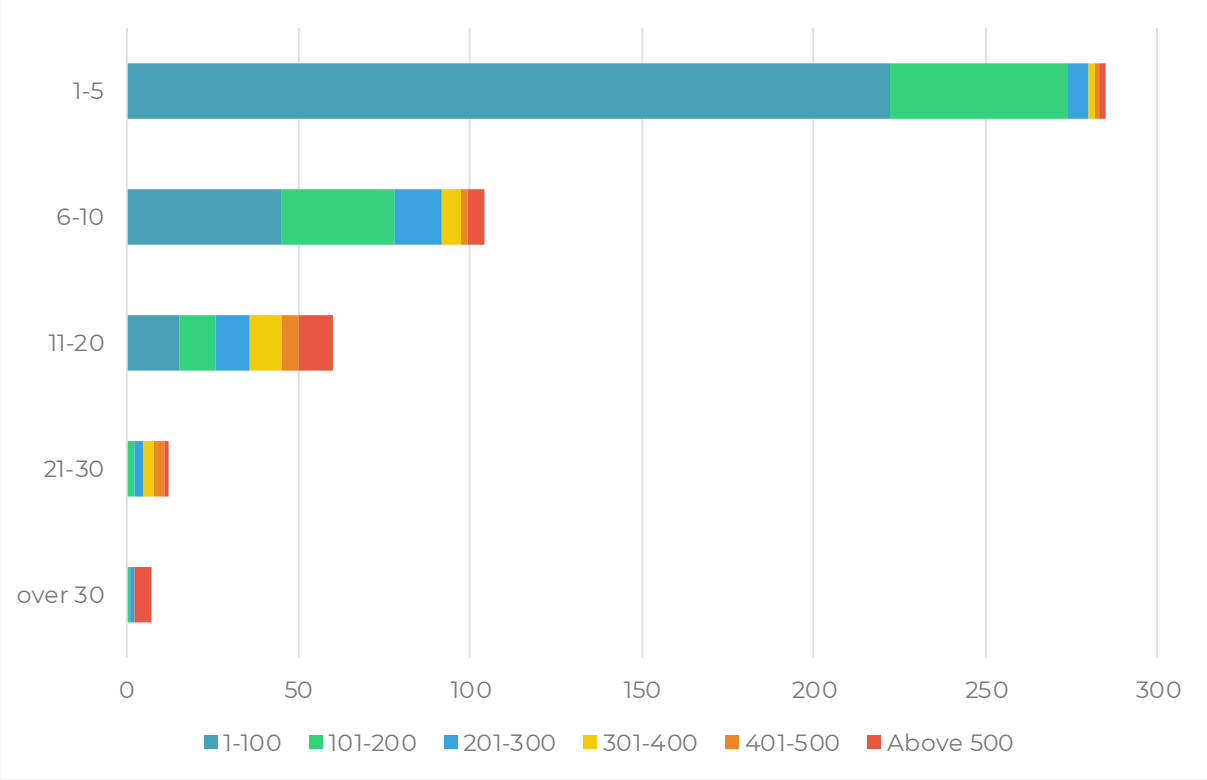
Figure 3: Size profile of EU-27 cluster organisations



Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021; summary data provided in Table A6.3 (Annex 6).

In terms of staffing levels, the size profile of European cluster organisations follows a similar pattern, with around 60% employing 1-5 cluster management staff, and only 4% employing more than 20 cluster management staff. Moreover, there is naturally a strong correspondence between the number of cluster management staff and the number of members (see Figure 4).

Figure 4: Management team size of EU-27 cluster organisations (by number of members)



Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021; summary data provided in Table A6.4 (Annex 6).

In total, EU-27 cluster organisations with updated profiles on the ECCP represent around 73,000 members, of which 70.4% are SMEs, 10.2% large firms and 8.1% research organisations. Table 2 provides a breakdown of the distribution of cluster members by country, where considerable variation can be observed in the types of members that make up cluster organisations:

- As the dominant group in all countries, SMEs range from 38% of cluster organisation members in Finland to 81% in Italy and Sweden.[24]
- Meanwhile, large firms are most prevalent in Czech cluster organisations (~20%) and least prevalent in Italian and Hungarian cluster organisations (~5%).
- Finally, research organisations are most represented in Greek and Slovenian cluster organisations (~20%) and least represented in Italian and Swedish (~4%) cluster organisations.

[24] The figure of 99% from Cyprus only returns the results from one cluster organisation.

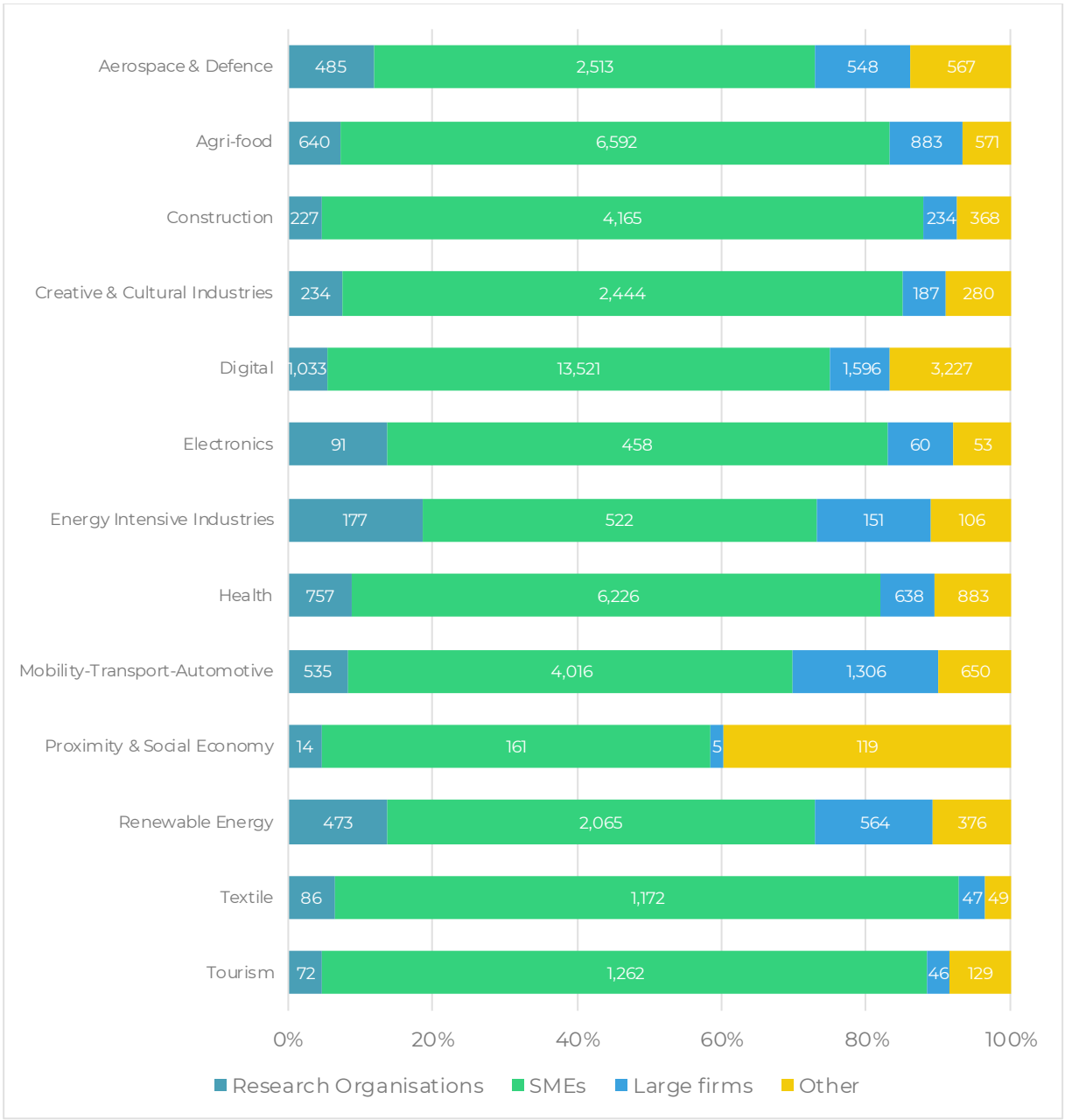
Table 2: Members represented by EU-27 cluster organisations (by actor type and country)

EU27 COUNTRY	Research Organisations		SMEs		Large firms		Other		Total #
	#	%	#	%	#	%	#	%	
Austria	165	11.0%	1,156	77.0%	135	9.0%	46	3.1%	1,502
Belgium	411	7.8%	3,209	60.5%	702	13.2%	978	18.5%	5,300
Bulgaria	64	6.5%	716	72.8%	61	6.2%	143	14.5%	984
Croatia	13	9.6%	89	65.9%	19	14.1%	14	10.4%	135
Cyprus	1	0.6%	167	99.4%	0	0.0%	0	0.0%	168
Czechia	45	10.9%	266	64.3%	79	19.1%	24	5.8%	414
Denmark	115	5.1%	1,671	74.2%	237	10.5%	228	10.1%	2,251
Estonia	16	7.7%	136	65.1%	29	13.9%	28	13.4%	209
Finland	160	9.3%	664	38.6%	142	8.3%	752	43.8%	1,718
France	1,873	11.6%	10,705	66.1%	2,023	12.5%	1,594	9.8%	16,195
Germany	790	9.2%	5,010	58.5%	875	10.2%	1,895	22.1%	8,570
Greece	73	23.4%	202	64.7%	23	7.4%	14	4.5%	312
Hungary	22	8.3%	207	78.1%	12	4.5%	24	9.1%	265
Ireland	43	15.8%	138	50.7%	42	15.4%	49	18.0%	272
Italy	585	4.8%	10,070	82.8%	684	5.6%	822	6.8%	12,161
Latvia	35	6.8%	395	77.3%	54	10.6%	27	5.3%	511
Lithuania	69	11.1%	450	72.7%	50	8.1%	50	8.1%	619
Netherlands	82	6.1%	1,011	75.4%	143	10.7%	105	7.8%	1,341
Poland	160	6.4%	1,868	75.1%	257	10.3%	201	8.1%	2,486
Portugal	173	13.6%	772	60.6%	148	11.6%	181	14.2%	1,274
Romania	158	12.4%	851	66.9%	92	7.2%	171	13.4%	1,272
Slovakia	39	6.2%	399	62.9%	70	11.0%	126	19.9%	634
Slovenia	90	17.3%	302	58.1%	85	16.3%	43	8.3%	520
Spain	700	5.8%	9,393	78.3%	1,340	11.2%	556	4.6%	11,989
Sweden	71	3.4%	1,710	81.3%	161	7.7%	162	7.7%	2,104
Grand Total	5,953	8.1%	51,557	70.4%	7,463	10.2%	8,233	11.2%	73,206

Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

The distribution of different types of cluster members can also be analysed according to industrial ecosystem. As illustrated in Figure 5, SMEs account for a relatively high proportion of members of cluster organisations working in the *Textiles* (87%), *Tourism* (84%) and *Construction* (83%) ecosystems, and a relatively low proportion of members in the *Energy intensive industries* (55%) ecosystem. Meanwhile, cluster organisations in the *Mobility-transport-automotive* ecosystems have a proportion of large firms that is considerably above the average (20%). *Energy intensive industries* (19%), *Electronics* (14%) and *renewable energy* (14%) are the ecosystems where cluster organisations have the highest proportion of research organisation members, and the *Proximity and social economy* ecosystem stands out for its high proportion of members in the 'other' category (40%).

Figure 5: Types of members of EU-27 cluster organisations by industrial ecosystem



Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021; summary data provided in Table A6.5 (Annex 6).

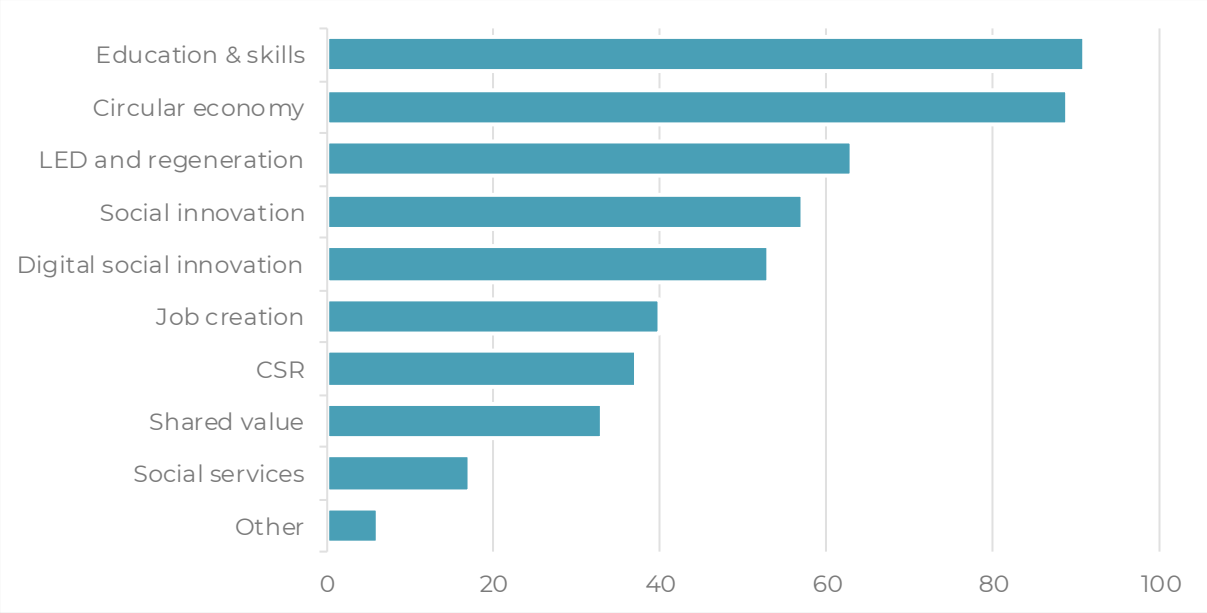
2.4 How do EU-27 cluster organisations support their members?

Internationalisation stands out as the key area in which EU-27 cluster organisations are currently supporting their members, with 85% of the sample engaged in supporting internationalisation. The top 10 target countries for these efforts are:

1. United States
2. Canada
3. China
4. Japan
5. Brazil
6. Israel
7. United Arab Emirates
8. United Kingdom
9. Mexico
10. India

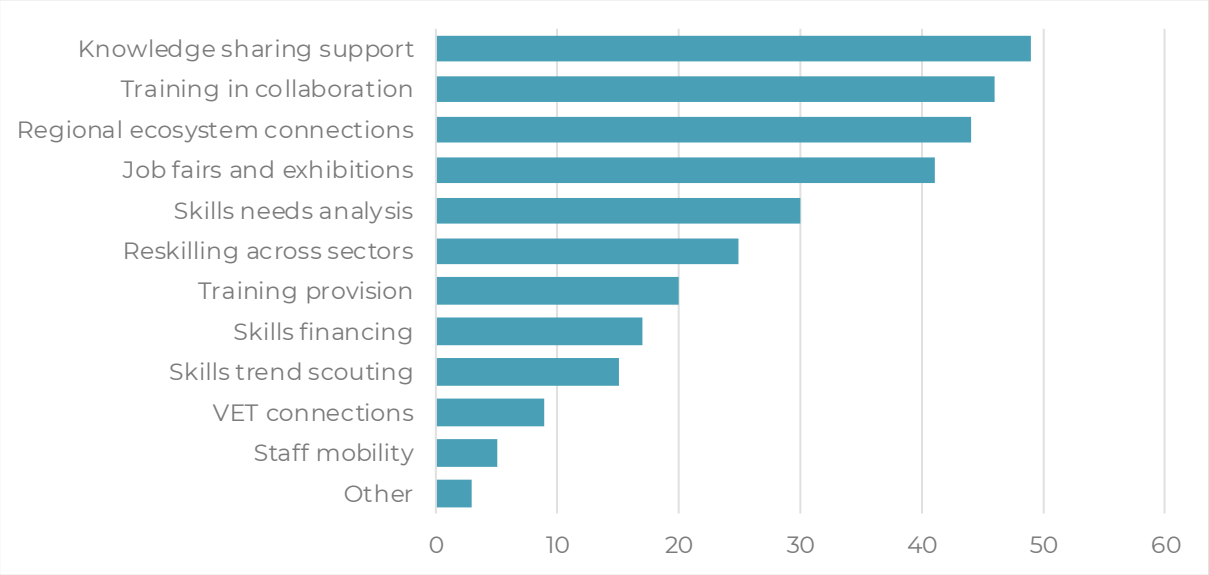
Digitalisation follows closely behind internationalisation, with 82% of cluster organisations supporting their members in this area, while 62% support companies to be green. These two key dimensions of cluster organisation support are analysed in more detail in Chapter 4. Moreover, 49% of cluster organisations indicate that they support social innovation and/or are engaged in social economy development, and 21% provide some form of training activities for their members. Figure 6 highlights the broad range of social economy expertise on offer from cluster organisations, with that in circular economy and education/skills being the most notable, while Figure 7 indicates that knowledge sharing support is the most provided training service, followed closely by training in collaboration, regional ecosystem connections and job fairs and exhibitions.

Figure 6: Social economy expertise of EU-27 cluster organisations



Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

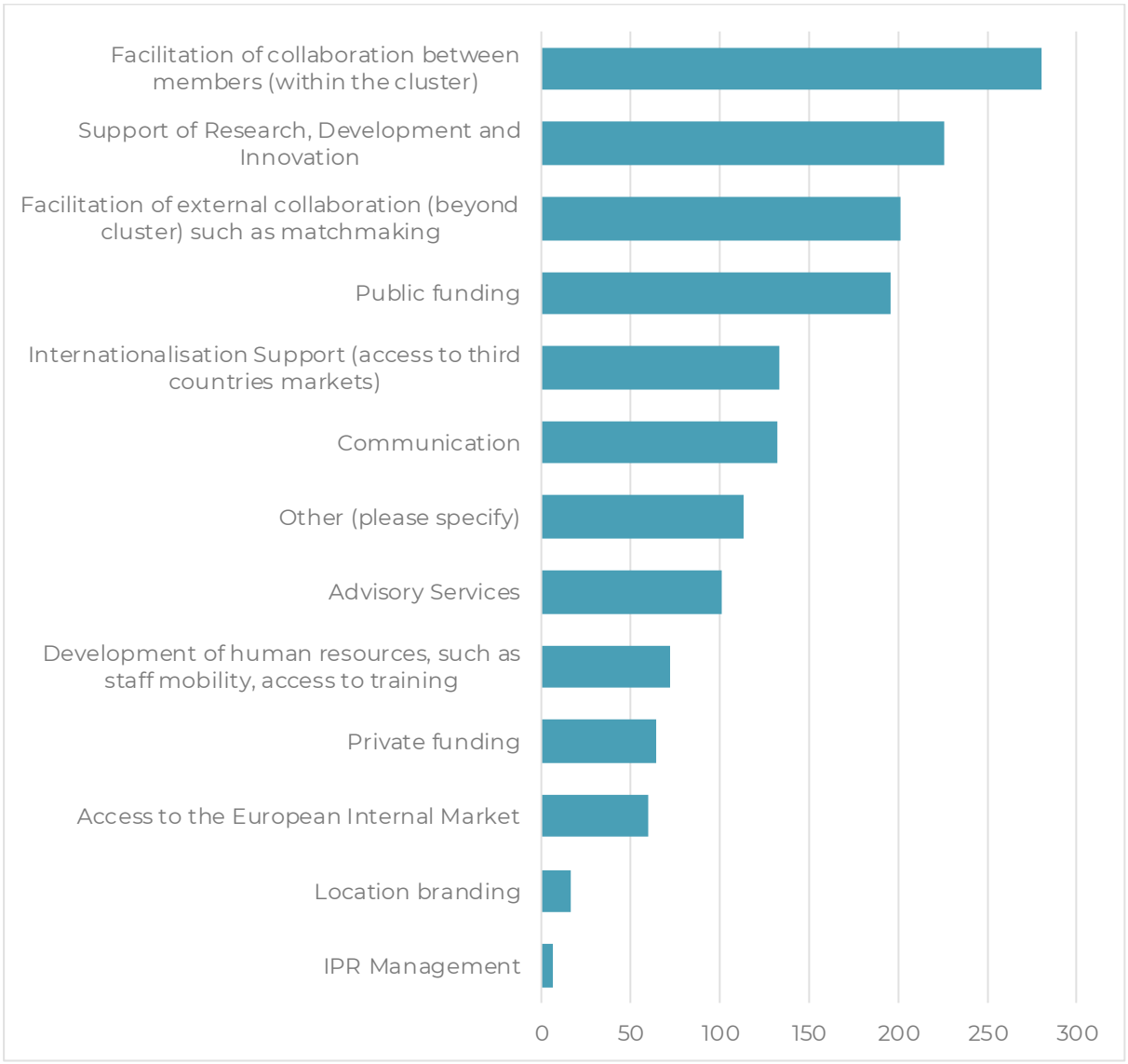
Figure 7: Training services offered by EU-27 cluster organisations



Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

More generally, EU-27 cluster organisations provide a wide range of services to their members (Figure 8). The most widespread service offered corresponds with the core transversal function of facilitating collaboration between members. This is closely followed by more focused support for research, development and innovation, the facilitation of external collaboration (e.g. matchmaking), and support for seeking public funding.

Figure 8: Top Services provided by EU-27 cluster organisations

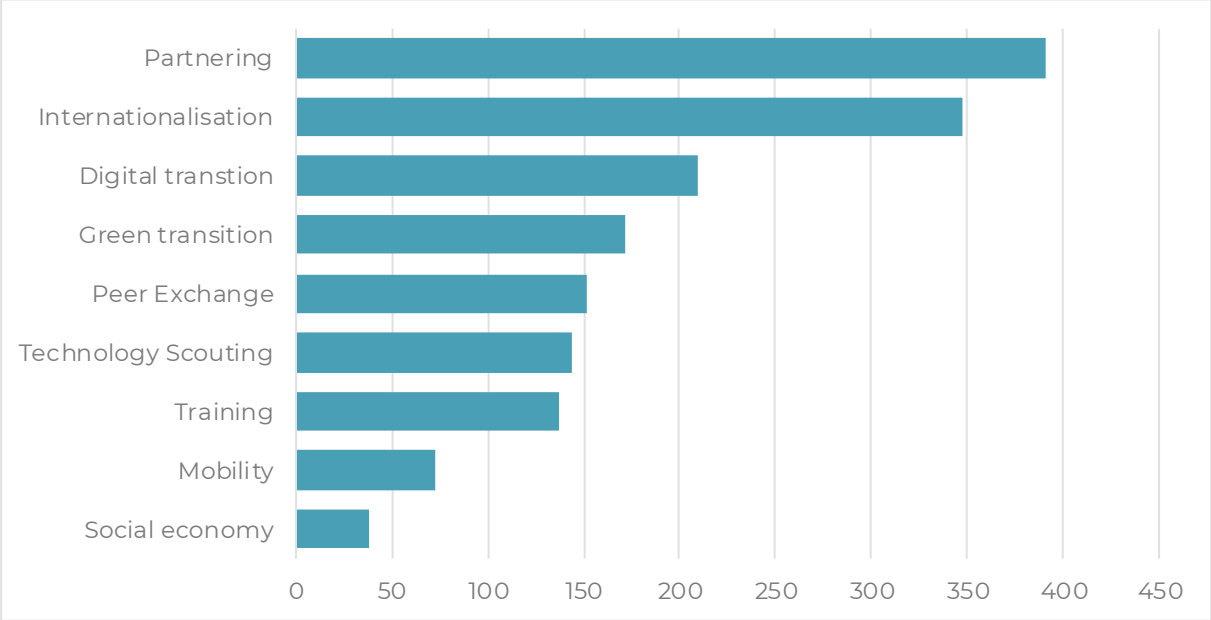


Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

The relatively low listing of internationalisation support services in comparison with the high proportion of cluster organisations (85%) who say that they support their members' internationalisation might suggest that support for internationalisation is seen by many cluster organisations as a more transversal, informal activity, rather than an explicit, dedicated service offering. Moreover, the clear cross-cutting interest in internationalisation is supported further by Figure 9, which reports the collaboration interests of the EU-27 cluster organisations in the sample. Only partnering for projects is more popular that internationalisation in terms of cross-cluster collaboration. The next most popular areas are digital and green transitions, with more than 150 cluster organisations highlighting each of these as a key collaboration interest. This reflects both recognition of the strategic importance of green and digital transition for cluster organisations and their members, and an understanding that these issues require collaboration across clusters.[25]

[25] Chapter 4 provides further analysis of the link between clusters and green and digital transition.

Figure 9: Collaboration interests of EU-27 cluster organisations



Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

Finally, EU-27 cluster organisations have become increasingly professionalised, and the ECCP has been profiling quality labels for a decade. Just over 68% of those in the sample for this analysis have some form of quality label and 42% have either the bronze (23%), silver (9%) or gold (10%) Cluster Management Excellence labels awarded by the European Secretariat for Cluster Analysis (ESCA).[26] Around 27% of cluster organisations have labels awarded by other regional, national and/or international organisations, either instead of or in addition to an ESCA label. Moreover, the sectoral and ecosystem breakdown of labelling corresponds closely with the sectoral and ecosystem breakdown of cluster organisations (Figure 1 and Figure 2), indicating that there is no notable tendency for cluster organisations in particular sectors or ecosystems to label more than others.[27]

[26] For more information on ESCA labelling, see: https://www.cluster-analysis.org/.
[27] Table A6.6 in Annex 6 provides a breakdown of the number of gold, silver, bronze and other labelled cluster organisations by industrial ecosystem and alliance.

03

Clusters and industrial ecosystems in Europe

3. Clusters and industrial ecosystems in Europe

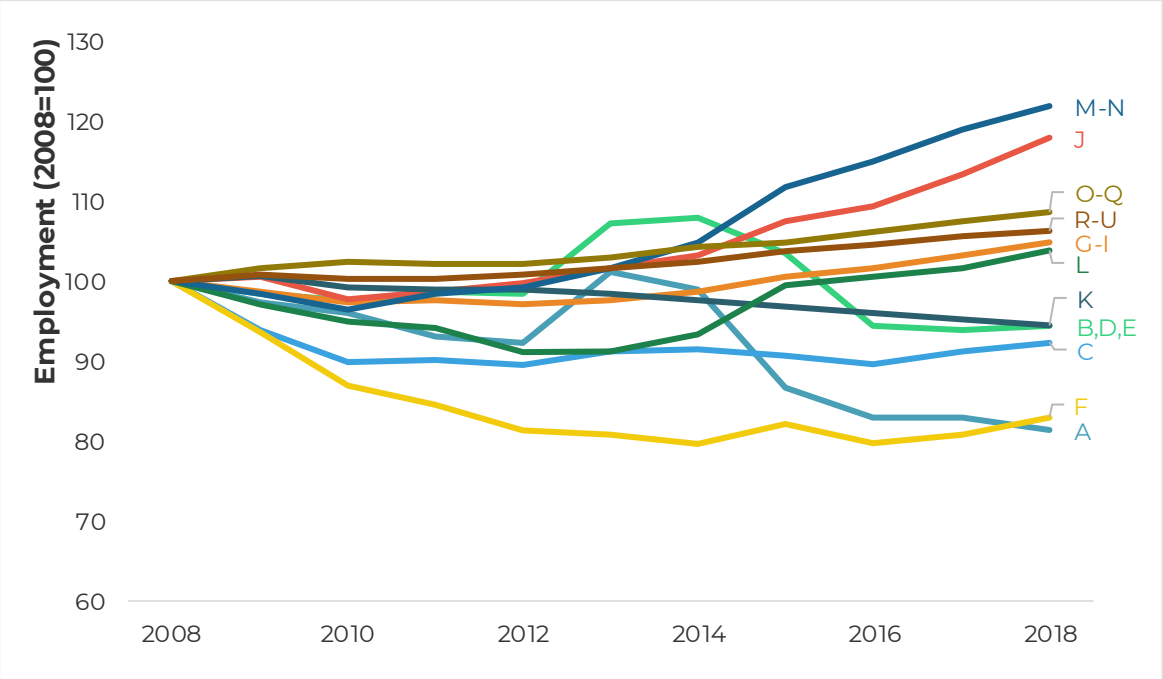
This chapter undertakes a detailed analysis of the panorama of clusters and industrial ecosystems in EU-27 countries. The first section combines data on the presence of cluster organisations with statistical data on the distribution and regional specialisation of 88 economic sectors. This is followed in the second section by a parallel analysis of the distribution and regional specialisation of 14 industrial ecosystems.

3.1 Clusters and the distribution and regional specialisation of sectors

Sector distribution and clusters

As a starting point to characterise the panorama of sector specialisation in Europe, Figure 10 illustrates the evolution of employment from the start of the financial crisis of 2008. Employment is measured in Full Time Equivalent (FTE) across 11 broad categories of activities that adapt the A*10 standard aggregation.[28]

Figure 10: Evolution of employment in 11 broad categories of activities in the EU-27



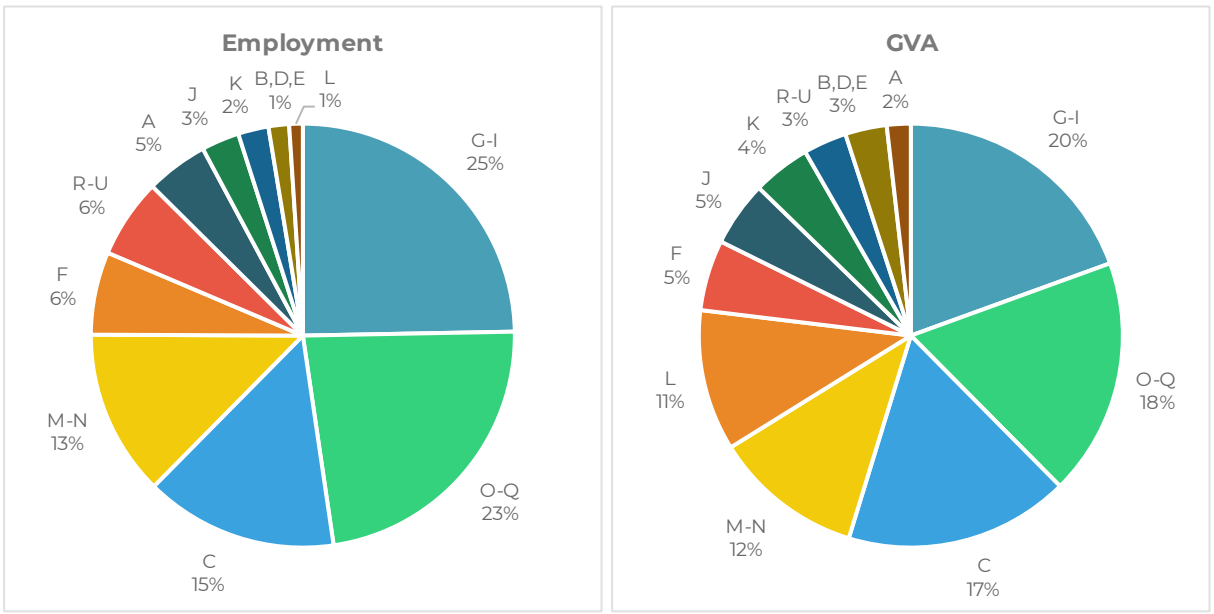
Source: Based on data from Eurostat and national statistics offices.
Note: A: Agriculture, forestry and fishing; B,D,E: Mining, Energy and Water supply; C: Manufacturing; F: Construction; G-I: Domestic trade, transport, accommodation and food service; J: Information and communication; K: Financial and insurance; L: Real estate; M-N: Professional, scientific and technical; administrative and support service; O-Q: Public admin., defence, education, human health and social work; R-U: Arts, entertainment and recreation; other services; act. of households and extra-territorial.

[28] The A*10 aggregation includes 10 non-overlapping categories of sectors plus *C: Manufacturing*, that is both part of *B-E: Industry (except construction)* and included as a separate category. Here *B-E* is separated into *B,D,E: Mining and quarrying, Electricity, gas, steam and air conditioning supply and Water supply, sewerage, waste management and remediation activities* (shortened to *Mining, Energy and Water supply*) on one hand and *C: Manufacturing*, on the other, to have 11 non-overlapping categories.

Employment in most sectors decreased at the beginning of the crisis. Many sectors have since recovered, reaching employment levels in 2018 that were higher than in 2008 in some cases (*G-I: Domestic trade, transport, accommodation, and food service*; *J: Information and communication*; *L: Real estate*; *M-N: Professional, scientific and technical; administrative and support service*) or not quite yet in others (*C: Manufacturing*; *F: Construction*). Employment in other sectors appears to still be falling (*A: Agriculture, forestry and fishing*; *K: Financial and insurance*), while some sectors never fell below the levels they had in 2008 (*O-Q: Public admin., defence, education, human health and social work*; *R-U: Arts, entertainment and recreation; other services; act. of households and extra-territorial*).

As can be observed in Figure 11, more than half of all employment concentrates in two large groups of activities that can be considered local or non-traded: a quarter of total employment is in activities classified as *Wholesale and retail trade, transport, accommodation and food service (G-I)* and 23% in *Public administration, defence, education, human health and social work (O-Q)*. These are also the top two activities in terms of Gross Value Added (GVA). However, the shares are smaller (20% and 18% respectively), implying that they are less productive than other activities. *Manufacturing (C)* is the third category both in terms of employment (15%) and GVA (17%), and hence with above-average productivity. Subsequent graphs present further details of employment, productivity and the presence of cluster organisations associated to these activities in the EU-27.

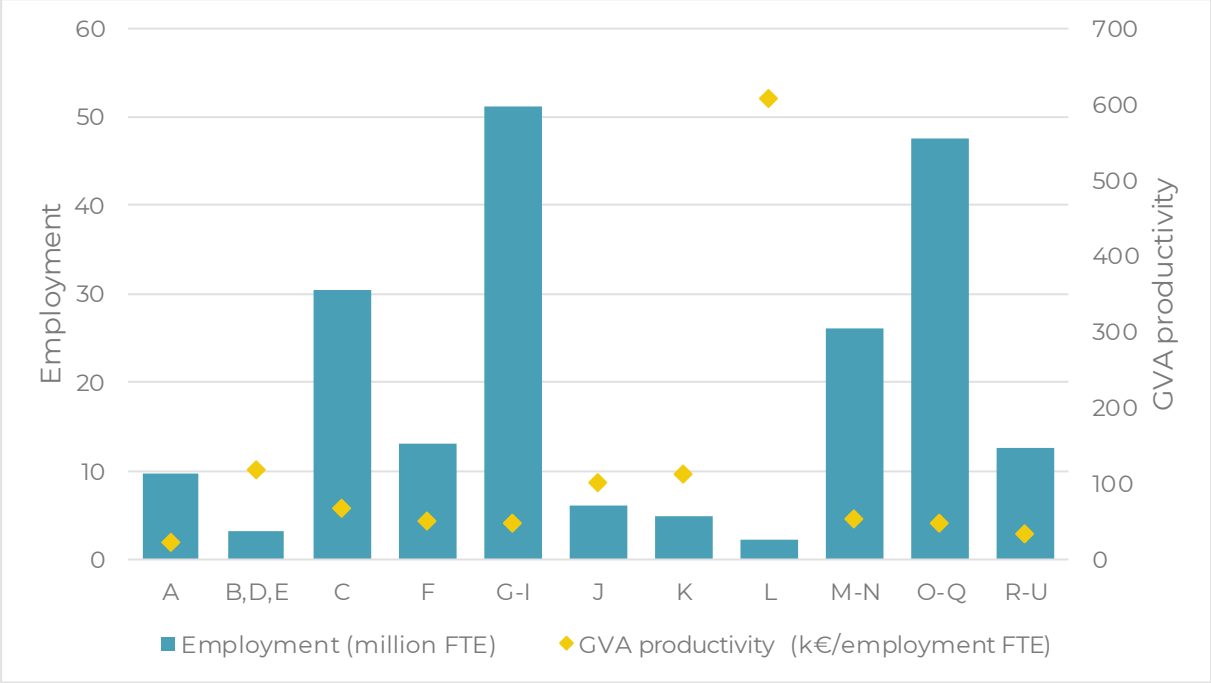
Figure 11: Distribution of employment and GVA in 11 categories of activities in the EU-27 (2018)



Source: Based on data from Eurostat and national statistics offices.
Note: A: Agriculture, forestry and fishing; B,D,E: Mining, Energy and Water supply; C: Manufacturing; F: Construction; G-I: Domestic trade, transport, accommodation and food service; J: Information and communication; K: Financial and insurance; L: Real estate; M-N: Professional, scientific and technical; administrative and support service; O-Q: Public admin., defence, education, human health and social work; R-U: Arts, entertainment and recreation; other services; act. of households and extra-territorial.

As shown in Figure 12, productivity varies across these categories. For example, *Real estate (L)*, while being the category with least employment is, by far, the most productive, with the other three categories with less employment (*Mining, Energy and Water supply (B,D,E)*, *Financial and insurance (K)* and *Information and communication (J)*) following it at great distance. On the other hand, the categories that count for greater employment are less productive, with *Manufacturing (C)* being the most productive among the top categories in terms of total employment.

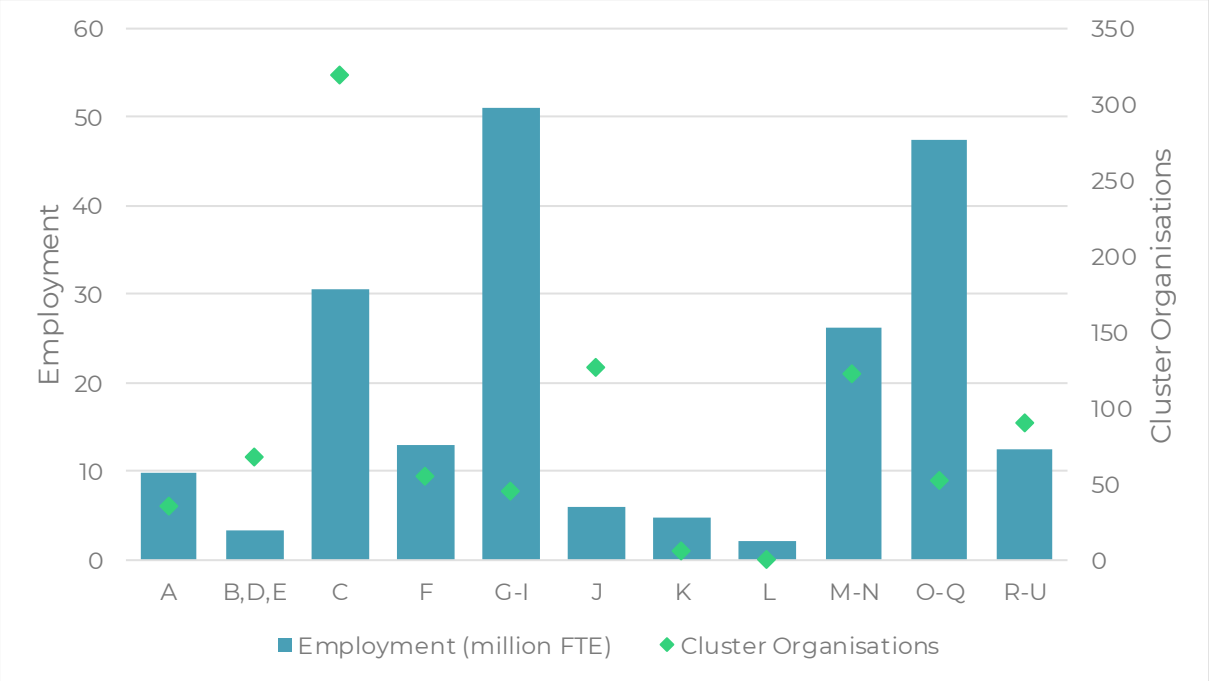
Figure 12: Employment and productivity in 11 categories of activities in the EU-27 (2018)



Source: Based on data from Eurostat and national statistics offices.
Note: A: Agriculture, forestry and fishing; B,D,E: Mining, Energy and Water supply; C: Manufacturing; F: Construction; G-I: Domestic trade, transport, accommodation and food service; J: Information and communication; K: Financial and insurance; L: Real estate; M-N: Professional, scientific and technical; administrative and support service; O-Q: Public admin., defence, education, human health and social work; R-U: Arts, entertainment and recreation; other services; act. of households and extra-territorial.

It is also important to note that EU-27 cluster organisations tend not to be present in the categories of activities that account for more employment (Figure 13). It is in sectors within *Manufacturing (C)* that cluster organisations are mostly present, followed by *Information and communication (J)* and *Professional, scientific and technical; administrative and support service (M-N)*. This is very much in line with the well-understood notion that clustering provides the greatest competitiveness advantages in activities that are traded outside of the region. Indeed, cluster policies have typically focused on those traded industrial activities and industry-related services that generate high value-added and provide the foundations for regional competitiveness, so it is unsurprising to see this reflected in the activities in which European cluster organisations are most present.

Figure 13: Employment and cluster organisations in 11 categories of activities in the EU-27 (2018)



Source: Based on data from Eurostat, national statistics offices and ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.
Note: A: Agriculture, forestry and fishing; B,D,E: Mining, Energy and Water supply; C: Manufacturing; F: Construction; G-I: Domestic trade, transport, accommodation and food service; J: Information and communication; K: Financial and insurance; L: Real estate; M-N: Professional, scientific and technical; administrative and support service; O-Q: Public admin., defence, education, human health and social work; R-U: Arts, entertainment and recreation; other services; act. of households and extra-territorial.

The presence of cluster organisations is not related either to high productivity levels (Figure 14) at this level of broad aggregation of activities, with *Real estate (L)* and *Financial and insurance (K)* being the two more productive categories of activities but having few associated cluster organisations. Only the third category in terms of productivity, *Information, and communication (J)*, combines high productivity and a considerable amount of cluster organisations. However, it is important to recall from Figure 11 that *Manufacturing (C)*, which has the highest number of cluster organisations, is the third largest category in terms of absolute employment (15%) and has above average productivity (GVA is 17%).

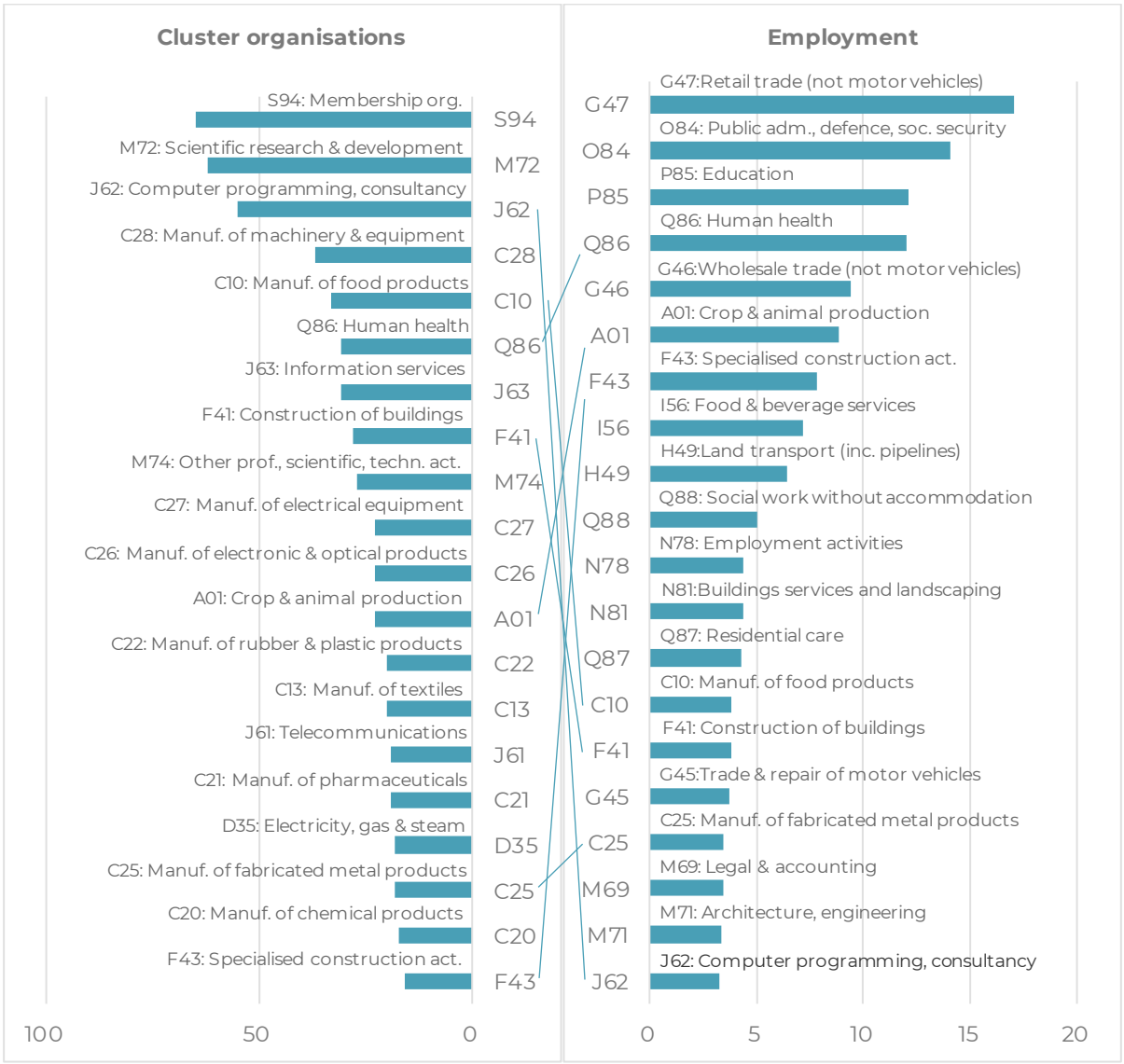
Figure 14: Productivity and cluster organisations in 11 categories of activities in the EU-27 (2018)

Source: Based on data from Eurostat, national statistics offices and ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

Note: A: Agriculture, forestry and fishing; B,D,E: Mining, Energy and Water supply; C: Manufacturing; F: Construction; G-I: Domestic trade, transport, accommodation and food service; J: Information and communication; K: Financial and insurance; L: Real estate; M-N: Professional, scientific and technical; administrative and support service; O-Q: Public admin., defence, education, human health and social work; R-U: Arts, entertainment and recreation; other services; act. of households and extra-territorial.

We can take a more granular look at the relationship (or lack of relationship) between employment and the presence of cluster organisations by examining the data on specific sectors. Figure 15 presents the top 20 NACE 2-digit sectors by cluster organisation presence and by employment in EU-27 countries. Only 7 out of the top 20 activities appear in both lists, implying that there is no correlation between presence of cluster organisations and high levels of employment *per se*. The top three sectors in terms of the number of cluster organisations correspond to transversal activities: *Scientific Research and Development (M72), Activities of Membership Organisations (S94),* and *Computer Programming, Consultancy and Related Activities (J62).* The most prevalent of the more specific activities are *Manufacture of Machinery and Equipment (C28)* and *Manufacture of Food Products (C10).* On the other hand, the top 5 sectors in terms of employment are in the fields of local commerce (*Retail trade (G47)* in position number 1 and *Wholesale trade* (G46) in position number 5), *Public administration (O84), Education (Q84) and Human health (Q86).* They are therefore mostly non-tradeable activities.

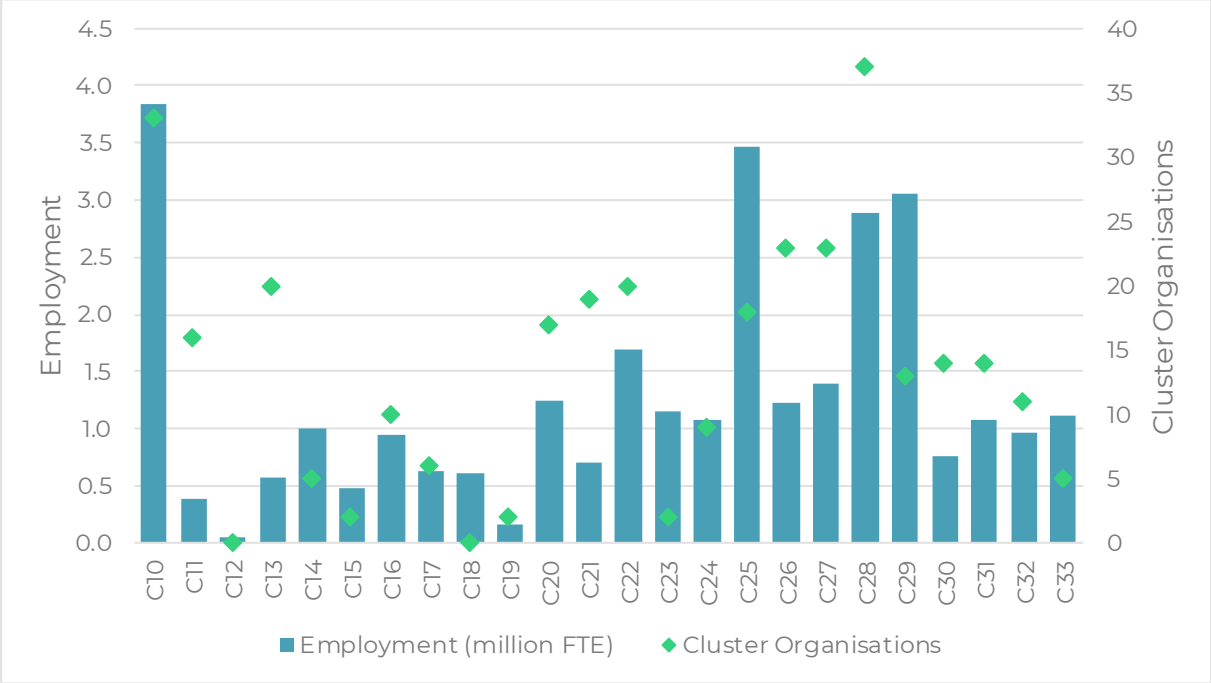
Figure 15: Top 20 sectors by cluster organisations vs top 20 sectors by employment (EU-27, 2018)



Source: Based on data from Eurostat, national statistics offices and ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

Focusing only on manufacturing activities, Figure 16 shows that cluster organisation presence is not necessarily associated with high levels of employment. It does happen in some sectors, such as *Manufacture of food products (C10)* and *Manufacture of machinery & equipment (C28),* but there are others with low levels of employment that do have relatively large numbers of associated cluster organisations, such as *Manufacture of beverages (C11)* and *Manufacture of textiles (C13).*

Figure 16: Employment and cluster organisations in manufacturing activities in the EU-27 (2018)



Source: Based on data from Eurostat, national statistics offices and ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.
Note: C10: Manuf. of food products; C11: Manuf. of beverages; C12: Manuf. of tobacco; C13: Manuf. of textiles; C14: Manuf. of wearing apparel; C15: Manuf. of leather products; C16: Manuf. of wood products; C17: Manuf. of paper products; C18: Manuf. of printing & reproduction; C19: Manuf. of coke & refined petroleum; C20: Manuf. of chemical products; C21: Manuf. of pharmaceuticals; C22: Manuf. of rubber & plastic products; C23: Manuf. of other nonmetal mineral products; C24: Manuf. of basic metals; C25: Manuf. of fabricated metal products; C26: Manuf. of electronic & optical products; C27: Manuf. of electrical equipment; C28: Manuf. of machinery & equipment; C29: Manuf. of motor vehicles & trailers; C30: Manuf. of other transport equipment; C31: Manuf. of furniture; C32: Other manufacturing; C33: Repair, installation of machinery.

Regional sector specialisation and clusters

Economic activity, and therefore employment, is not equally distributed in all regions. Non-traded activities tend to distribute more evenly, with larger regions accumulating more employment in these sectors than smaller regions, while representing approximately the same share of total employment in the region. However, there may be some variations. For instance, regions that provide better health facilities for their population will probably employ larger shares of the labour force in *Human health activities (Q86)* while regions where restaurants and bars abound will employ more people in *Food and beverage service activities (I56)*. However, it is in traded activities where larger specialisation is expected, indicating the presence of specialised clusters.

The uneven distribution of economic activity across Europe can be appreciated by considering the regions that account for the most employment in each of the 88 sectors. Table 3 lists the top 3 regions for each of the 20 sectors identified in Figure 15 as accounting for the highest shares of total European employment. It is important to note that several regions appear in various sectors (DEA. North Rhine - Westphalia, FR1. Île-de-France ...). Most of them are NUTS1 regions that tend to be larger than NUTS2 regions and hence not only do they account for more employment in these sectors, but in general in most activities. The share of total sector employment of the top 3 regions varies from 7.3% in the *Residential care (Q87)* sector, a non-traded activity that tends to be more evenly distributed across

regions, to 36.3% in *Computer programming, consultancy and related activities (J62)*, a traded activity that tends to cluster in a smaller number of regions. This implies that one in three people working in *Computer programming, consultancy and related activities* in the EU-27 is located in one of the top 3 regions. While this is indeed a large concentration of employment, it should be noted that the three top regions in this case (DEA. North Rhine-Westphalia, DE2. Bavaria and FR1. Île-de-France) are among the largest in the EU-27 and account for around 10% of total EU-27 employment.

Table 3: Top 3 regions in employment share in the 20 sectors with most employment in Europe

Sectors	Top 1	Top 2	Top 3	Share of TOP-3 in EU-27 sector employment
G47: Retail trade (not motor vehicles)	DEA. North Rhine-Westphalia	DE2. Bavaria	DE1. Baden-Württemberg	12.5%
O84: Public adm., defence, soc. security	FR1. Île-de-France	DEA. North Rhine-Westphalia	DE2. Bavaria	9.7%
P85: Education	FR1. Île-de-France	DEA. North Rhine-Westphalia	DE2. Bavaria	8.9%
Q86: Human health	DEA. North Rhine-Westphalia	DE2. Bavaria	DE1. Baden-Württemberg	15.2%
G46: Wholesale trade (not motor vehicles)	DEA. North Rhine-Westphalia	FR1. Île-de-France	DE2. Bavaria	13.0%
A01: Crop & animal production	RO21. North-East (Romania)	RO41. South-West Oltenia	RO31. South-Muntenia	15.4%
F43: Specialised construction act.	DEA. North Rhine-Westphalia	DE2. Bavaria	DE1. Baden-Württemberg	11.5%
I56: Food & beverage services	ITC4. Lombardy	ES61. Andalusia	ES51. Catalonia	8.9%
H49: Land transport (inc. pipelines)	FR1. Île-de-France	DE2. Bavaria	DEA. North Rhine-Westphalia	10.0%
Q88: Social work without accommodation	DEA. North Rhine-Westphalia	DE2. Bavaria	FR1. Île-de-France	17.4%
N78: Employment activities	FR1. Île-de-France	DEA. North Rhine-Westphalia	FRK. Auvergne-Rhône-Alpes	21.9%
N81: Buildings services and landscaping	DEA. North Rhine-Westphalia	BE2. Flemish Region	DE2. Bavaria	12.7%
Q87: Residential care	DEA. North Rhine-Westphalia	DE2. Bavaria	DE1. Baden-Württemberg	7.3%
C10: Manuf. of food products	DEA. North Rhine-Westphalia	DE2. Bavaria	DE9. Lower Saxony	6.8%
F41: Construction of buildings	RO21. North-East (Romania)	DE2. Bavaria	ES61. Andalusia	23.5%
G45: Trade & repair of motor vehicles	DEA. North Rhine-Westphalia	DE2. Bavaria	DE1. Baden-Württemberg	7.6%
C25: Manuf. of fabricated metal products	DEA. North Rhine-Westphalia	DE1. Baden-Württemberg	ITC4. Lombardy	17.9%
M69: Legal & accounting	ITC4. Lombardy	DEA. North Rhine-Westphalia	DE2. Bavaria	30.6%
M71: Architecture, engineering	DEA. North Rhine-Westphalia	DE2. Bavaria	DE1. Baden-Württemberg	18.6%
J62: Computer programming, consultancy	DEA. North Rhine-Westphalia	DE2. Bavaria	FR1. Île-de-France	36.3%

Source: Based on data from Eurostat and national statistics offices.
Note: Employment share is calculated as the proportion of total EU-27 sector employment in each region. Top 3 regions are those with highest shares of employment in each sector. Share of sectoral employment is the proportion of total sectoral employment accounted for by the top 3 regions.

A similar analysis can be conducted using specialisation indices calculated as location quotients (LQs) that reflect the relative specialisation of an activity in a region compared to the EU average.[29] Table 4 presents the results for the same 20 sectors.

Table 4: Top 3 regions in specialisation in the 20 sectors with most employment in Europe

Sectors	Top 1	Top 2	Top 3	Share of TOP-3 in EU-27 sector employment
G47: Retail trade (not motor vehicles)	AT32. Salzburg	HU12. Pest	ITF4. Apulia	1.6%
O84: Public adm., defence, soc. security	ES63. Ceuta	ES64. Melilla	HU31. North Hungary	0.7%
P85: Education	BE1. Brussels Region	FI1D. North and East Finland	FRY3. French Guiana	2.0%
Q86: Human health	FRY5. Mayotte	NL11. Groningen	BE3. Walloon Region	1.3%
G46: Wholesale trade (not motor vehicles)	ES62. Murcia	RO32. Bucharest-Ilfov	CZ01. Prague	2.7%
A01: Crop & animal production	RO21. North-East (Romania)	RO41. South-West Oltenia	EL65. Peloponnese	12.6%
F43: Specialised construction act.	FRM. Corsica	SE31. North-Central Sweden	FRY5. Mayotte	0.6%
I56: Food & beverage services	EL42. South Aegean	EL62. Ionian Islands	EL41. North Aegean	0.8%
H49: Land transport (inc. pipelines)	LT02. Cultural regions of Lithuania	RO11. North-West (Romania)	LT01. Vilnius County	2.7%
Q88: Social work without accommodation	DK02. Zealand	FRY5. Mayotte	FRM. Corsica	0.8%
N78: Employment activities	NL42. Limburg	NL13. Drenthe	NL11. Groningen	3.0%
N81: Buildings services and landscaping	FRM. Corsica	BE3. Walloon Region	ES64. Melilla	2.1%
Q87: Residential care	FI20. Åland Islands	DK02. Zealand	NL11. Groningen	1.0%
C10: Manuf. of food products	PL92. Mazowieckie-Regional	HU33. South Great Plain	FRH. Brittany	4.6%
F41: Construction of buildings	RO21. North-East (Romania)	RO12. Centre (Romania)	RO22. South-East (Romania)	6.3%
G45:Trade & repair of motor vehicles	FRY2. Martinique	AT32. Salzburg	HU12. Pest	0.8%
C25: Manuf. of fabricated metal products	AT34. Vorarlberg	CZ07. Central Moravia	SE21. Småland and islands	2.0%
M69: Legal & accounting	LU. Luxembourg	ITI4. Lazio	ITF3. Campania	5.7%
M71: Architecture, engineering	FRJ. Occitania	SE23. West Sweden	FRC. Burgundy-Franche-Comté	4.9%
J62: Computer programming, consultancy	SE11. Stockholm	FI1B. Helsinki-Uusimaa	HU11. Budapest	5.2%

Source: Based on data from Eurostat and national statistics offices.
Note: Specialisation is calculated as location quotients (LQ), reflecting relative employment in a region in each sector as compared to the EU-27 average (see Annex 3). Top 3 regions are those with highest specialisation (LQs) in each sector. Share of sectoral employment is the proportion of total sectoral employment accounted for by the top 3 regions.

The list of top regions is quite different, with only a couple of regions appearing in both lists for the same sector: North-East (Romania) and South-West Oltenia in *Crop & animal production (A1)* and the former also in *Construction of buildings (F41)*. This highlights the key distinction between a region

[29] See Annex 3 for methodological detail on the calculation of location quotients.

accounting for a large amount of employment in a sector, which is determined in part by the size of the region, and a region being specialised in a sector relative to other regions, which reflects the agglomeration advantages associated with clusters. Thus, the list of regions in Table 4 is also more diverse and includes many smaller regions, highlighting that regions of all sizes are specialised in specific activities.

Building further on this analysis of LQs, there are two alternative ways to analyse the significance of regional specialisation in specific sectors. The first is from the perspective of the sector at European level, where it is interesting to know which regions specialise in each sector only where that specialisation is also significant in terms of total sector employment in Europe. An alternative is from the perspective of the region, where it is possible to identify which sectors each region has strengths in, both because it is more specialised than other regions and because those sectors generate a significant share of employment within the region.

Two distinct indicators can therefore be developed to measure the presence of clusters:

- **Industry-relevant specialisation nodes:** When the region is specialised in the sector (or industrial ecosystem) (LQ > 1.5) and regional employment in the sector is relevant in the EU context (industry employment share > 1%).
- **Region-relevant specialisation nodes:** When the region is specialised in the sector (LQ > 1.5) and the employment share of that sector is relevant for the region (regional employment share > 1%).

Based on the LQs and regional employment shares of 88 sectors in 201 regions, Map 2 plots the number of industry-relevant specialisation nodes identified in each region on the left and the total share of employment accounted for by these nodes on the right. Map 3 does the same for industry-relevant specialisation nodes. Overall, there are 1160 industry-relevant specialisation nodes across the EU-27, accounting for 19.5% of total employment. Several regions do not have any industry-relevant nodes while the maximum is achieved in Budapest with 24 nodes, accounting for 44.1% of employment in the region. The maximum share of employment in industry-relevant nodes occurs in North-East (Romania), where 10 nodes accumulate 60.4% of regional employment.

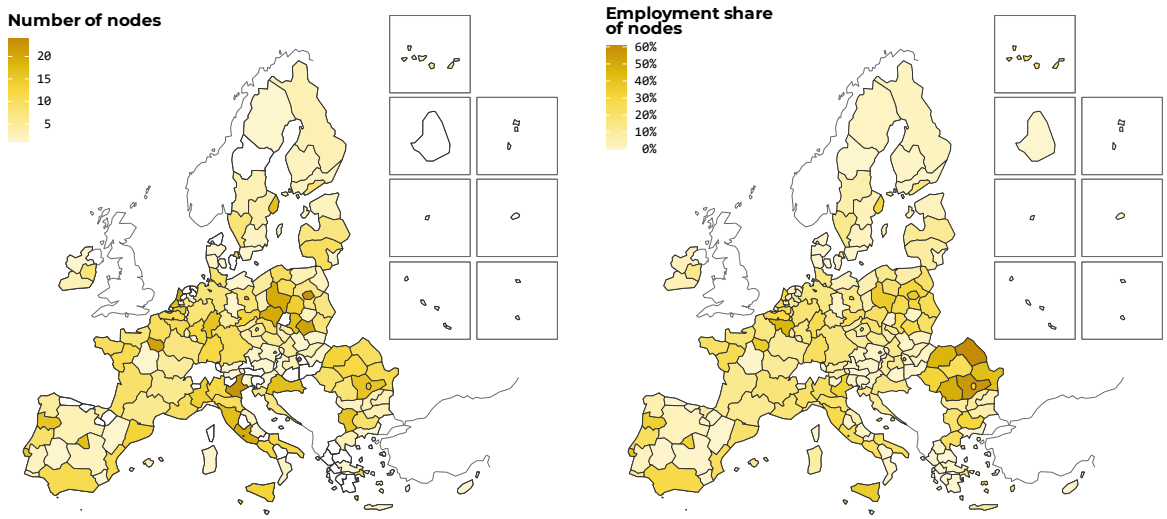
The general pattern of region-relevant specialisation nodes is quite similar in terms of regional distribution of both number of nodes and employment share, but there are subtle differences to be observed. Moreover, the overall number of these nodes in Europe is considerably larger at 1501, accounting for 24.4% of total employment. Above all, this highlights the tendency for sectors to cluster in specific places, and the importance of that clustered activity for European regions in terms of their employment and competitiveness.

While all regions have some region-relevant specialisation nodes, the maps highlight significant variation both in the number of nodes (from 2 to 15) and in their share of employment (from 2.2% in Lower Austria to 65.4% in Mayotte, France). That this pattern of variation differs across the maps suggests that some regions are dependent for a large amount of employment on a relatively smaller number of specialised sectors (e.g. North East, Romania), while other regions have a more diversified portfolio of economic activity that is reflected in a moderate share of employment from a relatively high number of specialisation nodes (e.g. Veneto, Italy).

It can also be observed that larger regions tend to have relatively more industry-relevant nodes than region-relevant nodes. This is because when they specialise in a particular sector, it is more likely that they reach employment levels that account for a significant share of total employment in the sector. However, if such a sector is quite small in terms of total employment in the EU-27, it might amount for a tiny share of employment in the region. Moreover, there is a general pattern by which peripheral regions appear to rely for a larger share of their employment on their specialised nodes (darker shades in the East, West, South, North and islands on the right-hand side of Map 3). This may indicate an enhanced need and/or capacity to derive employment from specialisation dynamics in regions that

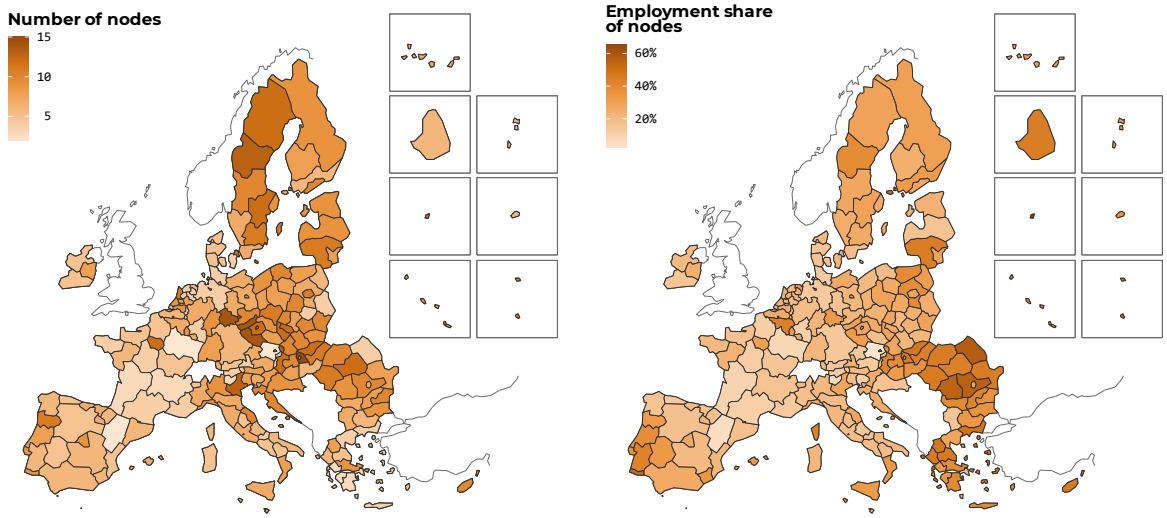
are peripheral (and that also tend to be smaller) as compared to the more diverse and usually larger regions closer to the dynamic centre of European industrial activity.

Map 2: Industry-relevant specialisation nodes and their share of regional employment



Source: Based on data from Eurostat and national statistics offices.
Note: Industry-relevant specialisation nodes indicate that the region is specialised in the sector (LQ > 1.5) and regional employment in the sector is relevant in the EU context (industry employment share > 1%). Employment share reflects the amount of employment in the nodes as a share of total employment in the region.

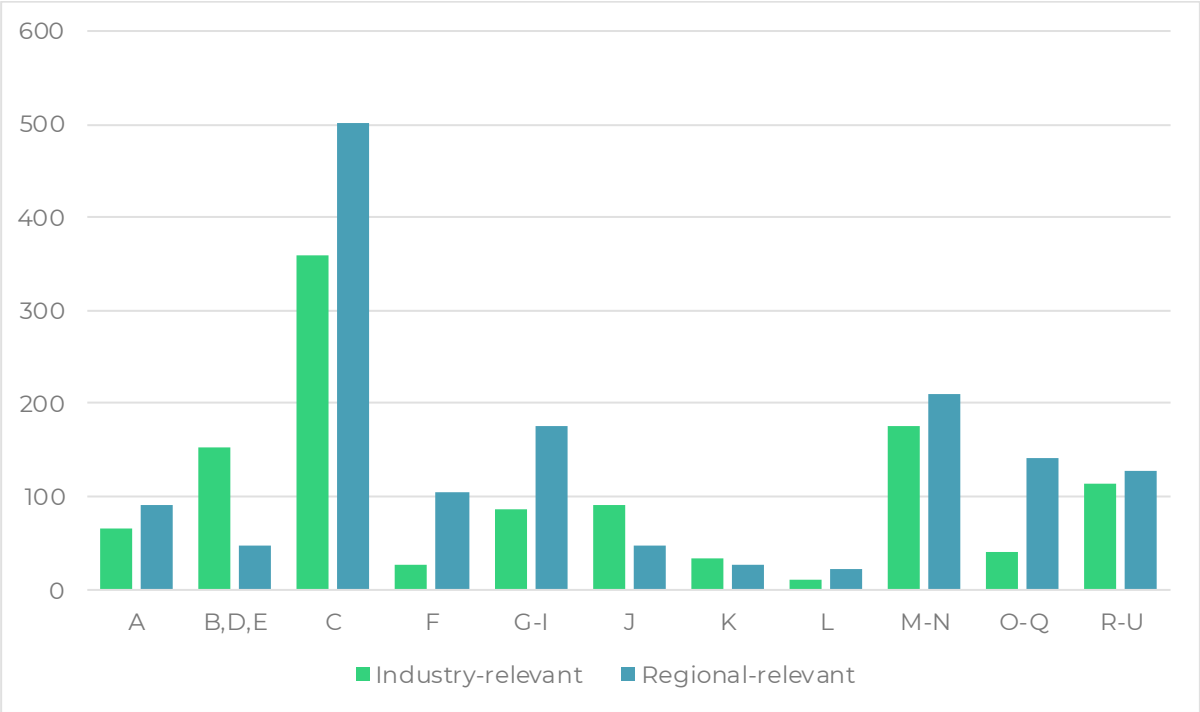
Map 3: Region-relevant specialisation nodes and their share of regional employment



Source: Based on data from Eurostat and national statistics offices.
Note: Region-relevant specialisation nodes indicate that the region is specialised in the sector (LQ > 1.5) and the employment share of that sector is relevant for the region (regional employment share > 1%). Employment share reflects the amount of employment in the nodes as a share of total employment in the region.

Figure 17 shows the distribution of nodes according to the broad categories of activities. *Manufacturing (C)* accounts for the largest number of nodes, confirming that clusters tend to occur mainly in traded activities, which are the bulk of activities in this category. It can also be observed that regional-relevant nodes are usually more prevalent than industry-relevant nodes. The exceptions are *Information and communication (J)* and *K: Financial and insurance*, because, except for *Computer programming, consultancy (J62)* and *Financial services (K64)*, they are composed of activities that are quite small in terms of total employment in Europe.

Figure 17: Number of nodes in 11 categories of activities in the EU-27 (2018)



Source: Based on data from Eurostat and national statistics offices.
Note: A: Agriculture, forestry and fishing; B,D,E: Mining, Energy and Water supply; F: Construction; G-I: Domestic trade, transport, accommodation and food service; J: Information and communication; K: Financial and insurance; L: Real estate; M-N: Professional, scientific and technical; administrative and support service; O-Q: Public admin., defence, education, human health and social work; R-U: Arts, entertainment and recreation; other services; act. of households and extra-territorial.

3.2 Clusters and the distribution and regional specialisation of industrial ecosystems

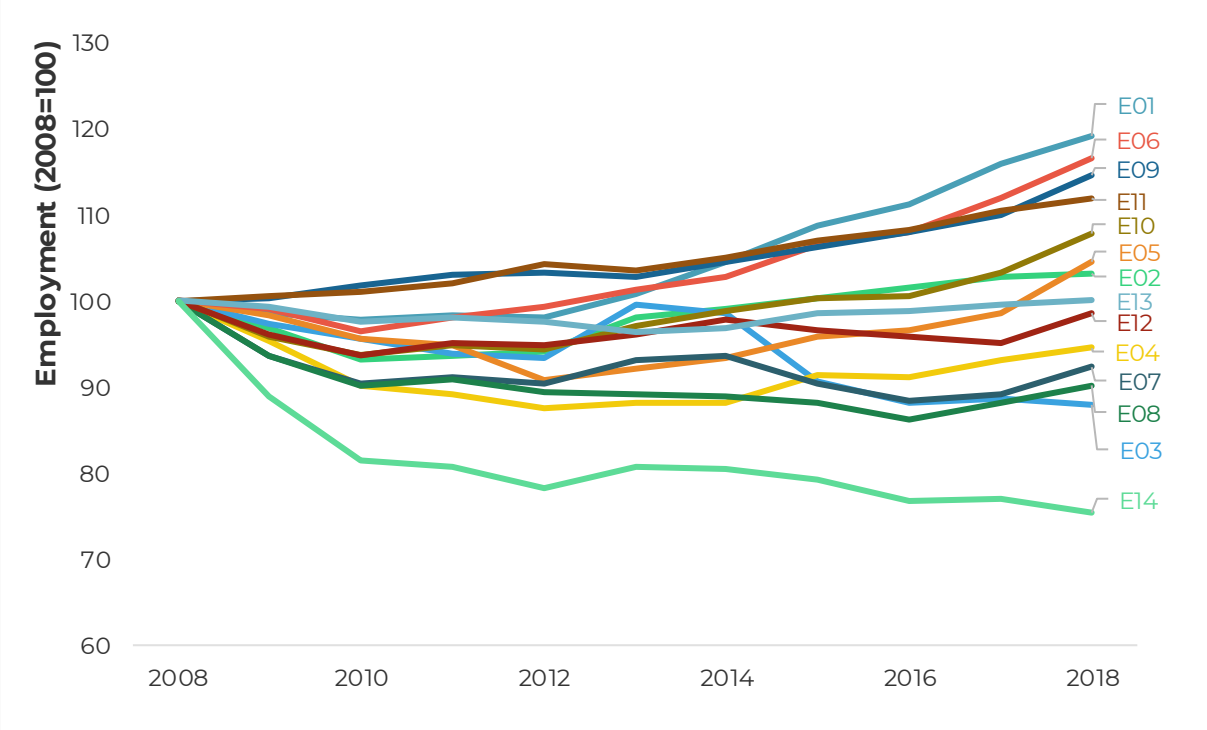
During the initial stages of the socioeconomic crisis caused by the COVID-19 pandemic the European Commission identified 14 industrial ecosystems with pan-European importance that would be critical for the recovery. These have become an important focus for policy, especially regarding the transformation pathways that are needed to propel Europe's green and digital transition and ensure ongoing resilience. This Section therefore conducts a parallel analysis to the previous Section for these 14 industrial ecosystems.[30]

[30] These 14 industrial ecosystems have been calculated by aggregating NACE 2-digit activities, following the methodology established in European Commission (2021c) that establishes connected activities based on their "inter-industry interdependencies" and assigns different weights to 2-digit NACE codes activities. The weights can be found in Annex 7.

Industrial ecosystem distribution and clusters

As observed in the previous section for sectors, the 14 ecosystems have also followed diverse evolution trends. Most of them saw employment declining at the beginning of the crisis. Several have already recovered and reached employment levels above their 2008 values (*Tourism (E01)*, *Digital (E06)*, *Mobility-Transport-Automotive (E10)*, *Creative & Cultural Industries (E05)*, *Aerospace & Defence (EO2)*, and *Retail (E13)*), while others are not there yet (*Renewable Energy (E12)*, *Construction (E04)*, *Electronics (E07)*, and *Energy Intensive Industries (E08)*). There are also some that are undergoing a continuous decline (*Agri-food (E03)* and *Textile (E14)*) and some that have continuously grown (*Health (E09)* and *Proximity & Social Economy (E11)*).

Figure 18: Evolution of employment in the 14 ecosystems in the EU-27



Source: Based on data from Eurostat and national statistics offices.
Note: E01. Tourism; E02. Aerospace & Defence; E03. Agri-food; E04. Construction; E05. Creative & Cultural Industries; E06. Digital; E07. Electronics; E08. Energy Intensive Industries; E09. Health; E10. Mobility-Transport-Automotive; E11. Proximity & Social Economy; E12. Renewable Energy; E13. Retail; E14. Textile.

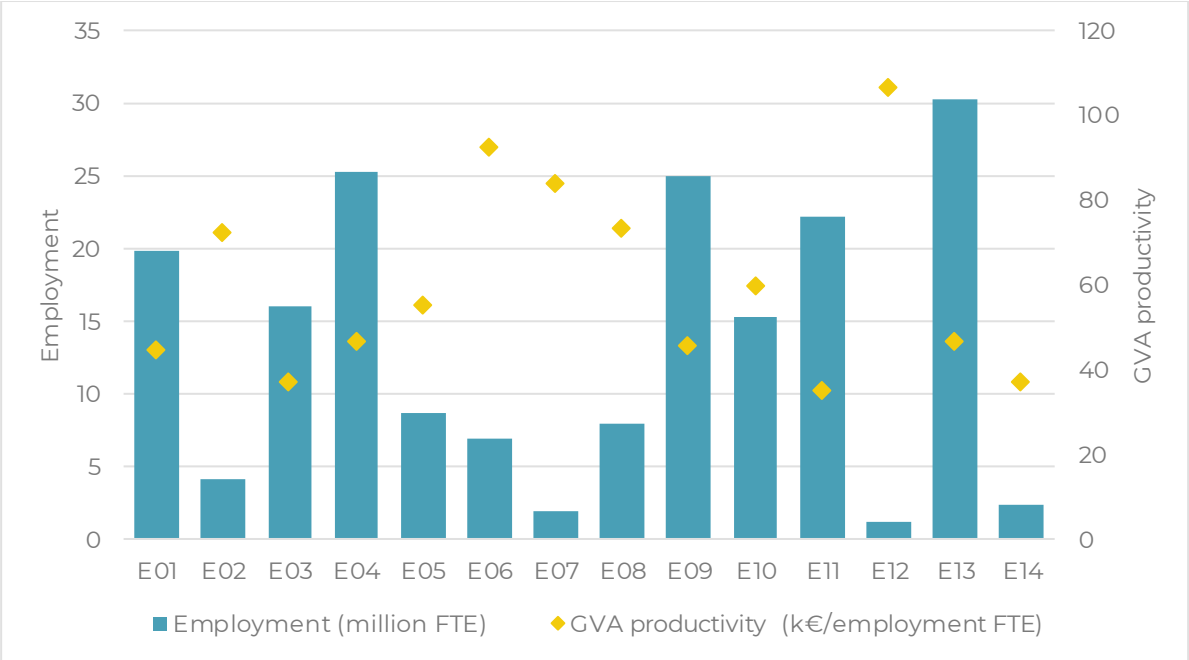
As shown in Figure 19, Figure 20 and Figure 21, productivity and presence of cluster organisations also varies across the ecosystems. Productivity is higher in the ecosystem with least employment, *Renewable energy (E12)* followed by the *Digital (E06)* and *Electronics (E07)* ecosystems. *Digital (E06)* is also the ecosystem where most cluster organisations are present, followed by *Agri-food (E03)* and *Health (E09)*, with *Renewable energies (E12)* coming in fourth position. The combination of high productivity and presence of cluster organisation in the *Digital (E06)* ecosystem is an asset to pursue the digital transition in Europe, as is the high productivity and relatively large number of cluster organisations in the *Renewable energies (E12)* ecosystem for the green agenda.

With lowest productivity, we find *Proximity and social economy (E11)*, *Textile (E14)* and *Agri-Food (E03)*. They each correspond with different combinations of employment and presence of cluster organisations. Both *Proximity and social economy (E11)*, and *Agri-Food (E03)* have relatively large levels of employment (over 15 million FTE each), but while there are very few cluster organisations

associated with the former, there are over 50 cluster organisations associated to the *Agri-Food (E03)* ecosystem. The *Textile (E14)* ecosystem, on the other hand, is characterised, not only by a low productivity level, but also by a low level of employment and scarce number of cluster organisations. Hence, there is no clear relationship between the three variables in the ecosystems.

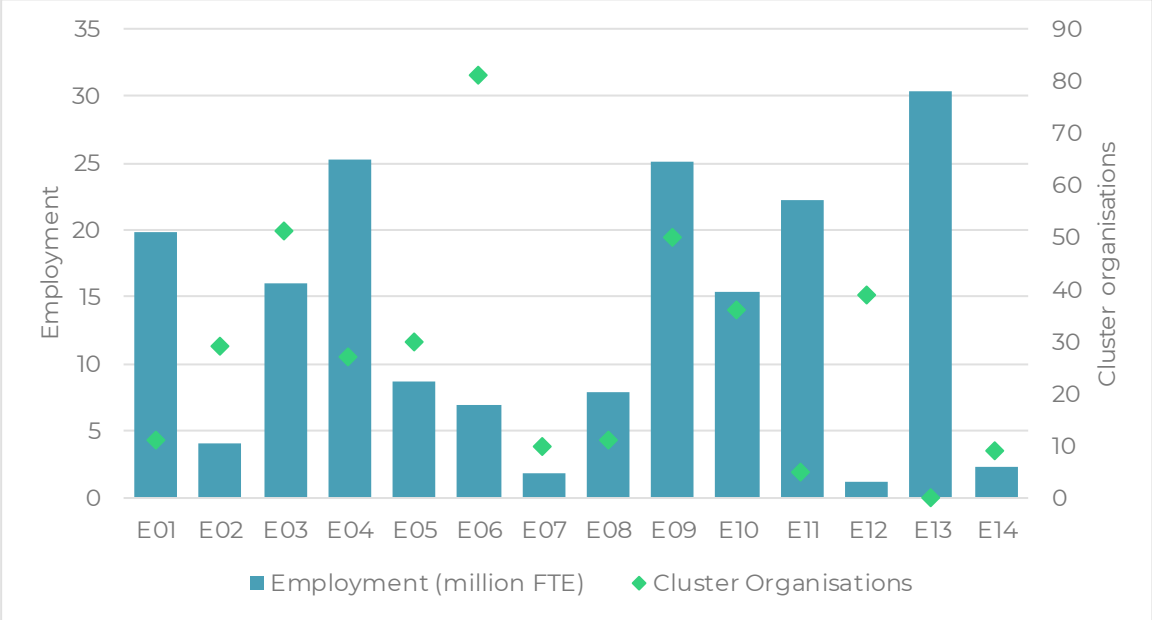
It is also interesting to note that out of the sample of 468 cluster organisations with updated ECCP profiles, 79 did not associate themselves with any of the ecosystems. This might be because cluster organisations have not yet become familiar with them, given that it is only during the last year that they have been highlighted by the European Commission for their critical role in the post-pandemic recovery process.

Figure 19: Employment and productivity in the 14 ecosystems in the EU-27 (2018)



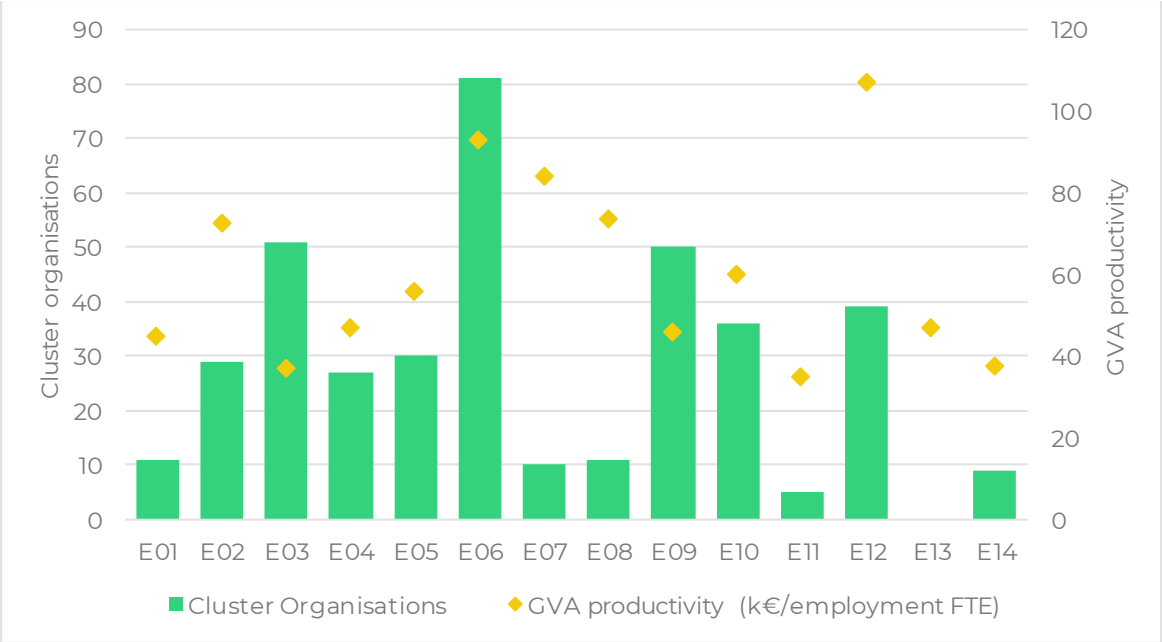
Source: Based on data from Eurostat and national statistics offices.
Note: E01. Tourism; E02. Aerospace & Defence; E03. Agri-food; E04. Construction; E05. Creative & Cultural Industries; E06. Digital; E07. Electronics; E08. Energy Intensive Industries; E09. Health; E10. Mobility-Transport-Automotive; E11. Proximity & Social Economy; E12. Renewable Energy; E13. Retail; E14. Textile.

Figure 20: Employment and cluster organisations in the 14 ecosystems in the EU-27 (2018)



Source: Based on data from Eurostat, national statistics offices and ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.
Note: E01. Tourism; E02. Aerospace & Defence; E03. Agri-food; E04. Construction; E05. Creative & Cultural Industries; E06. Digital; E07. Electronics; E08. Energy Intensive Industries; E09. Health; E10. Mobility-Transport-Automotive; E11. Proximity & Social Economy; E12. Renewable Energy; E13. Retail; E14. Textile

Figure 21: Productivity and cluster organisations in the 14 ecosystems in the EU-27 (2018)



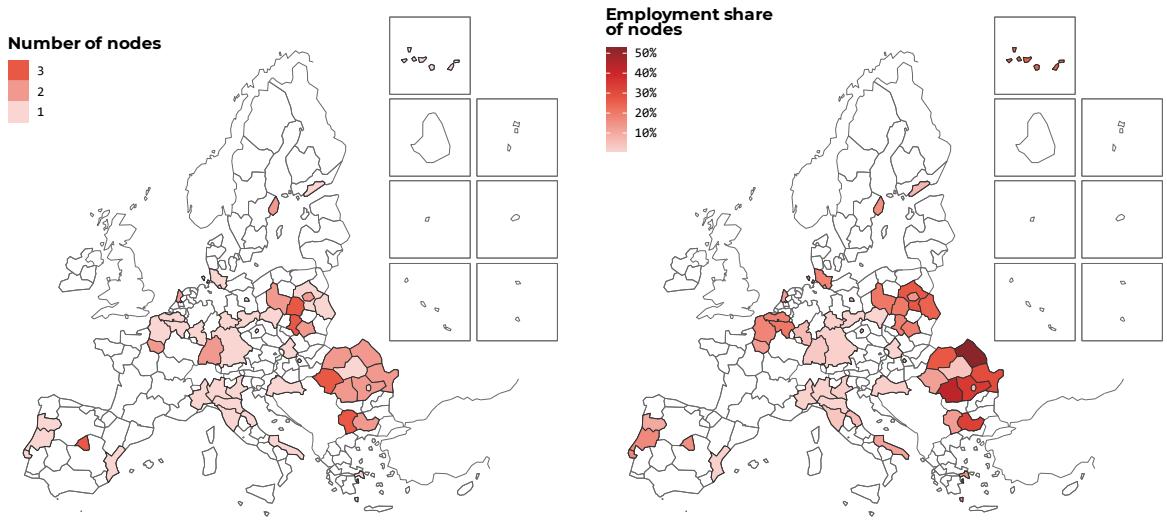
Source: Based on data from Eurostat, national statistics offices and ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.
Note: E01. Tourism; E02. Aerospace & Defence; E03. Agri-food; E04. Construction; E05. Creative & Cultural Industries; E06. Digital; E07. Electronics; E08. Energy Intensive Industries; E09. Health; E10. Mobility-Transport-Automotive; E11. Proximity & Social Economy; E12. Renewable Energy; E13. Retail; E14. Textile.

Regional industrial ecosystem specialisation and clusters

Following the definitions of region-relevant and industry-relevant nodes used in the previous section, in Map 4 and Map 5 we can explore how ecosystems are distributed across European regions. Overall, there are only 74 industry-relevant nodes and 276 region-relevant specialisation nodes in Europe, that account for, respectively, 5.9% and 11.2% of total employment. These figures are much smaller than in the case of sectors because, with only 14 ecosystems that aggregate several activities, all regions have employment in each of them. This therefore decreases the likelihood of regions being highly specialised.

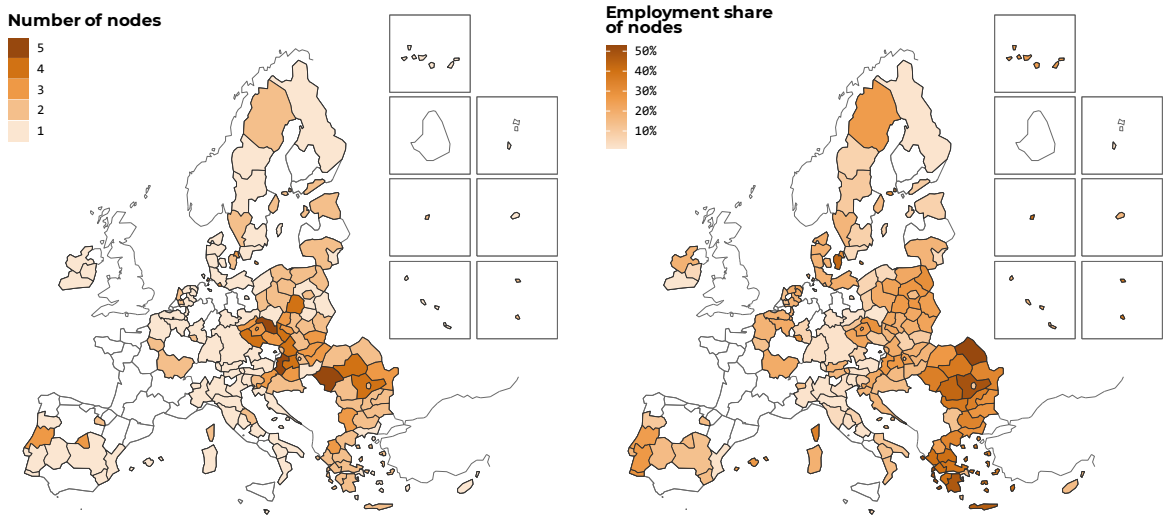
As can be seen from Map 4 and Map 5, therefore, many regions do not have any specialised nodes, either because they do not have much employment in the ecosystems or because the employment is spread among the ecosystems without any clear specialisation pattern. On the other hand, the regions with several specialisation nodes in industrial ecosystems tend to be concentrated in Eastern European countries and in some regions where the national capital is located. Moreover, some of these regions accumulate large shares of regional employment in the ecosystems in which they are specialised, above 30% or 40% in some cases. The effect in capital regions is related to the large amounts of employment in these regions in ecosystems such as *Creative and cultural, Tourism* and *Digital*, while the effect in Eastern European regions is related to their heavy concentration of employment associated with their specialisation in lower-value *Agri-food* and *Textile* activities (see also Map 6).

Map 4: Number of ecosystems' industry-relevant nodes and their share of regional employment



Source: Based on data from Eurostat and national statistics offices.
Note: Industry-relevant specialisation nodes indicate that the region is specialised in the ecosystem (LQ > 1.5) and regional employment in the ecosystem is relevant in the EU context (industry employment share > 1%). Employment share indicates the share of employment in the nodes over total employment in the region.

Map 5: Number of ecosystems' regional-relevant nodes and their share of regional employment



Source: Based on data from Eurostat and national statistics offices.
Note: Regional-relevant specialisation nodes indicate that the region is specialised in the sector (LQ > 1.5) and the employment share of that sector is relevant for the region (regional employment share > 1%). Employment share indicates the share of employment in the nodes over total employment in the region.

Map 6 allows us to further explore how each ecosystem is distributed in Europe and how they vary in terms of employment, specialisation, and productivity. In the first column, we can observe that large regions tend to account more employment in most ecosystems due to their size, but not in all. Thus, for instance, the *Agri-food* and *Textile* ecosystems exhibit a very different pattern employment-wise.

The second column depicts location quotients (LQs). The two darkest shades, being greater than 1.5, correspond to regions that are highly specialised and are potential nodes if employment reaches 1% of total regional employment and/or 1% of total ecosystem employment. It can be observed that some of the ecosystems, particularly those that account for more employment in Europe, show low levels of specialisation: most regions are either non-specialised or low specialised, below the 1.5 threshold. On the other hand, some ecosystems (such as *Agri-food*, *Energy intensive industries* and *Textile*) present a higher density of medium specialised and highly specialised nodes, indicating that these ecosystems tend to concentrate in some regions more than in others. This is also the case of the ecosystems that account for lower aggregate levels of employment: *Electronics*, *Energy-Intensive* and *Renewable Energy*.[31]

Finally, the last column shows the variation in productivity. There is a distinct pattern, with Eastern European regions (mainly in Bulgaria, Hungary and Romania) generally being more labour-intensive and, hence, less productive. Regions with national capitals such as Brussels, Copenhagen, Luxembourg, Paris and Stockholm, tend to be very productive in all ecosystems, as is the case in the Eastern and Midland region in Ireland, where Dublin is located, but also the neighbouring Southern region. For some ecosystems, there seems to be a national pattern, with most regions in some countries being more productive than regions elsewhere, for instance Swedish regions in *Construction* and *Proximity and social economy* and Finish regions in *Health*. On the reverse side,

[31] In the latter case, the amount of employment generated in the region is so low in many regions that they are considered not to be regionally relevant.

most regions in Greece are among the least productive in *Construction* and *Retail*, for instance, as are Polish regions in the *Digital* and *Energy intensive industries* ecosystems.

A few main points can be drawn for each ecosystem:

- **Aerospace & Defence**: The most specialised regions are in Eastern Europe, but neither them, nor the non-specialised regions in the same area are the most productive in the EU-27. There are large disparities in productivity levels, with Irish regions followed by some central European and Northern regions being the most productive. The largest levels of employment can be found in some large German regions, as well as in Île-de-France and Lombardy.

- **Agri-food**: There is a clear specialisation pattern in some Eastern and Southern EU-27 regions, but only a some of them combine high levels of employment and specialisation, for instance in Romania. Large levels of employment can be found in low specialised regions (such as Andalusia) and some non-specialised regions in Germany. Productivity is also high in non-specialised regions such as Eastern and Midland (Ireland), Île-de-France, North-Central Sweden, or the Basque Country.

- **Construction:** Being a largely non-traded activity, employment is quite widespread across the EU-27, with the largest regions having larger shares of employment. The most productive regions are in Ireland and Sweden.

- **Creative & Cultural:** Employment is clearly concentrated in a few regions, mainly capital regions, with large specialisation ratios. Some of them are also among the most productive, such as Île-de-France and Stockholm. Large levels of employment can be found in Île-de-France (that ranks high in the three indicators), large German regions and Lombardy.

- **Digital:** Performance in this ecosystem is very similar to the creative & cultural ecosystem, with capital regions also exhibiting more specialisation and some of them are being among the most productive, and a similar pattern in terms of the regions with the highest levels of employment.

- **Electronics:** There are several regions in Eastern Europe that specialise in this ecosystem, but also do some German regions that have high levels of employment (Bavaria and Baden-Württemberg). However, the most productive regions are elsewhere, with some extremely high values that could be associated with the presence of headquarters or with less robust estimations

- **Energy intensive:** Some regions in Eastern Europe, particularly in the Czech Republic, but also in Sweden, specialise in this ecosystem, but without high levels of employment. There are also some unusually high values of productivity that could be associated to the presence of headquarters in the regions or with less robust estimations in regions with very low employment levels.

- **Health:** Being a largely non-traded activity, employment is quite widespread across the EU-27, with largest regions having larger shares of employment and without large disparities in productivity levels.

- **Mobility-Transport:** A few regions in Eastern Europe are highly specialised in this ecosystem. Employment levels are high in the largest regions and there not many disparities in productivity levels.

- **Proximity & Social:** An example of non-traded activities that spread quite evenly with only a handful of regions being highly specialised (and all of them with LQ ratios below 2) and similar levels of productivity that are not very high.

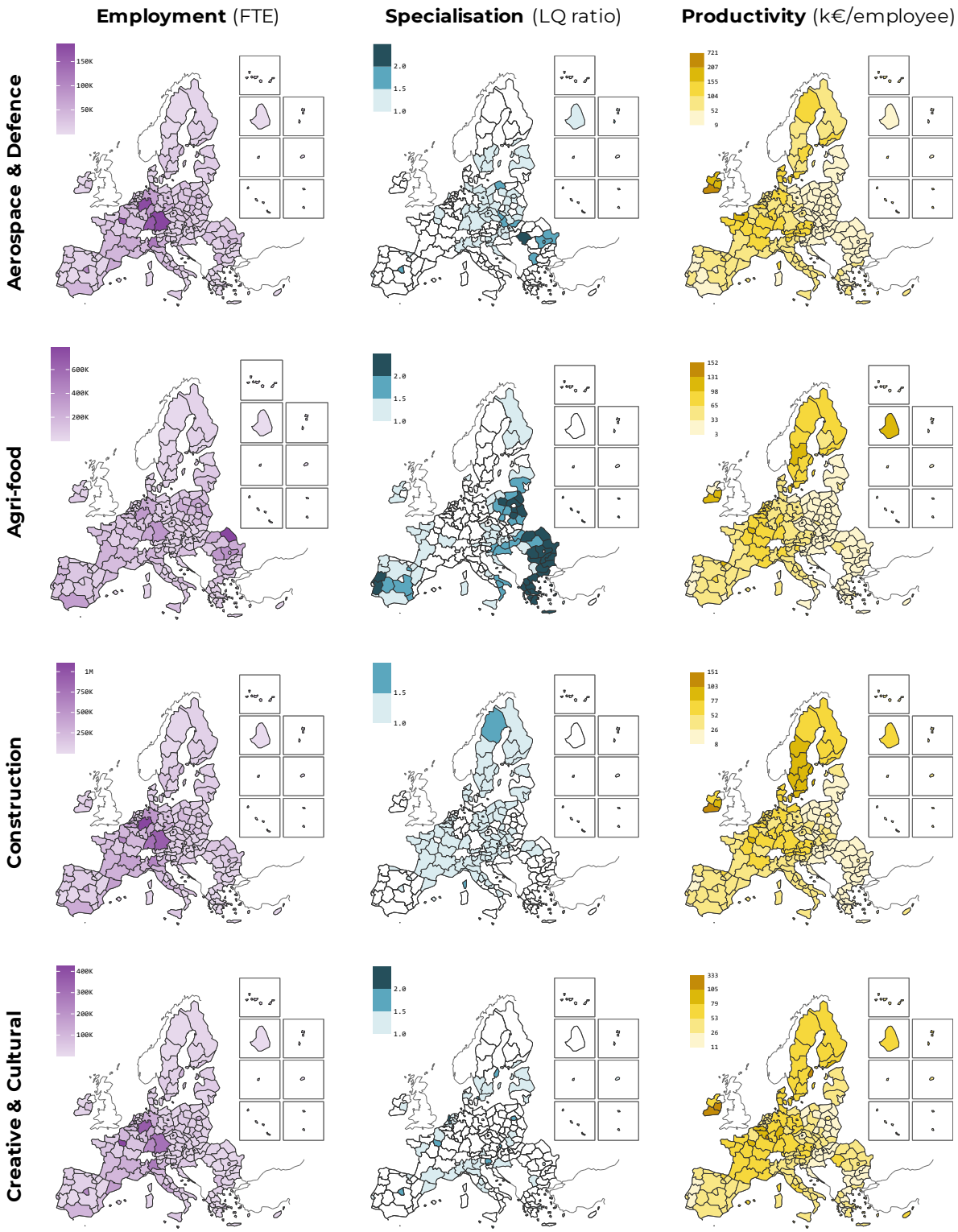
- **Renewable Energy:** Highly specialised regions in this ecosystem are mainly located in Eastern Europe, but Baden-Württemberg exhibits not only high specialisation but also high levels of employment. There are also some unusually high values of productivity that could be associated with the presence of headquarters in the regions or with less robust estimations in regions with very low employment levels.

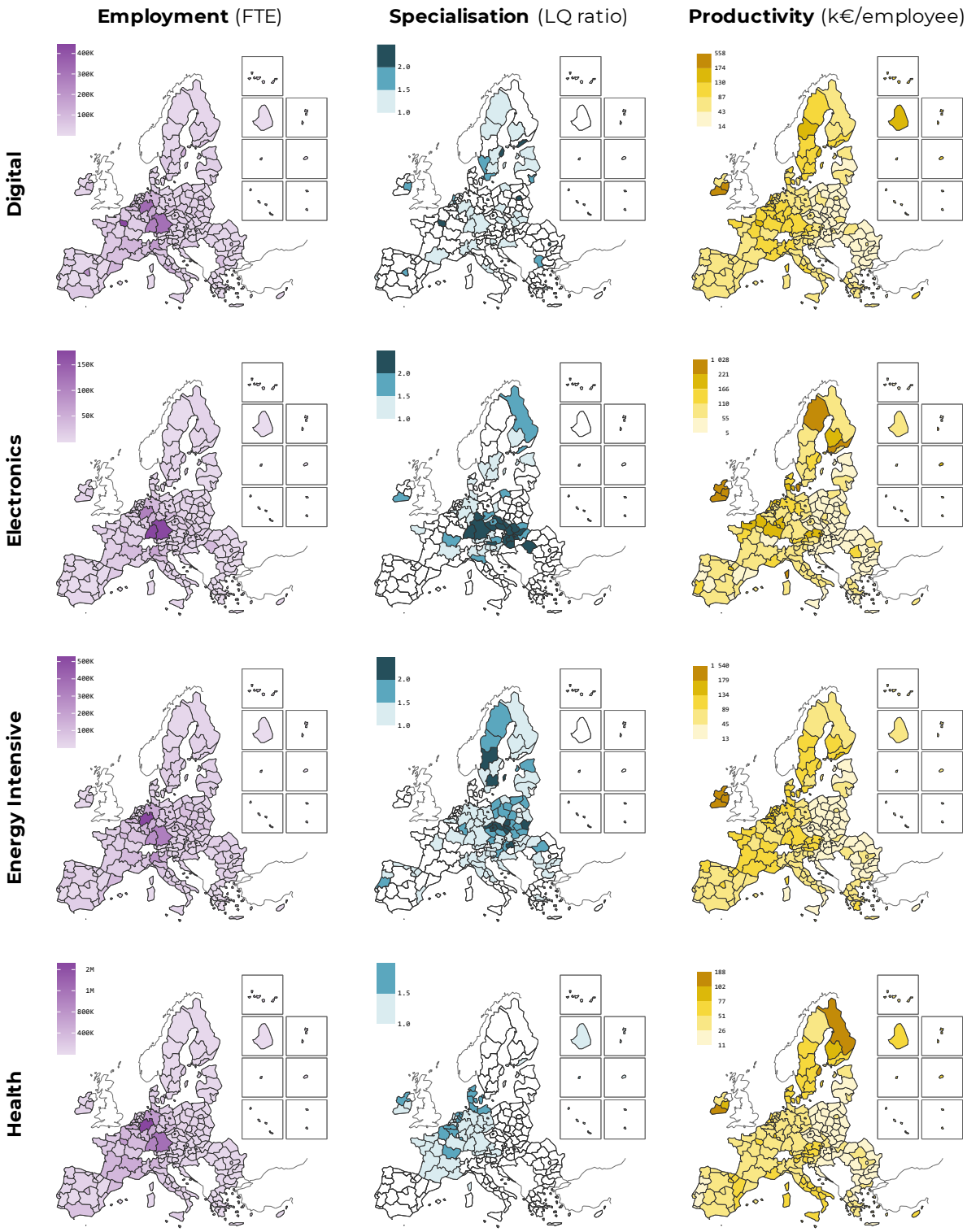
- **Retail:** The clearest example of an ecosystem composed of non-traded activities. Only one of the regions (Pest) is barely highly specialised. Therefore, employment distributes in the EU-27 according to the relative sizes of regions. Productivity is low and similar across all regions.

- **Textile:** Eastern and Southern European regions tend to specialise in this ecosystem. Some of them, such as North (Portugal), North West (Romania) or Tuscany, also have high levels of employment. However, productivity is higher in Southern (Ireland) and several regions in Spain.

- **Tourism:** Southern regions are the most specialised in this ecosystem. This is a very labour-intensive ecosystem and, as a consequence, even if there are some disparities across regions, productivity levels are generally low, as compared to the other ecosystems.

Map 6: Employment, specialisation and productivity in the 14 ecosystems in the EU27 regions




Employment (FTE)
Specialisation (LQ ratio)
Productivity (k€/employee)
Digital
Electronics
Energy Intensive
Health
400K
300K
200K
100K
150K
100K
50K
500K
400K
300K
200K
100K
2M
1M
800K
400K
2.0
1.5
1.0
558
174
130
87
43
14
1 028
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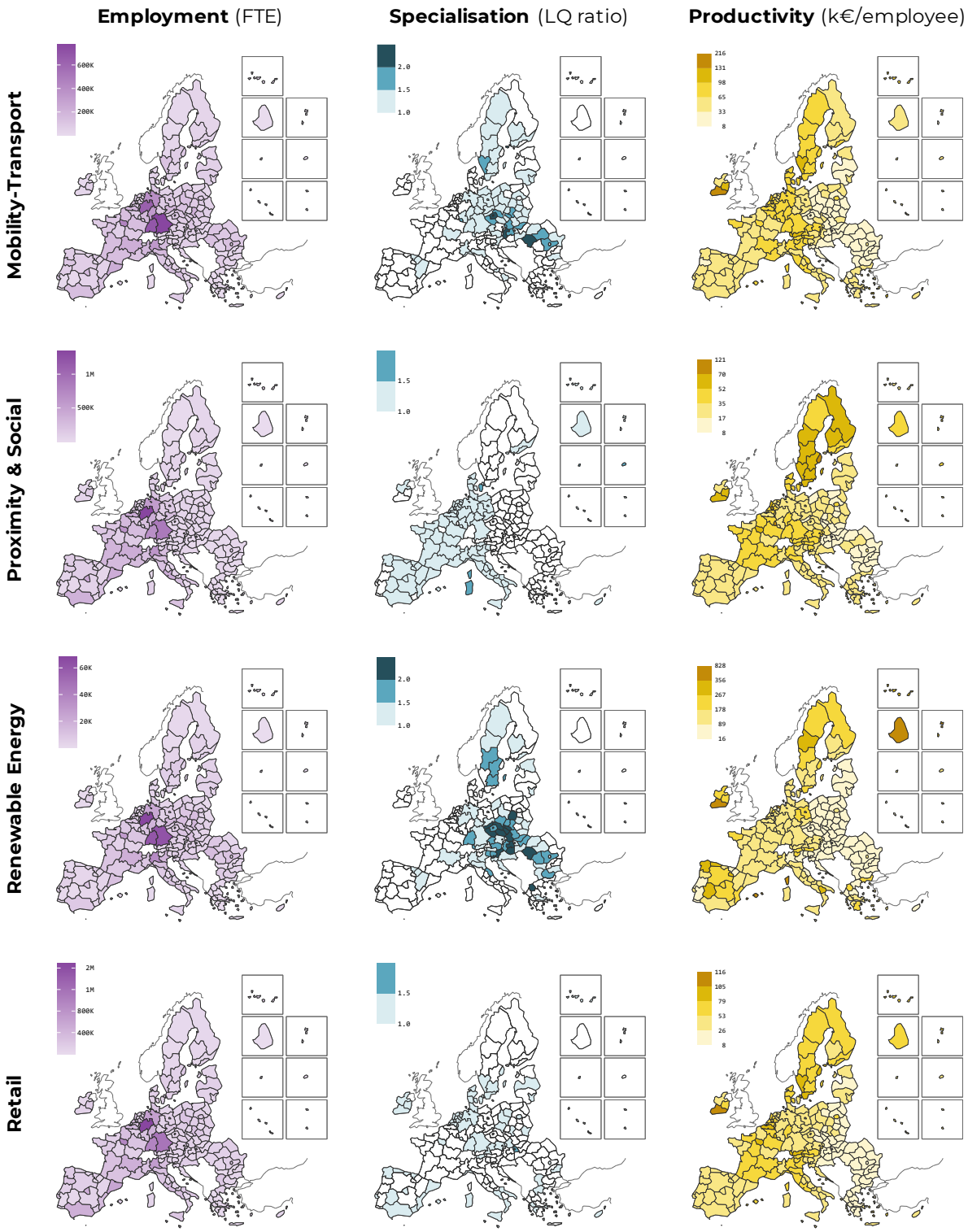
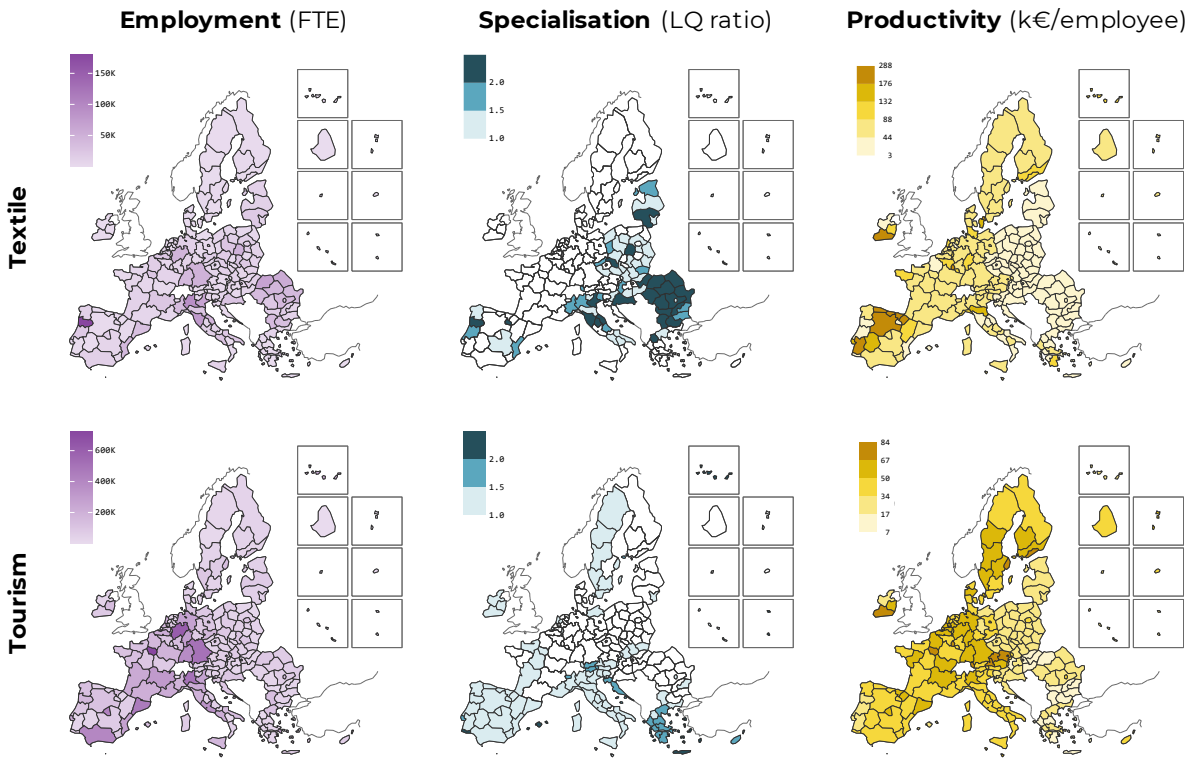

Employment (FTE)
Specialisation (LQ ratio)
Productivity (k€/employee)
Mobility-Transport
Proximity & Social
Renewable Energy
Retail



Source: Based on data from Eurostat and national statistics offices.

Note: Specialisation is calculated as location quotients (LQ), reflecting relative employment in a region in each sector as compared to the EU-27 average (see Annex 3); Productivity is calculated as GVA (k€) / employment (FTE).

04

Clusters and the green and digital transitions

4. Clusters and the green and digital transitions

Having explored the overall panorama of cluster organisations and specialisation in sectors and industrial ecosystems in Europe, this chapter zooms in on the links between clusters and the green and digital transitions. These transitions are both a feature of the competitiveness scenario in regions across Europe as firms adapt their activities, and a key focus for policy aimed at accelerating transitions and leveraging them for enhanced international competitiveness.

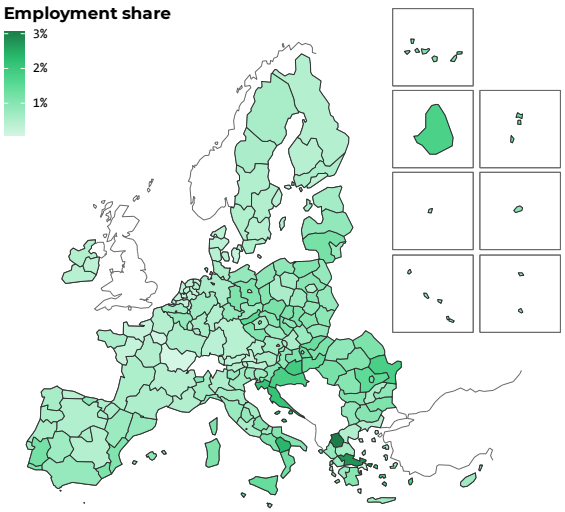
4.1 Employment in green and digital sectors

An initial understanding of the spread of green and digital activities can be obtained by examining data on employment. Map 7 shows the distribution of employment in green and digital sectors in Europe, based on assigning a selection of NACE 2-digit activities as green or digital.[32] Sectors classified as green account only for 0.7% of European employment and are spread fairly evenly, with a slight concentration in the South-East of Europe, while sectors classified as digital reach 2.8% of total employment and tend to concentrate in national capitals and more developed regions.

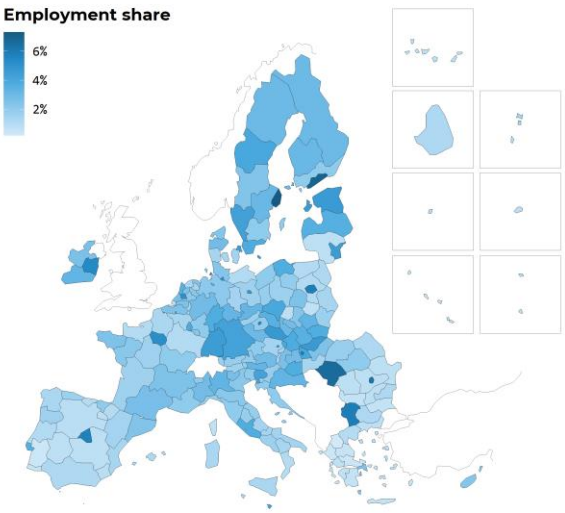
However, as indicated by the low levels of employment captured, this picture is unsatisfactory due to the need to artificially isolate green and digital activities in a narrow set of standard sector categories, when the reality is that green and digital activities permeate and cut across a whole range of different sectors. Indeed, taking alternative approaches to mapping green and digital cluster organisations, the transversality of these activities becomes much more apparent.

Map 7: Share of regional employment in green and digital sectors

Green sectors



Digital sectors



Source: Based on data from Eurostat and national statistics offices;

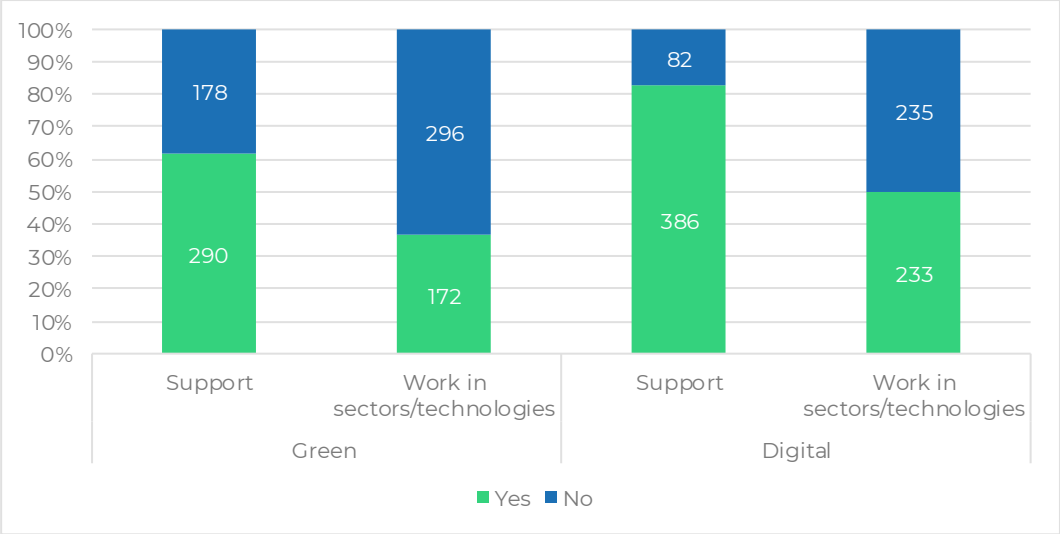
[32] Sectors E36-E39 (related to water and waste management and materials recovery) are assigned as green sectors, while sectors C26, J62 and J63 (related to computer and electronics manufacture, programming, and information services) are assigned as digital sectors. See Annex 2 for a list of sector codes and full definitions.

4.2 Green and digital cluster organisations

The mapping of green and digital clusters in the ECCP has been addressed through two different routes. On the one hand, cluster organisations (and other cluster actors) are automatically classified as working in green sectors or digital sectors, according to options that they select in their profiles reflecting the sectors, industrial ecosystems and alliances, and technologies in which they work.[33] On the other hand, they are asked to indicate whether they support companies to be green and/or companies' digitalisation.

As shown in Figure 22, the proportion of cluster organisations that work in green and digital sectors/technologies is markedly higher than would be expected from the picture of employment distribution provided in Map 7. This is due to a broader interpretation of green and digital activities to also include certain industrial ecosystems and alliances, cross-sectoral industries and technologies.[34] Even more striking is the proportion of cluster organisations that say that they support their companies to be green (62%) or to digitalise (83%). These figures starkly highlight the transversal nature of green and digital transitions for cluster organisations, in terms of their reach far beyond traditionally 'green' and 'digital' sectors.

Figure 22: Cluster organisations related to green and digital transitions



Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

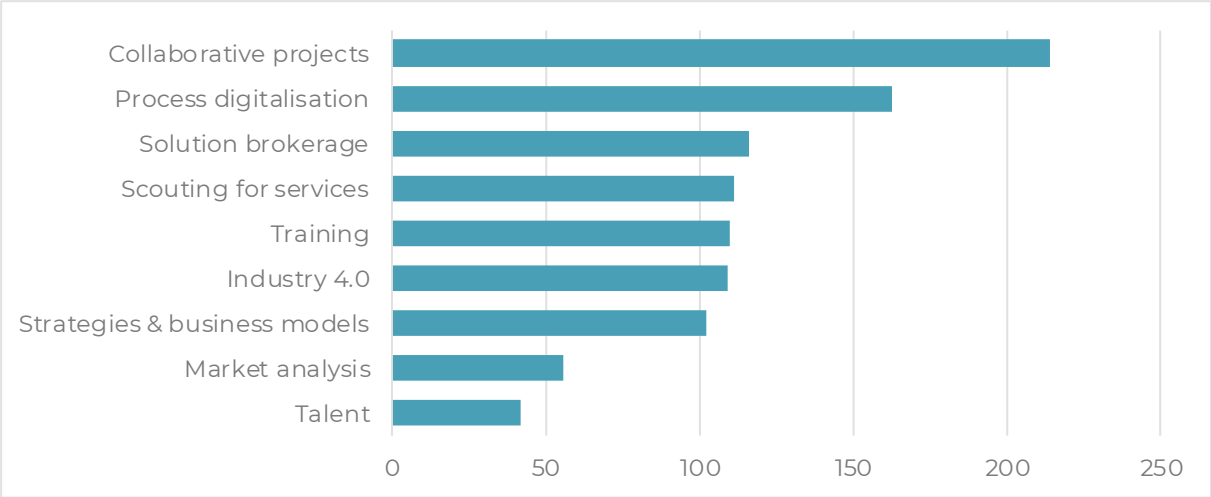
The ECCP profile data also enables a more granular look at the types of services and expertise that cluster organisations are providing their members in support of green and digital transition. Figure 23 details the wide range of resource efficiency services that are provided by EU-27 cluster organisations to their members. The most popular are transversal services related to the core collaboration function of clusters – practice sharing, collaboration brokering, networking, dissemination, awareness raising – and the importance of cluster collaboration for circular economy transition is also highlighted. Figure 24, on the other hand, zooms in on the type of digital expertise leveraged by European cluster organisations to support their members' digitalisation. It highlights both the breadth and depth of different areas of expertise, with hotspots in identifying and promoting collaborative projects for digitalisation and support for the digitalisation of processes. Figure 9 (in Chapter 2) also positioned both digital and green transition among the most popular areas for collaboration among EU-27 cluster organisations.

[33] The criteria to identify cluster actors as working in green or digital sectors can be found in Annex 8.
[34] See Annex 8.

Figure 23: Resource efficiency services provided by EU-27 cluster organisations

Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

Figure 24: Digitalisation expertise of European cluster organisations



Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

Finally, additional insight on the specific nature of the transversality of the green and digital transition can be drawn from analysing the link between cluster organisations working in different industrial ecosystems and the S3 priority areas and technology fields in which they identify themselves as being active.[35]

[35] A recent survey of regional policy makers conducted by the European Commission's Joint Research Centre (JRC) identified intermediary institutions, including cluster organisations, as being among the regional actors that most

Table 5 presents this analysis for the 8 industrial ecosystems with more than 20 cluster organisations (from the sample), and the transversality of digital and environmental priority areas and technologies across several ecosystems stands out. For example, AI and ICTs are linked not only to the *Digital* ecosystem, but also to the *Health*, *Mobility-transport-automotive*, *Construction*, *Creative and cultural industries* and *Aerospace and defence* ecosystems, and environmental priority areas and technologies are prevalent in the *Renewable energy*, *Agri-food*, *Construction*, and *Creative and cultural industries* ecosystems.

Table 5: Linking industrial ecosystems with S3 priority areas and technology fields

Industrial ecosystem (number of cluster organisations present)	Top S3 priority areas cited by cluster organisations (number of times cited)	Top technology fields cited by cluster organisations (number of times cited)
Digital (81)	· AI, cognitive systems, augmented and virtual reality, visualisation, simulation, gamification & interaction technologies (46) · Digitising Industry (Industry 4.0, smart and additive manufacturing) (36) · ICT trust, cyber security & network security (35)	· Information or communication technologies having an impact on other technology areas (40) · Information and communication technology [ICT] specially adapted for specific application fields (29) · Technologies or applications for mitigation or adaptation against climate change (18)
Agri-food (51)	· Bioeconomy (20) · Food security & safety (19) · Sustainable agriculture (18)	· Foods or foodstuffs; their treatment, not covered by other classes (28) · Agriculture; forestry; animal husbandry; hunting; trapping; fishing (22) · Butchering; meat treatment; processing poultry or fish (7)
Health (50)	· e-Health (e.g. healthy ageing) (32) · Public health & well-being (18) · AI, cognitive systems, augmented and virtual reality, visualisation, simulation, gamification & interaction technologies (12)	· Medical or veterinary science; hygiene (32) · Biochemistry; beer; spirits; wine; vinegar; microbiology; enzymology; mutation or genetic engineering (8) · Information and communication technology [ICT] specially adapted for specific application fields (8)
Renewable Energy (39)	· Sustainable energy & renewables (21) · Blue renewable energy (11) · Bio fuels & energy efficiency (11)	· Technologies or applications for mitigation or adaptation against climate change (18) · Generation, conversion, or distribution of electric power (14) · Treatment of water, waste water, sewage, or sludge (5)
Mobility-Transport-Automotive (36)	· Transport & logistics (11) · AI, cognitive systems, augmented and virtual reality, visualisation, simulation, gamification & interaction technologies (10) · Digitising Industry (Industry 4.0, smart and additive manufacturing) (9)	· Vehicles in general (12) · Railways (5) · Information and communication technology [ICT] specially adapted for specific application fields (5)
Creative & Cultural Industries (30)	· Development of regional cultural & creative industries (18) · Support to link cultural & creative industries with traditional industries (8) · Digitising Industry (Industry 4.0, smart and additive manufacturing) (6)	· Information or communication technologies having an impact on other technology areas (9) · Sports; games; amusements (5) · Technologies or applications for mitigation or adaptation against climate change (5)
Aerospace & Defence (29)	· Aeronautics (12) · Aeronautics & environment (10) · Safety & security (8)	· Aircraft; aviation; cosmonautics (14) · Information or communication technologies having an impact on other technology areas (8) · Optics (4)
Construction (27)	· Resource efficiency (7) · Eco-innovations (6) · AI, cognitive systems, augmented and virtual reality, visualisation, simulation, gamification & interaction technologies (5)	· Building (18) · Technologies or applications for mitigation or adaptation against climate change (6) · Construction of roads, railways, or bridges (4)

Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021; S3 priority areas correspond with the list developed by the European Commission's Joint Research Centre (JRC); Technology fields correspond with the list established by the World Intellectual Property Organisation.

participate in S3 strategy processes, evidence that was further supported by in-depth analysis of 18 regional case studies. See: Perianez-Forte and Wilson (2021).

05

Regional specialisation: A typology

5. Regional specialisation: A new typology

Given the policy relevance of industrial ecosystems as a focal point for transformation pathways, this chapter explores how regions can be grouped together according to their specialisation patterns in different ecosystems and analyses the presence of cluster organisations across the resulting typologies.

5.1 Seven types of regions based on their industrial ecosystems

The maps analysed in the previous section suggest that some regions might share similar specialisation patterns. To further explore this, we have undertaken a statistical cluster analysis that groups regions based on their LQ in each of the 14 ecosystems. This is carried out by constructing dichotomous variables that assign a value of 1 if the region is specialised (LQ>1.5) and the level of employment is regionally relevant (greater than 1% of total regional employment) and a value of 0 otherwise.[36] Following the methodology that is set out in detail in Annex 9, seven groups of regions are identified according to their similarities in industrial ecosystem specialisation patterns (Map 8):

- **Group 1: Agri-textile**
  This group contains 37 regions that present a clear orientation towards specialization in the agri-food and textile ecosystems. Regions come mainly from countries in Southern and Eastern Europe: Italy (10 regions, from both North and South), Spain, Romania, and Bulgaria (5 regions each), Poland (3 regions), Portugal (3 regions), and a single region from Greece, Lithuania, Austria, and Hungary.

- **Group 2: Agri-tourism**
  This group contains 22 regions with significant average specialization in the agri-food and tourism ecosystems. The majority are from countries in Southern Europe: Greece (11 regions, 50% of group), Portugal (3 regions), Spain (2 regions), and one region each from Austria, Finland, Cyprus and Croatia.

- **Group 3: Energy / Industry**
  The 35 regions in this group have significant average specialisation in the energy-intensive industries and renewable energy ecosystems. In addition, their average LQ is greater than 1 in a further 6 ecosystems, suggestive of a broad industrial character. They are mainly from Eastern European countries: Poland (11 regions), Czech Republic (7 regions), Slovenia (5 regions), Hungary (3 regions), and others such as Upper Austria, Rhineland (Germany), Estonia, West Macedonia (Greece), Centre-Portugal, and Centre Romania.

- **Group 4: Creative / Digital / Capitals**
  The 19 regions in this group have significant average specialisation in the cultural and creative industries and digital ecosystems, and their average LQ is also greater than 1 in the retail, tourism and aerospace and defence ecosystems. Above all, these are regions containing national capital cities (Amsterdam, Berlin, Budapest, Bucharest, Copenhagen, Dublin, Helsinki, Madrid, Paris, Prague, Sofia, Stockholm, Vienna, Vilnius, Warsaw) or large cities in each country (Gothenburg, Hamburg, Malmö, Utrecht).

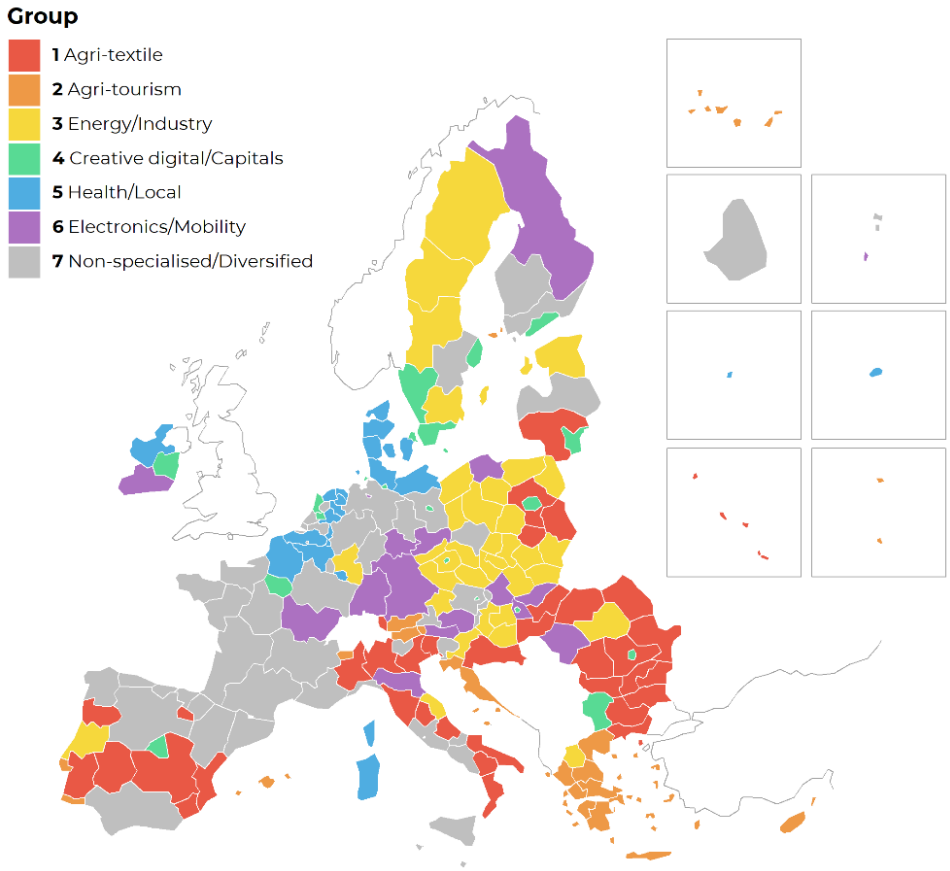
[36] See Annex 3 for methodological detail on the calculation of location quotients.

- **Group 5: Health / Local**
  The 21 regions in this group have significant average specialisation in the health ecosystem, alongside average LQs of greater than 1 in the retail, proximity (social) and construction ecosystems. The component regions are from the more developed countries in Europe: Netherlands (6 regions), Belgium (3 regions), Germany (2 regions), Denmark (4 regions), France (4 regions), and one each from Italy and Ireland.

- **Group 6: Electronics / Mobility**
  The 17 regions in this group have significant average specialisation in the electronics ecosystem, complemented by a moderate presence of mobility, aerospace and defence, renewable energy, energy intensive industry, health and construction. Most regions come from Germany (5 regions), Austria (2 regions), Hungary (2 regions) and France (2 regions), with single regions also from Finland, Ireland, Italy, Poland, Romania and Slovakia.

- **Group 7: Non-specialised / Diversified**
  The largest group of 50 regions are characterized by the lack of a clear pattern of specialization in any of the ecosystems. A moderate average LQ is observed in the construction, health, proximity (social) and tourism ecosystems. Most regions come from Western Europe and Southern Europe, particularly from France and Spain (11 regions each), Italy (6 regions), Germany (5 regions), and Netherlands (4 regions).

Map 8: Regional typology based on industrial ecosystem specialisation



Source: Based on data from Eurostat and national statistics offices.
Note: The list of regions in each group can be found in Annex 10.

Table 6 presents the average value of the LQ in each ecosystem for the 7 groups, with those industrial ecosystems in which the regions are highly specialised shaded in dark green and those in which they are mildly specialised shaded in light green. For example, regions in the agri-tourism grouping have high average specialisation (dark green shading) in the agri-food (1.68) and tourism (2.16) industrial ecosystems but are not specialised in any other ecosystem (white shading, all below 1). Regions in the health/local grouping, meanwhile, have high average specialisation in the health ecosystem (shaded dark green, 1.59) that is accompanied by mild average specialisation (shaded light green) in the construction (1.02), proximity and social economy (1.43) and retail (1.04) ecosystems. This helps to visualise that, while the regions in each group tend to be highly specialised on the ecosystems that are used to name the group, they may also be mildly specialised in other ecosystems. Additionally, as these are average values for all regions in each group, the specialisation pattern of a particular region might not exactly correspond to the average in the group. Thus, a region such as North West (Bulgaria) belongs to the agri-textile group with a large LQ coefficient both in the agri-food (4.12) and the textile (5.16) ecosystems, while Abruzzo is also assigned to the same group but is only highly specialised in the textile ecosystem (1.86) and only mildly specialised in agri-food (1.11).

Table 6: Average LQ values in each ecosystem by typology group

Group:	Agri-textile	Agri-tourism	Energy/Industry	Creative/Digital/Capital	Health/Local	Electronics/Mobility	Non-specialized/Diversified
Number of regions:	**37**	**22**	**35**	**19**	**21**	**17**	**50**
Aerospace & Defence	0.81	0.50	1.05	1.18	0.69	1.31	0.87
Agri-Food	2.37	1.68	1.31	0.43	0.80	0.94	0.82
Creative & Cultural Industries	0.73	0.77	0.82	1.58	0.92	0.83	0.96
Construction	0.90	0.80	1.07	1.00	1.02	1.03	1.03
Digital	0.50	0.53	0.76	1.92	0.72	0.90	0.82
Energy Intensive Industries	1.00	0.48	1.82	0.58	0.70	1.10	0.85
Electronics	0.60	0.27	1.23	0.82	0.61	2.33	0.65
Health	0.63	0.63	0.65	0.93	1.59	1.02	1.04
Mobility-Transport-Automotive	0.90	0.68	1.26	0.85	0.81	1.28	0.93
Proximity & Social economy	0.78	0.90	0.62	0.88	1.43	0.91	1.11
Renewable Energy	0.94	0.58	1.61	0.79	0.64	1.32	0.83
Retail	0.93	0.97	0.92	1.08	1.04	0.91	0.98
Textile	2.34	0.39	1.49	0.55	0.33	0.86	0.48
Tourism	0.95	2.16	0.84	1.11	0.95	0.89	1.07

Source: Based on data from Eurostat and national statistics offices.

Note: Industrial ecosystems in which regions in each typology are highly specialised (average LQ > 1.5) are shaded in dark green, and those that are mildly specialised (average LQ between 1 and 1.5) are shaded in lighter green.

5.2 Presence of cluster organisations in different region types

Based on the sample of EU-27 cluster organisations with updated ECCP profiles used in previous chapters, here we explore the distribution of cluster organisations across the different region types identified by the typology. Table 7 highlights that regions falling into the *Creative/Digital/Capitals*, *Electronics/Mobility*, and *Non-specialised/Diversified* categories have considerably more cluster organisations on average than those regions falling into the other four categories. However, it should be noted that in all typologies the standard deviation is high (in relation to the average), indicating considerable variation across regions within each typology.

The percentage of regions within each typology that host cluster organisations is also calculated. Here it can be seen that while almost 70% of all regions are home to at least one of the 468 cluster organisations included in the sample, those regions in the *Agri-tourism* and *Health/Local* groupings are much less likely to host a cluster organisation than other regions. Taking this finding together with the breakdown of cluster organisations by industrial ecosystem provided in Figure 2 (Chapter 2),[37] this result is being driven by the low number of cluster organisations that identify themselves as working in tourism and proximity/social economy activities, alongside the prevalence of regions that are specialised in such activities in these two groupings. It suggests a lower tradition of clusters in these sectors to formally establish dedicated cluster organisations, perhaps due to a stronger tradition of other types of intermediary institutions (tourism boards, place branding organisations, civil society organisations, etc.).

Table 7: Type of region and cluster organisation presence

	Number of Regions	Number of COs	Average COs	St.Dev.	% regions with CO
Agri-textile	37	79	2.14	2.11	75.7%
Agri-tourism	22	18	0.82	1.44	36.4%
Energy/Industry	35	63	1.80	1.59	77.1%
Creative/Digital/Capitals	19	66	3.47	3.89	84.2%
Health/Local	21	31	1.48	1.99	52.4%
Electronics/Mobility	17	35	3.82	3.70	76.5%
Non-specialised/Diversified	50	146	2.92	3.54	72.0%
Total	**201**	**468**	**2.33**	**2.86**	**69.2%**

Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

The simple presence (or not) of cluster organizations, however, does not ensure that they are relevant for the economic activity orientation of the typology. To explore this further, Table 8 sets out the proportion of cluster organisations in each region type that are associated with each of the 14 industrial ecosystems. To help interpret this data, cells have been shaded in three colours:

- Green corresponds to those industrial ecosystems that would be expected to have a higher-than-average proportion of cluster organisations because of the specialisation of that typology AND that do have a higher-than-average proportion of cluster organisations (e.g. the tourism ecosystem in the agri-tourism grouping of regions)

[37] See also the breakdown of cluster organisations by region type and industrial ecosystem in Table 8 below.

- Yellow corresponds to those industrial ecosystems that would be expected to have a higher-than-average proportion of cluster organisations because of the specialisation of that typology BUT that actually have a lower-than-average proportion of cluster organisations (e.g. the agro-food ecosystem in the agri-tourism grouping of regions).

- Grey corresponds to those industrial ecosystems that have a higher-than-average proportion of cluster organisations in a regional typology where this would not be expected from the specialisation of regions in that typology (e.g. the health ecosystem in the agri-tourism grouping of regions).

Three main conclusions stand out from this analysis. Firstly, the *Non-Specialised/Diversified* typology of regions, as would be expected, contains cluster organisations associated with diverse industrial ecosystems. Second, there is at least one green-shaded cell in each of the other six regional types with a specific character of specialization, suggesting a broad alignment between the presence of cluster organisations with the core characteristics of the typology of the regions. However, there are some cases where a lack of COs related to industrial ecosystems matching the regional specialisation are detected: the yellow-shaded cells for the *Agri-food* industrial ecosystem in the agri-textile and agri-tourism groupings of regions, and the *Creative and cultural industries* ecosystem in the creative/digital/capitals group of regions. Thirdly, there is clear pattern of transversality in relation to the presence of cluster organisations working in the *Digital* (and to a lesser extent) *Health* industrial ecosystems, as they account for a significant proportion of cluster organisations in almost all region types (including several grey-shaded cells).

Table 8: Type of region and cluster organization presence by industrial ecosystem (%)

Region Type	Aerospace & Defence	Agri-food	Construction	Creative and cultural industries	Digital	Electronics	Energy Intensive industries	Health	Mobility-Transport-Automotive	Proximity & Social economy	Renewable energy	Textile	Tourism	TOTAL
Agri-textile	1.6	9.8	6.6	13	28	0	3.3	13	4.9	1.6	8.2	6.6	3.3	100
Agri-tourism	0	10	0	10	20	0	0	30	0	0	10	0	20	100
Energy/Industry	13	7.5	7.5	7.5	18	5	5	2.5	5	0	25	2.5	2.5	100
Creative/Digital/Capitals	8.5	8.5	11	4.3	23	2.1	2.1	17	13	0	11	0	0	100
Health/Local	5	25	5	0	5	0	5	25	5	0	25	0	0	100
Electronics/Mobility	0	13	2.5	7.5	18	5	0	20	18	2.5	13	2.5	0	100
Non-specialised/Diversified	8.3	19	7.4	3.7	18	1.9	3.7	10	13	0	7.4	1.9	5.6	100
Average	**6.1**	**14**	**6.7**	**6.4**	**20**	**2.1**	**3.1**	**13**	**10**	**0.6**	**12**	**2.5**	**3,4**	**100**

Source: Based on ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.
Note: Cells in shaded green signal that the % of COs is higher than average, as expected given the specialisation; Cells in shaded yellow signal that the % of COs is unexpectedly lower than average; Cells shaded in grey indicate that the % of COs is unexpectedly higher than average.

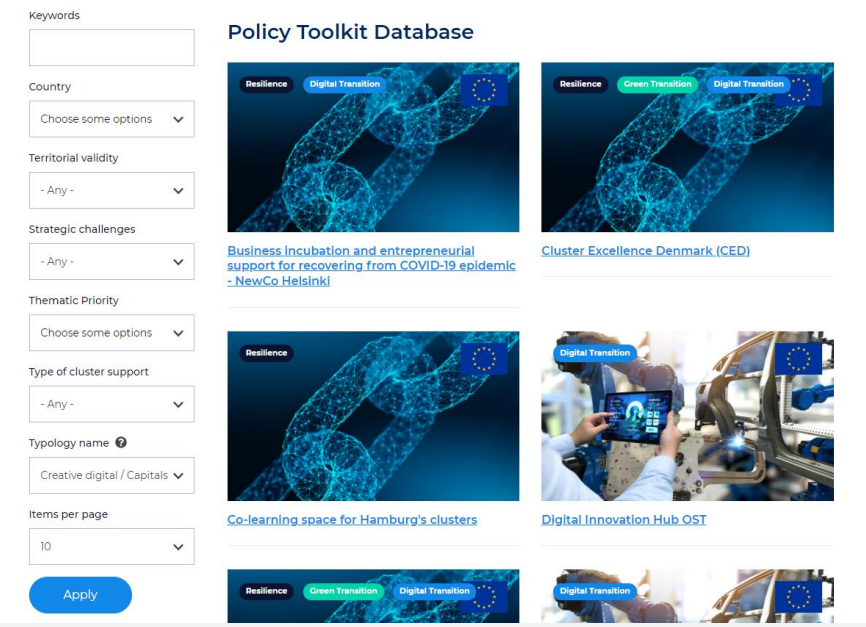
5.3 Putting the typology into practice

As illustrated by the above analysis, this typology provides a useful benchmark for exploring the different types of cluster organisations that can be found in different types of regions, analysis that further highlights, for example, the transversality of cluster organisations working on digitalisation. Such a typology also provides a practical input to policy makers and cluster practitioners that are working on industrial ecosystem transformation pathways in terms of helping them to identify regions with similar specialisation profiles for benchmarking and/or partnering. For example, a region that is highly specialised in energy intensive industries can easily identify 34 other regions that share a similar specialisation, which can help to identify suitable regions for benchmarking policy approaches towards boosting energy efficiency in energy-intensive industries. This feature of the typology has been put into practice through the development of a newly launched ECCP cluster policy toolkit, which helps policy makers identify relevant practical examples of cluster policy experiences that can provide inspiration for cluster policy development. The regional typology provides one of several filtering options, which allows a policymaker from a capital city specialised in creative industries, for example, to find inspiring cluster-related policy examples from similar regions (see screenshot in the box below).

ECCP Policy Toolkit

Strengthen cluster policy practice and leverage clusters for the implementation of other policies

The ECCP policy toolkit builds on the recommendations of the European Expert Group on Clusters by enabling policymakers to search a growing database of over 150 inspiring examples of cluster policy practice that can be tailored to their own specific policy agendas and cluster landscape.



Click to start exploring: **https://clustercollaboration.eu/policytoolkit**

06

Clusters, industrial ecosystems and regional competitiveness

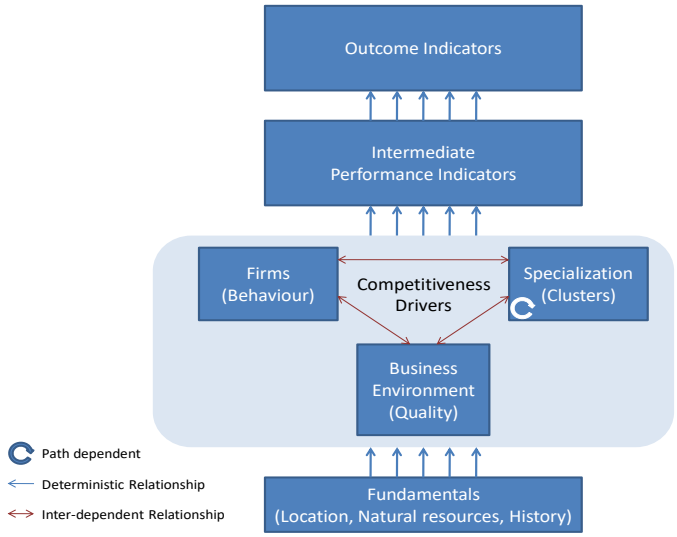
6. Clusters, industrial ecosystems, and regional competitiveness

Having explored in the previous chapters the panorama of regional specialisation and cluster organisation presence in sectors and industrial ecosystems in Europe, here we turn to examine the relationships between clustering and regional competitiveness. We first present a framework and set of indicators that capture different dimensions of regional competitiveness performance, including several related to green and digital transition. These indicators are then used to: (i) undertake correlation analyses that explore whether relationships exist between specialising in certain sectors and ecosystems, and different dimensions of regional competitiveness; and (ii) to explore the relationships between each of the 7 regional types identified in Chapter 5 and different dimensions of regional performance.

6.1 Indicators of regional competitiveness

Data for all 201 regions has been collected on a set of 23 indicators of regional competitiveness, which are arranged according to the framework presented in Figure 25.[38] The framework distinguishes between different levels of indicators (outcomes, intermediate performance, drivers, and fundamentals). The outcomes refer to the overall goals to be achieved in their different dimensions: economic, social, and environmental. The intermediate performance indicators (related to employment, productivity, and innovation) are important to achieving the final outcomes, but it is within the competitiveness drivers, including the presence of clusters, where policies can have a more obvious impact.

Figure 25: Competitiveness framework



Source: Aranguren et al. (2010)

[38] This framework is partly inspired by the competitiveness framework developed for the European Cluster Observatory: see Aranguren *et al.* (2010). The description of the indicators, including units and sources can be found in Annex 11. Other similar approaches can be found in the Regional Competitiveness Index (https://ec.europa.eu/regional_policy/en/information/maps/regional_competitiveness/), or in the Regional Innovation Scoreboard (https://ec.europa.eu/info/research-and-innovation/statistics/performance-indicators/regional-innovation-scoreboard_en), although in the latter the objective is limited to levers and outcomes of innovation.

The regional indicators collected for this analysis fall into four of these framework categories. On the one hand, the categories of outcome and intermediary performance indicators that sit at the top of the framework, and include key dimensions reflecting the progression of the green and digital transition. On the other hand, the competitiveness drivers of firm behaviour and business environment quality, where indicators capturing capacities and R&D investment feature strongly.

The outcome indicators include measures of economic prosperity (GDP per capita) that aim to be socially inclusive (population at risk of poverty and exclusion) through insertion in the labour market (long-term unemployment) without negatively impacting the environment (air pollution and population satisfied with efforts to preserve the environment). This is achieved through increased productivity (apparent labour productivity) that generates employment (employment rate) and innovation (PCT patents), particularly through environment-related technologies (green PCT patents) and digital technologies (PCT patents in ICT).

Indicators reflecting the behaviour of firms include their investment in R&D (business R&D expenditure), collaboration in the innovation processes (patents co-invention) and general investment (proxied through gross fixed capital formation). The largest number of indicators correspond to the quality of the business environment, with different sub-dimensions related to innovation capacities (public R&D expenditure and human resources in science and technology), skilled human resources (population with upper secondary and tertiary education and lifelong learning), green energy capacity (electricity production that comes from renewable sources), digitalisation (households with broadband access, individuals purchases over the internet and digital engagement), and institutions (quality of government).

6.2 Regional competitiveness and cluster presence

Here correlation analyses are used to explore whether relationships exist between the various dimensions of regional competitiveness performance and the presence of clusters in the region. Using the 201 regions as the unit of analysis, Table 9 shows the correlation coefficients between each regional competitiveness indicator and the number of sector specialisation nodes (regional-relevant and industry-relevant) and active cluster organisations. Only significant correlation coefficients are shown, with the numbers coded so that green indicate a positive relationship with better competitiveness results and red a negative relationship.

The presence of cluster organisations is only significantly related to 6 regional competitiveness indicators, and in all cases the relationship is positive: greater presence of cluster organisations is associated with better performance. In terms of outcome indicators, there is a positive relationship with higher levels of GDP per capita. However, there is no significant relationship with environmental outcomes, poverty and exclusion or long-term unemployment.

In terms of intermediate performance indicators, the presence of cluster organisations is positively related with labour productivity and PCT patents, but there is no relationship with employment rates or the more specific indicators that measure environmental and digitalisation elements. Finally, when it comes to competitiveness drivers, the presence of cluster organisations is positively related to two out of the three indicators associated with firms' behaviour (R&D expenditure and patent co-invention) but only one of the indicators associated with the business environment (human resources in science and technology).

Table 9: Correlation between cluster presence and competitiveness performance

Dimension		Indicator	Cluster organisations	Regional relevant nodes	Industry relevant nodes
Outcome indicators		GDP per capita (PPP)	0.16		0.23
		Air pollution (pm2.5)		0.19	0.31
		Population satisfied with efforts to preserve the environment			
		Population at risk of poverty and exclusion		-0.16	
		Long-term unemployment		-0.26	-0.21
Intermediate performance indicators		Apparent labour productivity	0.16		
		Employment rate		0.21	
		PCT patents per million population	0.20		0.15
		PCT patents in ICT		0.16	0.17
		Green PCT patents			
		CO_2 emissions per electricity production		0.20	0.25
Drivers of competitiveness:	Firms' behaviour	Business R&D expenditure	0.27		0.28
		PCT Patent co-invention	0.19		0.20
		Gross fixed capital formation			
	Business environment	Electricity production that comes from renewable sources			-0.25
		Public R&D expenditure			0.16
		Human resources in science and technology	0.16	0.21	0.29
		Population aged 25-64 with upper secondary or tertiary education		0.32	0.18
		Lifelong learning			
		Households with broadband access			
		Individuals purchases over the internet			
		Digital engagement (freq. of internet access)			
		Quality of Government			

Source: Based on data from Eurostat, national statistics offices, the sources indicated in Annex 11, and ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.
Note: The numbers in the table indicate Pearson correlation coefficients that are significant at 95% level. Green indicates a positive relationship with better competitiveness results and red a negative relationship.

In summary, it seems that the presence of cluster organisations is mainly related to indicators that measure the economic or technological aspects of competitiveness, either in final outcomes or intermediate performance, and with those that measure the behaviour of firms in terms of their propensity to undertake innovation activities. There is no significant relationship with indicators that measure green or digital elements, nor with employment or the broader business environment. This

is a pattern that is consistent with the predominant rationale for cluster policy – and the primary focus of cluster organisations – in seeking to enhance business-level innovation and competitiveness. It is only recently that cluster policies and cluster organisations have started to be leveraged towards a broader set of objectives and their explicit focus on greening and digitalisation as competitiveness levers is also relatively new. It is therefore unsurprising that significant relationships with these variables are not yet detected.[39]

When it comes to the presence of clusters, as measured by the number of region-relevant and industry-relevant nodes of sector specialisation, the picture is more mixed, but still largely positive in terms of the relationships that are detected with performance. The presence of region-relevant nodes appears to be positively related with employment outcomes (employment rate and long-term unemployment) and the related social outcome of poverty and exclusion rate. However, it is the presence of industry-relevant nodes that appear to be positively associated with the more economic related outcome, GDP per capita, alongside drivers of competitiveness connected to innovation (R&D expenditure and co-patenting at firm-level and public R&D expenditure). This might suggest that, while clusters of economic activities that are fairly large within the region are associated with stronger employment outcomes *per se*, it is only when that clustering reaches a critical mass of European-level employment that spill-overs in terms of innovation investments and related economic outcomes are consolidated. Or *vice-versa*, that specialisation with a critical mass of European employment is more likely to occur in more developed regions where income and R&D investments are higher.

The results are also interesting in terms of the indicators associated with green and digital outcomes. Both types of nodes are negatively correlated with key dimensions of green performance (air pollution and CO_2 emissions per electricity production), but positively correlated with a key dimension of digital performance (PCT patents in ICT). This is consistent with the concentration of specialised nodes in traded, manufacturing activities, as discussed in Chapter 3 when analysing Figure 17. These are activities which would tend towards stronger environmental impacts on the one hand, and a stronger link to digitalisation (Industry 4.0) on the other. The results therefore highlight the challenges in pursuing better economic outcomes while advancing an environmental agenda.

Concerning the other drivers of competitiveness, both types of specialisation nodes are positively correlated with key dimensions associated with human resources: population with upper secondary or tertiary education and human resources in science and technology. The latter is also positively correlated with the presence of cluster actors, and these results highlight the significance of clusters for skills agendas.[40]

It is worth mentioning that several indicators included in the business environment part of the framework do not seem to be associated with the presence of clusters in the territory. Thus, overall, the evidence suggests that the presence of specialisation nodes and cluster actors are associated with higher performance in various dimensions of regional competitiveness (and negative performance in several green dimensions in the case of specialisation nodes), but not at all with several key dimensions of business environment quality (e.g. quality of government, digital engagement or lifelong learning opportunities). This would appear to be consistent with the conclusions of recent research by Ketels and Protsiv (2020), using data from the previous European Cluster Observatory, which finds that "*specialization in strong clusters is helping locations at all levels of business environment quality to support higher levels of prosperity*".[41]

[39] See, for example: Alberti and Belfanti (2019), Konstantynova and Wilson (2017) or Wilson (2019).
[40] For a detailed discussion of clusters and skills, see the recent ECCP discussion paper on supporting skills for industry through clusters (Wilson, 2020).
[41] Ketels and Protsiv (2020), pp. 217-218.

Which activities are attractive (or unattractive) for regional competitiveness?

One of the limitations of the specialisation analysis in terms of total number of nodes presented in Table 9 is that it mixes all types of activities. It does not discriminate between local and traded activities or between manufacturing and services activities. To get a more granular view, the 23 regional competitiveness indicators have been correlated with the location quotients (LQs) of all 88 NACE 2-digit sectors across 201 regions.[42] Table 10 includes what could be described as the most attractive activities in which to specialise, because it presents, for each competitiveness indicator, the 3 activities in which higher specialisation is correlated with more desirable results (such as higher levels of GDP per capita or lower levels of air pollution), as measured by higher significant correlation coefficients. Table 11 does the same, but only for manufacturing activities. On the other hand, Table 12 and Table 13 present the other side of the coin, with the top 3 activities (out of 88 in the whole economy or out of 24 manufacturing activities) more correlated with undesirable outcomes (such as high levels of long-term unemployment or low employment rates).

Regarding desirable activities, there are several points worth mentioning. The first is that the list of more desirable activities in the economy (Table 10) tend to repeat in different indicators. There are several professional, scientific, and technical activities, such as *Activities of head offices; management consultancy activities (M70)* and *Architectural and engineering activities; technical testing and analysis (M71)*. Also, some Information and communication activities, such as *Computer programming, consultancy, and related activities (J62)* and *Publishing activities (J58)*. Among manufacturing activities, Table 11 reveals that *Manufacturing of machinery & equipment (C28), Manufacturing of pharmaceuticals (C21) and Other manufacturing (C32)* are the most positively related with desirable outcomes. The gaps in several indicators, mainly related to the green transition, in Table 11 indicate that none of the manufacturing activities is associated with such indicators.

The least desirable activities in Table 12 also tend to repeat themselves. Specialisation in agricultural, forestry and fishing sectors are repeatedly negatively associated with several regional competitiveness indicators, as are *Water collection, treatment, and supply (E36)* and *Manufacturing of wearing apparel (C14)*. This list also features mining activities and activities with low value added, such as *Food & beverage services (I56)* or *Households as employers activities (T97)*. Within manufacturing activities in Table 13, in addition to *Manufacturing of wearing apparel (C14),* we can also find *Manufacturing of leather products (C15), Manufacturing of food products (C10)* and *Manufacturing of beverages (C11),* that is, activities at the lower end of the scale in terms of technological level and value-added.

Few activities seem to be positively associated both with some desirable results (Table 10) and negatively with others (Table 12). The exceptions are:

- *Forestry and logging (A02)*, mainly associated with negative performance, but positively with Green PCT patents;
- *Fishing & aquaculture (A03)*, mainly associated with negative performance, but positively with Electricity production that comes from renewable sources;
- *Manufacture of rubber & plastic products (C22)*, positively associated with Population with upper secondary or tertiary education and Long-term unemployment and negatively with Air pollution;
- *Education (P85)*, positively associated with Electricity production that comes from renewable sources, but negatively with Employment rates.

In the case of manufacturing activities, the exceptions are:

[42] LQ coefficients have been capped at 5 for the analysis, to avoid distortions by outliers. See Annex 3 for methodological detail on the calculation of location quotients.

- *Manufacturing of rubber & plastic products (C22)*, associated, as previously mentioned, with good performance in Population aged 25-64 with upper secondary or tertiary education and Long-term unemployment, but negatively associated not only with Air pollution, but also with other green transition indicators and Public R&D expenditure;
- *Manufacturing of fabricated metal products (C25),* associated with good performance in Population at risk of poverty and exclusion and Long-term unemployment, but negatively associated with PCT patents in ICT;
- *Manufacturing of furniture (C31),* mainly associated with negative performance, but positively with Green PCT patents.

These four tables can also help to identify activities that are more positively associated with indicators related to the green and digital transition. Starting with green-related outcomes (air pollution and satisfaction with efforts to preserve the environment), we can observe that activities related to social work, recreation and professional and administrative services top the list. Among the intermediate performance indicators, activities related to forests and wood, either in the primary sector (*Forestry & logging*) or in manufacturing (of *wood products* and of *furniture*) are positively associated with Green PCT patents, while *Architecture and engineering activities* are also associated with lower levels of CO_2 emissions per electricity production, together with some local activities (*Specialised construction* and *Veterinary activities*). Two local activities (*Accommodation and Education*) are also related to Electricity production from renewable sources, together with a primary activity (*Fishing and aquaculture*).

On the other side of the coin, there are several manufacturing and mining activities that are negatively correlated with green-related indicators, particularly with air pollution and CO_2 emissions per electricity production. *Water supply (E36)*, support and administrative activities and lower value-added activities such as *Food and beverage services (I56)* and *Retail trade (G47)* also tend to demonstrate a negative relationship with these dimensions of green performance.

It is also remarkable that the activities that are positively associated with other elements of the framework are absent when considering green-related indicators. Hence, territories that specialise in the activities that appear as more attractive from an environmental perspective have comparatively less employment in activities that have a positive relationship with other competitiveness indicators. As mentioned previously in this section, specialising in activities that are associated with good competitive performance seems to be rather incompatible with achieving good environmental performance.

On the elements related to digitalisation, the picture is quite different: the activities associated with worse digital-related performance in terms of intermediate outcomes (patents in ICT) and business environment (households with broadband access, individuals purchases over the internet and digital engagement) are quite similar to those generally mentioned above when describing Table 12 and Table 13. Additionally, the activities that are more positively associated with better digital performance are also associated with better general performance, in particular *Activities of head offices; management consultancy activities (M70)* and *Computer programming, consultancy and related activities (J62)*, but also *Residential care (Q87)* and *Employment activities (N78)*, and an activity that only appears once in the list, with regard to patents in ICT: *Business support activities (N82)*. Within manufacturing, it is mainly *Manufacturing of machinery & equipment (C28)* and *Other manufacturing (C32)*. Therefore, it seems that activities that are generally associated with good competitiveness performance are also associated with good digital performance.

Table 10: Sector specialisations more correlated with better results

Dimension		Indicator	1	2	3
Outcome indicators		GDP per capita (PPP)	K64: Financial services	M70: Head offices, management consult.	J62: Computer program, consultancy
		Air pollution (pm2.5)	R93: Sports, amusement, recreat	Q87: Residential care	M71: Architecture, engineering
		Population satisfied with efforts to preserve the environment	Q87: Residential care	Q88: Social work without accom.	N78: Employment activities
		Population at risk of poverty and exclusion	L68: Real estate	F43: Specialised construction act.	J62: Computer program, consultancy
		Long-term unemployment	C28: Manuf. machinery & equipment	C22: Manuf. of rubber & plastic products	C25: Manuf. fabricated metal products
Intermediate performance indicators		Apparent labour productivity	N81: Buildings services and landscaping	K64: Financial services	K65: Insurance, pension funding
		Employment rate	M70: Head offices, management consult.	J62: Computer program, consultancy	L68: Real estate
		PCT patents per million population	M70: Head offices, management consult.	J58: Publishing activities	M71: Architecture, engineering
		PCT patents in ICT	J62: Computer program, consultancy	M70: Head offices, management consult.	N82: Business support activities
		Green PCT patents	A02: Forestry & logging	C16: Manuf. of wood products	C31: Manuf. of furniture
		CO_2 emissions per electricity production	F43: Specialised construction act.	M75: Veterinary activities	M71: Architecture, engineering
Drivers of competitiveness:	Firms' behaviour	Business R&D expenditure	M71: Architecture, engineering	M72: Scientific research & development	M70: Head offices, management consult.
		PCT Patent co-invention	J62: Computer program, consultancy	N78: Employment activities	M70: Head offices, management consult.
		Gross fixed capital formation	F43: Specialised construction act.	L68: Real estate	C32: Other manufacturing
	Business environment	Electricity production that comes from renewable sources	I55: Accommodation	P85: Education	A03: Fishing & aquaculture
		Public R&D expenditure	M72: Scientific research & development	S94: Membership org.	M71: Architecture, engineering
		Human resources in science and technology	J62: Computer program, consultancy	M70: Head offices, management consult.	J58: Publishing activities
		Population aged 25-64 with upper secondary or tertiary education	H49: Land transport (inc. pipelines)	C22: Manuf. of rubber & plastic products	F42: Civil engineering
		Lifelong learning	M71: Architecture, engineering	J58: Publishing activities	Q87: Residential care
		Households with broadband access	M70: Head offices, management consult.	N78: Employment activities	J62: Computer program, consultancy
		Individuals purchases over the internet	Q87: Residential care	M70: Head offices, management consult.	N78: Employment activities
		Digital engagement (freq. of internet access)	Q87: Residential care	M70: Head offices, management consult.	N78: Employment activities
		Quality of Government	Q87: Residential care	Q88: Social work without accommodation	N78: Employment activities

Source: Based on data from Eurostat, national statistics offices and sources indicated in Annex 11.
Note: The table shows the activities with highest Pearson correlation coefficients that are significant at 95% level and are associated with positive performance of the competitiveness indicator.

Table 11: Manufacturing specialisations more correlated with better results

Dimension		Indicator	1	2	3
Outcome indicators		GDP per capita (PPP)	C21: Manuf. of pharmaceuticals	C32: Other manufacturing	--
		Air pollution (pm2.5)	--	--	--
		Population satisfied with efforts to preserve the environment	C32: Other manufacturing	C28: Manuf. of machinery & equip.	C20: Manuf. of chemical products
		Population at risk of poverty and exclusion	C28: Manuf. of machinery & equip.	C18: Manuf. of printing & reproduction	C25: Manuf. of fabricated metal prod.
		Long-term unemployment	C28: Manuf. of machinery & equip.	C22: Manuf. of rubber & plastic products	C25: Manuf. of fabricated metal products
Intermediate performance indicators		Apparent labour productivity	C21: Manuf. of pharmaceuticals	C32: Other manufacturing	--
		Employment rate	C28: Manuf. of machinery & equip.	C32: Other manufacturing	C18: Manuf. of printing & reproduction
		PCT patents per million population	C28: Manuf. of machinery & equip.	C21: Manuf. of pharmaceuticals	C20: Manuf. of chemical products
		PCT patents in ICT	--	--	--
		Green PCT patents	C16: Manuf. of wood products	C31: Manuf. of furniture	C23: Manuf. of other non-metal mineral
		CO_2 emissions per electricity production	--	--	--
Drivers of competitiveness:	Firms' behaviour	Business R&D expenditure	C28: Manuf. of machinery & equip.	C21: Manuf. of pharmaceuticals	C26: Manuf. of electronic & optical products
		PCT Patent co-invention	C32: Other manufacturing	C21: Manuf. of pharmaceuticals	C20: Manuf. of chemical products
		Gross fixed capital formation	C32: Other manufacturing	C21: Manuf. of pharmaceuticals	C26: Manuf. of electronic & optical
	Business environment	Electricity production that comes from renewable sources	--	--	--
		Public R&D expenditure	--	--	--
		Human resources in science and technology	C18: Manuf. of printing & reproduction	C21: Manuf. of pharmaceuticals	C28: Manuf. of machinery & equip.
		Population aged 25-64 with upper secondary or tertiary education	C22: Manuf. of rubber & plastic products	C26: Manuf. of electronic & optical products	C27: Manuf. of electrical equipment
		Lifelong learning	C17: Manuf. of paper products	C21: Manuf. of pharmaceuticals	C28: Manuf. of machinery & equip.
		Households with broadband access	C32: Other manufacturing	C28: Manuf. of machinery & equip.	C20: Manuf. of chemical products
		Individuals purchases over the internet	C28: Manuf. of machinery & equip.	C32: Other manufacturing	C20: Manuf. of chemical products
		Digital engagement (freq. of internet access)	C21: Manuf. of pharmaceuticals	C32: Other manufacturing	C28: Manuf. of machinery & equip.
		Quality of Government	C28: Manuf. of machinery & equip.	C32: Other manufacturing	C21: Manuf. of pharmaceuticals

Source: Based on data from Eurostat, national statistics offices and sources indicated in Annex 11.

Note: The table shows the activities with highest Pearson correlation coefficients that are significant at 95% level and are associated with positive performance of the competitiveness indicator.

Table 12: Sector specialisations more correlated with worse results

Dimension		Indicator	1	2	3
Outcome indicators		GDP per capita (PPP)	A01: Crop & animal production	E36: Water supply	A02: Forestry & logging
		Air pollution (pm2.5)	B05: Mining of coal & lignite	C14: Manuf. of wearing apparel	C22: Manuf. of rubber & plastic products
		Population satisfied with efforts to preserve the environment	C14: Manuf. of wearing apparel	E36: Water supply	A01: Crop & animal production
		Population at risk of poverty and exclusion	A01: Crop & animal production	A03: Fishing & aquaculture	E36: Water supply
		Long-term unemployment	I56: Food & beverage services	A03: Fishing & aquaculture	P85: Education
Intermediate performance indicators		Apparent labour productivity	A01: Crop & animal production	E36: Water supply	A02: Forestry & logging
		Employment rate	T97: Households as employers act.	P85: Education	E38: Waste activities
		PCT patents per million population	E36: Water supply	A01: Crop & animal production	A03: Fishing & aquaculture
		PCT patents in ICT	B08: Other mining & quarrying	I56: Food & beverage services	A03: Fishing & aquaculture
		Green PCT patents	N79: Travel agency, tour operators	I56: Food & beverage services	N77: Rental & leasing
		CO_2 emissions per electricity production	B05: Mining of coal & lignite	C19: Manuf. of coke & refined petroleum	G47: Retail trade (not motor vehicles)
Drivers of competitiveness:	Firms' behaviour	Business R&D expenditure	E36: Water supply	A01: Crop & animal production	F41: Construction of buildings
		PCT Patent co-invention	E36: Water supply	A01: Crop & animal production	I56: Food & beverage services
		Gross fixed capital formation	A01: Crop & animal production	C14: Manuf. of wearing apparel	T97: Households as employers act.
	Business environment	Electricity production that comes from renewable sources	C19: Manuf. of coke & refined petroleum	B05: Mining of coal & lignite	S95: Repair of computers & personal goods
		Public R&D expenditure	E36: Water supply	C14: Manuf. of wearing apparel	A01: Crop & animal production
		Human resources in science and technology	A01: Crop & animal production	E36: Water supply	A03: Fishing & aquaculture
		Population aged 25-64 with upper secondary or tertiary education	T97: Households as employers act.	A03: Fishing & aquaculture	I56: Food & beverage services
		Lifelong learning	E36: Water supply	A01: Crop & animal production	C14: Manuf. of wearing apparel
		Households with broadband access	A01: Crop & animal production	E36: Water supply	A03: Fishing & aquaculture
		Individuals purchases over the internet	A01: Crop & animal production	C14: Manuf. of wearing apparel	E36: Water supply
		Digital engagement (freq. of internet access)	A01: Crop & animal production	E36: Water supply	C14: Manuf. of wearing apparel
		Quality of Government	E36: Water supply	C14: Manuf. of wearing apparel	A01: Crop & animal production

Source: Based on data from Eurostat, national statistics offices and sources indicated in Annex 11.
Note: The table shows the activities with highest Pearson correlation coefficients that are significant at 95% level and are associated with negative performance of the competitiveness indicator.

Table 13: Manufacturing specialisations more correlated with worse results

Dimension		Indicator	1	2	3
Outcome indicators		GDP per capita (PPP)	C10: Manuf. of food products	C14: Manuf. of wearing apparel	C31: Manuf. of furniture
		Air pollution (pm2.5)	C14: Manuf. of wearing apparel	C22: Manuf. of rubber & plastic products	C31: Manuf. of furniture
		Population satisfied with efforts to preserve the environment	C14: Manuf. of wearing apparel	C15: Manuf. of leather products	C11: Manuf. of beverages
		Population at risk of poverty and exclusion	C14: Manuf. of wearing apparel	--	--
		Long-term unemployment	--	--	--
Intermediate performance indicators		Apparent labour productivity	C14: Manuf. of wearing apparel	C10: Manuf. of food products	C31: Manuf. of furniture
		Employment rate	C15: Manuf. of leather products	--	--
		PCT patents per million population	C14: Manuf. of wearing apparel	C10: Manuf. of food products	C15: Manuf. of leather products
		PCT patents in ICT	C25: Manuf. of fabricated metal products	--	--
		Green PCT patents	--	--	--
		CO_2 emissions per electricity production	C19: Manuf. of coke & refined petroleum	C22: Manuf. of rubber & plastic products	--
Drivers of competitiveness:	Firms' behaviour	Business R&D expenditure	C14: Manuf. of wearing apparel	C10: Manuf. of food products	C31: Manuf. of furniture
		PCT Patent co-invention	C14: Manuf. of wearing apparel	--	--
		Gross fixed capital formation	C14: Manuf. of wearing apparel	C15: Manuf. of leather products	C31: Manuf. of furniture
	Business environment	Electricity production that comes from renewable sources	C19: Manuf. of coke & refined petroleum	C22: Manuf. of rubber & plastic products	C29: Manuf. of motor vehicles & trailers
		Public R&D expenditure	C14: Manuf. of wearing apparel	C22: Manuf. of rubber & plastic products	C31: Manuf. of furniture
		Human resources in science and technology	C14: Manuf. of wearing apparel	C10: Manuf. of food products	C15: Manuf. of leather products
		Population aged 25-64 with upper secondary or tertiary education	C15: Manuf. of leather products	C11: Manuf. of beverages	--
		Lifelong learning	C14: Manuf. of wearing apparel	C31: Manuf. of furniture	C10: Manuf. of food products
		Households with broadband access	C14: Manuf. of wearing apparel	C10: Manuf. of food products	C11: Manuf. of beverages
		Individuals purchases over the internet	C14: Manuf. of wearing apparel	C15: Manuf. of leather products	C11: Manuf. of beverages
		Digital engagement (freq. of internet access)	C14: Manuf. of wearing apparel	C15: Manuf. of leather products	C11: Manuf. of beverages
		Quality of Government	C14: Manuf. of wearing apparel	C15: Manuf. of leather products	C11: Manuf. of beverages

Source: Based on data from Eurostat, national statistics offices and sources indicated in Annex 11.
Note: The table shows the activities with highest Pearson correlation coefficients that are significant at 95% level and are associated with negative performance of the competitiveness indicator.

6.3 Regional competitiveness and industrial ecosystems

This section takes an alternative approach by exploring the relationships between industrial ecosystems, as reflected in the seven regional types identified in Chapter 5, and the same set of regional competitiveness indicators. In Table 14, the average values of the 23 indicators are presented for each of the 7 groups of regions. The performance in each indicator among the different groups is coloured in a green scale: the darker the colour, the better the performance is. The last two columns of Table 14 contain the value of the non-parametric "H" statistic of Kruskal-Wallis, which allow us to test the hypothesis that the ranges between groups are similar. In almost all the cases we can reject that hypothesis, indicating that there are significant differences in performance between the different groups of indicators. For ease of interpretation, these results are used to generate an ordering (ranking) of the regional groups in each indicator (Table 15).

In general, the grouping of 19 Creative/Digital/Capitals regions, mainly composed of regions with capital cities, shows a better relative performance in most of the variables in each pillar. In terms of overall competitiveness performance, they are followed by those regions characterised by Health/Local ecosystems and Electronics/Mobility ecosystems and by those regions who are diversified (or non-specialised) across a range of ecosystems. At the other end of the performance scale, the most "lagging" regions are found in the Agri-food, Agri-textile, and Energy/Industry groupings.

This performance pattern across the groupings is quite homogeneous for the different indicators, but there are some interesting differences relevant for understanding the green and digital transitions. With regards the green transition, it can be observed that the group of creative/digital/capitals regions has its worst performance in the four indicators associated with environmental aspects. While the differences across the 7 groups of regions are not significant accordingly to the Kruskal-Wallis test in two of the indicators (Electricity production from renewable sources and CO_2 emissions per electricity production), the overall picture could point towards a contradiction between the material advantages of urban agglomeration (that generate good overall competitiveness performance) and the associated environmental impacts.

The energy/industry group also strands out for relatively poor performance in electricity production from renewables, but high performance in green PCT patents, which could be indicative of awareness of the competitiveness benefits of green transition and the consequent drive to modify practices and accelerate green transition in those regions characterised my more energy-intensive activities.

In terms of green energy generation, the two groups with an agri-food specialization have good relative positions which is complemented with a top position in green PCT patents (the agri-textile group). Surprisingly, the creative/digital/capitals group is almost last in the green patent indicator, which could be attributed to the effect that total PCT patents per million population are far larger among this group of regions, including both green and non-green patents, while the smaller number of total patents among other groups contain a larger proportion of patents classified as green, even if their total number is significantly lower than in the creative/digital/capitals group.

Finally, the two end-result indicators related to the green transition correspond to population satisfaction with efforts to preserve the environment (a subjective indicator on how the population assesses whether the territory is achieving a good environmental outcome) and air pollution (an objective indicator to measure it). Regarding satisfaction, regions in the health and creative/digital/capitals groups are the best positioned, while the worst positions correspond to the agri and industry groups. This could reflect actual differences in the public and private efforts associated to improve the environment, but it could also indicate different levels of awareness regarding the challenge of the climate transition across these regions with quite different

characteristics. In terms of air pollution, the group of creative/digital/capitals is badly positioned, although not as badly as the agri-textile and energy/industry groups, while the health/local and the agri-tourism groups perform the best. Hence creative/digital/capitals perform badly in the objective indicator but get a good result in the subjective indicator, which could indicate that people living in big cities are aware of the negative environmental situation but value the efforts that are being implemented to change it. The opposite happens in the agri-tourism group, where the situation is comparatively better than in other regions in terms of air pollution, but the population consider that more effort should be put into place to improve the environment.

In terms of the digital transition, the variables related to digital infrastructure and behaviour indicate that the agri and energy/industry groups are clearly lagging the creative/digital/capitals and health groups. These trends are also reflected in the provision of resources in science and technology (assuming that they are users of digital tools) and in the expenditure that companies make in research and development (assuming that in these areas digital tools are used intensively).

Finally, the apparent "duality" between the agri and energy/industry groups of regions and the other groups that is evident in digitalisation variables is also mirrored in labour productivity and material well-being (GDP per capita). This highlights the need for regions characterised by these specialisations to work on digital transition in parallel with and as a route towards enhanced labour productivity and value generation. Paradoxically, however, such duality is not reflected quite so strongly in the social welfare indicator (risk of poverty and exclusion), and in fact the agri-textile and energy/industry groups of regions perform comparatively well in long-term unemployment. This performance, which is suggestive of different routes towards achieving social outcomes, may be associated with a range of historical and institutional aspects, alongside factors such as inter-regional transfers and migration dynamics between regions (serving to reduce long-term unemployment in regions lacking dynamism in other areas).

Table 14: Values of competitiveness indicators by ecosystem group

		Agri-textile	Agri-tourism	Energy / Industry	Creative / Digital / Capitals	Health / Local	Electronics / Mobility	Non-specialised / Diversified	K-W	p-value
	Size (number of regions)	37	22	35	19	21	17	50		
Outcome indicators	GDP per capita (PPP)	21.030	24.980	22.820	46.170	28.880	31.610	31.280	71	0.000
	Air pollution (pm2.5)	14.5	10.9	16.1	13.0	10.2	12.4	12.1	28.3	0.000
	Population satisfied with efforts to preserve the environment	35.5	36.4	52.3	56.3	64.0	55.0	53.7	60.5	0.000
	Population at risk of poverty and exclusion	27.7	25.7	18.3	17.6	18.0	18.1	20.9	30.2	0.000
	Long-term unemployment	3.8	6.7	1.7	1.4	3.0	1.8	4.1	53.4	0.000
Intermediate performance indicators	Apparent labour productivity	49.8	55.6	51.0	80.6	65.1	67.2	68.9	73	0.000
	Employment rate	64.2	63.6	70.1	75.2	68.7	71.0	66.5	41.1	0.000
	PCT patents per million population	32.9	16.9	41.4	164.8	83.0	114.0	84.1	57.8	0.000
	PCT patents in ICT	16.4	14.4	17.3	30.1	16.2	25.5	25.8	34.6	0.000
	Green PCT patents	7.7	1.8	7.2	3.6	4.8	4.0	4.0	15.7	0.015
	CO_2 emissions per electricity production	313.1	270.7	395.2	428.7	353.1	326.0	302.5	4.9	0.551
Drivers of competitiveness: Firms' behaviour	Business R&D expenditure	0.82	0.85	1.20	2.65	1.72	2.22	1.62	65.43	0.000
	PCT Patent co-invention	54.3	50.7	58.1	70.3	61.6	68.4	66.0	25.6	0.000
	Gross fixed capital formation	18	17	21	24	22	22	20	39	0.000
Drivers of competitiveness: Business environment	Electricity production that comes from renewable sources	46	61	39	29	40	48	42	9	0.156
	Public R&D expenditure	0.3	0.5	0.4	1.0	0.7	0.7	0.6	43.0	0.000
	Human resources in science and technology	14.5	15.0	19.2	32.6	22.4	21.5	21.2	87.3	0.000
	Population aged 25-64 with upper secondary or tertiary education	69.6	70.3	87.2	87.5	77.3	85.2	75.1	66.6	0.000
	Lifelong learning	6.1	7.0	9.0	17.8	15.1	9.7	13.6	55.0	0.000
	Households with broadband access	81.6	80.8	85.4	91.9	88.8	87.4	88.0	46.2	0.000
	Individuals purchases over the internet	38.4	44.0	57.6	68.9	70.0	60.9	61.4	76.6	0.000
	Digital engagement (freq. of internet access)	74.1	78.0	81.5	90.0	88.1	84.9	85.6	68.9	0.000
	Quality of Government	-0.9	-0.7	-0.3	0.4	0.9	0.2	0.1	62.1	0.000

Source: Based on data from Eurostat, national statistics offices and sources indicated in Annex 11.

Note: Values in the columns for the ecosystem groups indicate the average value in each group of regions. The last two columns in the table indicate the value of the Kruskal-Wallis test and its significance level,

Table 15: Rankings of competitiveness indicators by ecosystem group

		Agri-textile	Agri-tourism	Energy / Industry	Creative / Digital / Capitals	Health / Local	Electronics / Mobility	Non-specialised / Diversified
	Size (number of regions)	37	22	35	19	21	17	50
Outcome indicators	GDP per capita (PPP)	7	5	6	1	4	2	3
	Air pollution (pm2.5)	6	2	7	5	1	4	3
	Population satisfied with efforts to preserve the environment	7	6	5	2	1	3	4
	Population at risk of poverty and exclusion	7	6	4	1	2	3	5
	Long-term unemployment	5	7	2	1	4	3	6
Intermediate performance indicators	Apparent labour productivity	7	5	6	1	4	3	2
	Employment rate	6	7	3	1	4	2	5
	PCT patents per million population	6	7	5	1	4	2	3
	PCT patents in ICT	5	7	4	1	6	3	2
	Green PCT patents	1	7	2	6	3	4	4
	CO_2 emissions per electricity production	3	1	6	7	5	4	2
Drivers of competitiveness: Firms' behaviour	Business R&D expenditure	7	6	5	1	3	2	4
	PCT Patent co-invention	6	7	5	1	4	2	3
	Gross fixed capital formation	6	7	4	1	2	2	5
Drivers of competitiveness: Business environment	Electricity production that comes from renewable sources	3	1	6	7	5	2	4
	Public R&D expenditure	7	5	6	1	2	2	4
	Human resources in science and technology	7	6	5	1	2	3	4
	Population aged 25-64 with upper secondary or tertiary education	7	6	2	1	4	3	5
	Lifelong learning	7	6	5	1	2	4	3
	Households with broadband access	6	7	5	1	2	4	3
	Individuals purchases over the internet	7	6	5	2	1	4	3
	Digital engagement (freq. of internet access)	7	6	5	1	2	4	3
	Quality of Government	7	6	5	2	1	3	4

Source: Based on data from Eurostat, national statistics offices and sources indicated in Annex 11.

Note: Values in the columns for the ecosystem groups indicate the average value in each group of regions. The last two columns in the table indicate the value of the Kruskal-Wallis test and its significance level,

07

Conclusions

7. Conclusions

Clusters, cluster organisations and cluster policies play key roles in shaping industrial transitions and building regional resilience, and these roles have been heightened over the last two years in the context of the COVID-19 pandemic. The recommendations of the *European Expert Group on Clusters* provide a framework for further enhancing the impacts of clusters on socioeconomic development across Europe, and their implementation will require reliable strategic information on the panorama of clusters in Europe.

This *European Cluster Panorama* report has brought together for the first time comprehensive statistical data on economic specialisation in both traded[43] and non-traded[44] sectors with detailed data on a large sample of EU-27 cluster organisations. This enables a nuanced picture of the panorama of clusters in Europe and an exploration of the roles that clusters are playing to develop resilient, green, and digital regional economies. It has also integrated analysis of the 14 industrial ecosystems with pan-European importance that have been identified by the European Commission as critical for the transformation pathways that will shape the recovery.

Chapter 1 of the report framed the issues and set out the change of approach to cluster mapping that has been undertaken for the re-launched ECCP. Chapters 2, 3, and 4 then presented a detailed snapshot of the current panorama of clusters and industrial ecosystems in Europe based on a combination of statistical data and information from a sample of 468 ECCP profiles of cluster organisations with updated profiles. The key features of this panorama can be summarised as follows.

Key features of the European cluster panorama

- **Clustering is a key feature of the European economy**, as reflected in the clear geographic specialisation of NACE 2-digit sector activity. Across 201 EU-27 regions there are 1501 specialisation nodes with a share of at least 1% of regional employment, and these region-relevant specialisation nodes account for 24.4% of total EU-27 employment. They are heavily concentrated in traded activities and are not prevalent in the non-traded activities that account for the largest shares of employment (almost 50%), but are more evenly distributed across regions.

- **Clusters with a significant share of EU employment are concentrated in fewer regions**, as reflected in a smaller number of specialisation nodes with a share of at least 1% of total sector employment. There are 1160 of these industry-relevant specialisation nodes in total, and they account for 19.5% of EU-27 employment.

- **Cluster organisations are widespread in the EU-27**, as reflected in the 1036 cluster organisations that have registered profiles on the ECCP over the last decade, 468 of which have updated their profiles following the ECCP relaunch in 2021. Like the specialisation nodes, their presence is heavily concentrated in traded activities, and especially in manufacturing. Their membership is made up of around 70% SMEs, 10% large firms and 8% research organisations on average, with significant variation between countries.

[43] Activities such as agriculture and manufacturing industry whose outputs can be traded internationally, beyond the regions where they are located.
[44] Activities such as education, health, arts, and retail whose outputs are predominantly locally rendered services and thus tend not to be traded outside of the regions where they are located.

- **European cluster organisations provide a wide range of services** to their members, above all related to the core transversal function of facilitating collaboration between members. Support for internationalisation is widespread, as is support for research, development and innovation, the facilitation of external collaboration (e.g. matchmaking), and support for seeking public funding. They are also largely professionalised, with a high proportion (68%) having some form of quality label.

- **European regions tend not to be highly specialised in specific industrial ecosystems,** as reflected in the small number of region-relevant (276) and industry-relevant (74) ecosystem specialisation nodes. However, while EU-27 employment is spread more evenly across industrial ecosystems than sectors, there are specific patterns in specialisation, employment and productivity that can be explored for each of the 14 ecosystems. For example, the *Agri-food*, *Energy intensive industries* and *Textile* ecosystems tend to greater regional specialisation, and regions with national capitals tend to be more productive in all ecosystems.

- **European cluster organisations are most prevalent in the digital, agri-food, health and renewable energies industrial ecosystems,** and the combination of presence of cluster organisations and high productivity in both the digital and renewable energy ecosystems represent an asset to pursue digital and green transition.

- **The green and digital transitions are transversal issues that cut across clusters in all sectors and industrial ecosystems**, as reflected in the over 80% of European cluster organisations that say that they support companies in digitalisation and over 60% that say they support companies to be green. The transversality of the green and digital transitions is also reflected in the services they provide, their collaboration interests and the S3 priority areas and technology fields in which they are working.

A new typology of regions according to their specialisation in industrial ecosystems

Given the policy relevance of industrial ecosystems as a focal point for transformation pathways, Chapter 5 introduced a new typology of regions based on their specialisation patterns in the 14 ecosystems. Seven groups of regions were identified:

- **Agri-textile**: 37 regions that present a clear orientation towards specialization in the agri-food and textile ecosystems.

- **Agri-tourism**: 22 regions with significant average specialization in the agri-food and tourism ecosystems.

- **Energy / Industry**: 35 regions with significant average specialisation in the energy-intensive industries and renewable energy ecosystems, alongside less significant specialisation in several other ecosystems suggestive of a broad industrial character.

- **Creative / Digital / Capitals**: 19 regions with significant average specialisation in the cultural and creative industries and digital ecosystems, alongside less significant specialisation in retail and tourism.

- **Health / Local**: 21 regions with significant average specialisation in the health ecosystem, less significant specialisation in the retail, proximity (social) and construction ecosystems.

- **Electronics / Mobility**: 17 regions with significant average specialisation in the electronics ecosystem, complemented by less significant specialisation in energy, health, mobility, aerospace and construction.

- **Non-specialised / Diversified**: 50 regions characterized by the lack of a clear pattern of specialization in any of the ecosystems.

Analysis of the presence of cluster organisations across this regional typology showed that regions in the *Creative/Digital/Capitals*, *Electronics/Mobility*, and *Non-specialised/Diversified* categories have considerably more cluster organisations on average than other regions, while regions in the *Agri-tourism* and *Health / Local* groupings are less likely to have a cluster organisation. It also demonstrated that there is broad alignment in terms of the presence of cluster organisations working in industrial ecosystems that fit the specialisation pattern of their regions. However, there is also a pattern of transversality with regards cluster organisations working in the *Digital* ecosystem (and to a lesser extent the *Health* ecosystem), which are strongly present in almost all region types. This underlines the relevance of digitalisation across all economic activities, on the one hand, and the universal importance of local clusters in health activities across all types of regions on the other hand.

The relationships between clusters and regional competitiveness

The next step in the analysis of the report was to explore the relationships between clustering and regional competitiveness in Chapter 6. The main conclusions from this analysis can be summarised as follows:

- **The relationship between sector specialisation and stronger innovation behaviour and economic performance is only significant when specialisation nodes account for a significant proportion of European employment in their sectors (industry-relevant nodes).** However, specialisation in activities that account for significant proportions of regional employment (region-relevant nodes) is positively correlated with regional employment outcomes and other social outcomes.

- **The presence of cluster organisations in European regions is correlated with stronger performance in several key regional competitiveness indicators** and does not show a significant negative correlation with any of the 23 indicators considered. The indicators where correlation is positive and significant are:
    - GDP per capita
    - Apparent labour productivity
    - PCT patents per million population
    - Business R&D expenditure
    - PCT patent co-operation
    - Human resources in science and technology

- **The presence of cluster organisations is mainly related to stronger performance in the economic or technological aspects of competitiveness**, a finding that is consistent with the predominant rationale for cluster policy – and the primary focus of cluster organisations – in seeking to enhance business-level innovation and competitiveness.

- **Sector specialisation is negatively correlated with key dimensions of green performance and positively correlated with a key dimension of digital performance, while cluster organisation presence is not correlated with either.** This reflects the concentration of

specialisation nodes in manufacturing activities and highlights the challenges in pursuing better economic outcomes while advancing an environmental agenda.

- **Regional competitiveness performance varies in line with the 7-group typology developed based on industrial ecosystem specialisation.** Overall, Creative/Digital/Capitals regions show a better relative performance in most variables, followed by those regions characterised by Health/Local ecosystems and Electronics/Mobility ecosystems and by those regions who are diversified (or non-specialised) across a range of ecosystems. At the other end of the performance scale, the most "lagging" regions are found in the Agri-food, Agri-textile, and Energy/Industry groupings.

Driving forward green and digital transitions through clusters

Finally, it is worth returning to the roles that clusters are playing in green and digital transitions. In the context of these ongoing and interconnected transitions that require fundamental market realignments across geographies, sectors and value chains, clusters have been hypothesised to play key roles. Their triple function as sources of market intelligence, brokers for the development of stakeholder networks, and direct providers of support services to businesses is indeed at the core of the paradigm shift that is required for these transitions to be successful.

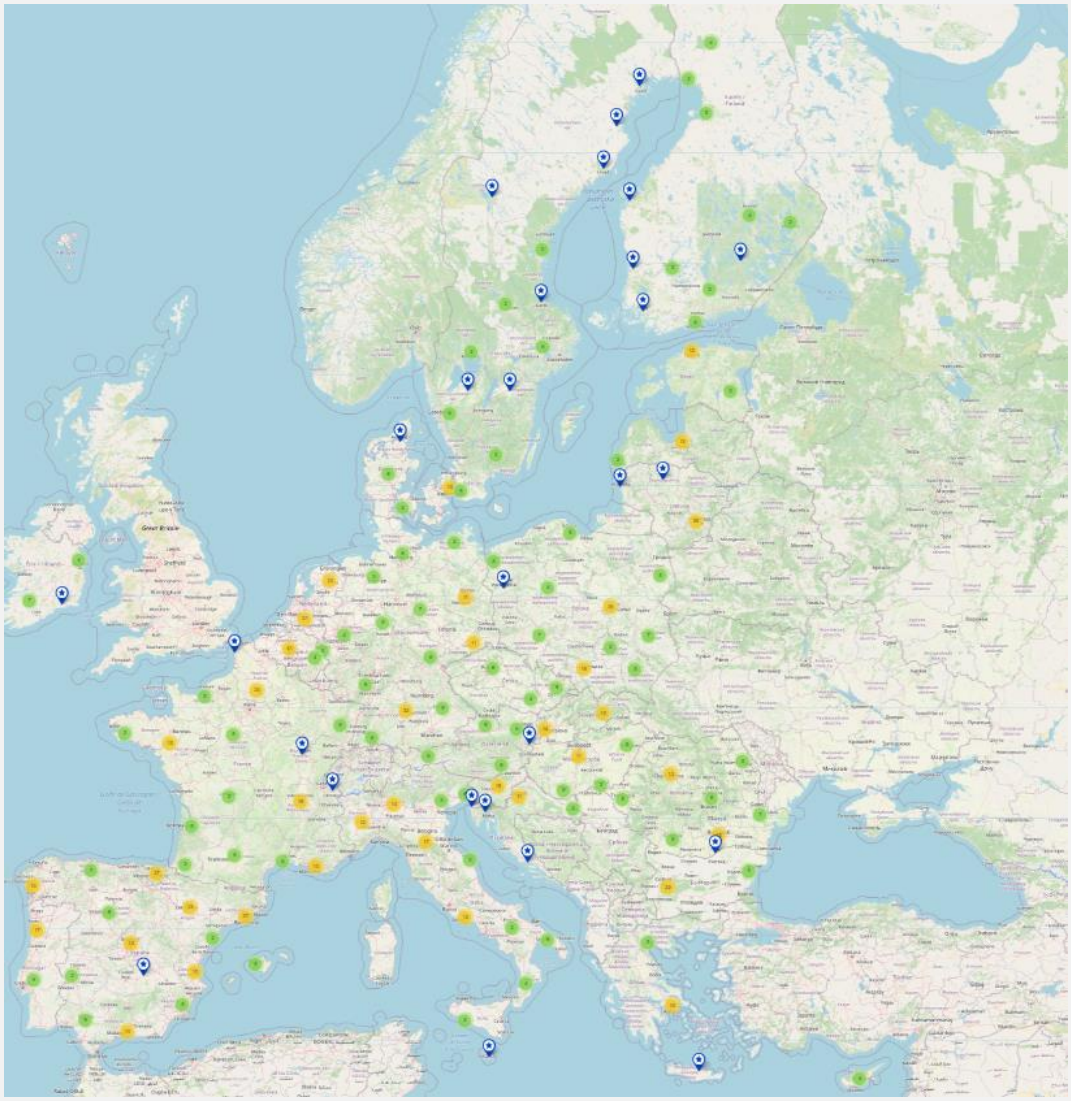
However, the findings of this report suggest that there are significant challenges ahead in achieving this in the traded, industrial activities in which clusters and cluster organisations tend to predominate. Given the energy intensity and transportation needs of much traded industrial activity, these are precisely the parts or our economy where greatest effort is needed to accelerate the green transition. Moreover, it is in the traded, manufacturing activities where clusters predominate that the digital transition is most critical for sustained international competitiveness. This accentuates the importance of cluster organisations in supporting policy makers to drive forward learning and change among their members that accelerate the transitions. Indeed, they provide a unique collaborate bridge into the day-to-day practices of European SMEs. In this regard, there is clear evidence that European cluster organisations see themselves as playing these roles, both in clusters that might traditionally be considered green or digital, and transversally across the full spectrum of clusters.

The policy challenge therefore is to capitalise on the collaborative power of clusters, and their specific presence in industrial activities across Europe, to accelerate advances in the green and digital transitions. Critically, this is a message not only for 'cluster policy makers' that are used to working with cluster organisations, but also for a much broader spectrum of policy makers working on policy agendas in the domains of innovation, skills, environment and others that are critical for the ongoing resilience of European economies in the face of these transitions. Through the policy toolkit introduced in Chapter 5 and the interactive mapping tool highlighted in the box below, along with a whole range of other services, events, and capacity building activities, the ECCP aims to support policy makers and cluster organisations in these challenges.

ECCP Interactive Cluster Mapping Tool

Explore the latest statistical data and cluster actor data on clusters in Europe and customise maps, graphs and correlations for specific regions, sectors and industrial ecosystems

The ECCP interactive mapping tool allows users to choose how they engage with the large ECCP database containing the statistical data analysed in this report alongside profile data on 8 different types of cluster actors. Users can explore the data by cluster actor, sector, industrial ecosystem, or region, and link directly into the cluster policy data contained in factsheets for each country.



Click here to start exploring: **https://reporting.clustercollaboration.eu/**

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Annex 1: List of 201 regions and their codes

Region name and codes

Austria
- AT11. Burgenland
- AT12. Lower Austria
- AT13. Vienna
- AT21. Carinthia
- AT22. Styria
- AT31. Upper Austria
- AT32. Salzburg
- AT33. The Tyrol
- AT34. Vorarlberg

Belgium
- BE1. Brussels Region
- BE2. Flemish Region
- BE3. Walloon Region

Bulgaria
- BG31. North-West (Bulgaria)
- BG32. North-Central (Bulgaria)
- BG33. North-East (Bulgaria)
- BG34. South-East (Bulgaria)
- BG41. South-West (Bulgaria)
- BG42. South-Central (Bulgaria)

Croatia
- HR03. Adriatic Croatia
- HR04. Continental Croatia

Cyprus
- CY. Cyprus

Czechia
- CZ01. Prague
- CZ02. Central Bohemia
- CZ03. South-West (Czechia)
- CZ04. North-West (Czechia)
- CZ05. North-East (Czechia)
- CZ06. South-East (Czechia)
- CZ07. Central Moravia
- CZ08. Moravian Silesia

Denmark
- DK01. Capital (region)
- DK02. Zealand
- DK03. South Denmark
- DK04. Central Jutland
- DK05. North Jutland

Estonia
- EE. Estonia

Finland
- FI19. West Finland
- FI1B. Helsinki-Uusimaa
- FI1C. South Finland
- FI1D. North and East Finland
- FI20. Åland Islands

France
- FR1. Île-de-France
- FRB. Centre-Val de Loire
- FRC. Burgundy-Franche-Comté
- FRD. Normandy
- FRE. Hauts-de-France
- FRF. Grand Est
- FRG. Loire Region
- FRH. Brittany
- FRI. New Aquitaine
- FRJ. Occitania
- FRK. Auvergne-Rhône-Alpes
- FRL. Provence-Alpes-Côte d'Azur
- FRM. Corsica
- FRY1. Guadeloupe
- FRY2. Martinique
- FRY3. French Guiana
- FRY4. Réunion
- FRY5. Mayotte

Germany
- DE1. Baden-Württemberg
- DE2. Bavaria
- DE3. Berlin
- DE4. Brandenburg
- DE5. Bremen
- DE6. Hamburg
- DE7. Hessen
- DE8. Mecklenburg-Western Pomerania
- DE9. Lower Saxony
- DEA. North Rhine-Westphalia
- DEB. Rhineland-Palatinate
- DEC. Saarland
- DED. Saxony
- DEE. Saxony-Anhalt
- DEF. Schleswig-Holstein
- DEG. Thuringia

Greece
- EL30. Attica
- EL41. North Aegean
- EL42. South Aegean
- EL43. Crete
- EL51. East Macedonia, Thrace
- EL52. Central Macedonia
- EL53. West Macedonia
- EL54. Epirus
- EL61. Thessaly
- EL62. Ionian Islands
- EL63. Western Greece
- EL64. Central Greece
- EL65. Peloponnese

Hungary
- HU11. Budapest
- HU12. Pest
- HU21. Central Transdanubia
- HU22. West Transdanubia
- HU23. South Transdanubia
- HU31. North Hungary
- HU32. North Great Plain
- HU33. South Great Plain

Ireland
- IE04. Northern and Western (Ireland)
- IE05. Southern (Ireland)
- IE06. Eastern and Midland (Ireland)

Italy
- ITC1. Piedmont
- ITC2. Valle d'Aosta
- ITC3. Liguria
- ITC4. Lombardy
- ITF1. Abruzzo
- ITF2. Molise
- ITF3. Campania
- ITF4. Apulia
- ITF5. Basilicata
- ITF6. Calabria
- ITG1. Sicily
- ITG2. Sardinia
- ITH1. Autonomous Province of Bolzano
- ITH2. Autonomous Province of Trento
- ITH3. Veneto
- ITH4. Friuli-Venezia Giulia
- ITH5. Emilia-Romagna
- ITI1. Tuscany
- ITI2. Umbria
- ITI3. Marche
- ITI4. Lazio

Latvia
- LV. Latvia

Lithuania
- LT01. Vilnius County
- LT02. Cultural regions of Lithuania

Luxembourg
- LU. Luxembourg

Malta
- MT. Malta

Netherlands
- NL11. Groningen
- NL12. Friesland
- NL13. Drenthe
- NL21. Overijssel
- NL22. Gelderland
- NL23. Flevoland
- NL31. Utrecht
- NL32. North Holland
- NL33. South Holland
- NL34. Zeeland
- NL41. North Brabant
- NL42. Limburg

Poland
- PL21. Małopolskie
- PL22. Śląskie
- PL41. Wielkopolskie
- PL42. Zachodniopomorskie
- PL43. Lubuskie
- PL51. Dolnośląskie
- PL52. Opolskie
- PL61. Kujawsko-pomorskie
- PL62. Warmińsko-mazurskie
- PL63. Pomorskie
- PL71. Łódzkie
- PL72. Świętokrzyskie
- PL81. Lubelskie
- PL82. Podkarpackie
- PL84. Podlaskie
- PL91. Warsaw-Capital
- PL92. Mazowieckie-Regional

Portugal
- PT11. North (Portugal)
- PT15. Algarve
- PT16. Centre (Portugal)
- PT17. Lisbon Metropolitan Area
- PT18. Alentejo
- PT20. Azores
- PT30. Madeira

Romania
- RO11. North-West (Romania)
- RO12. Centre (Romania)
- RO21. North-East (Romania)
- RO22. South-East (Romania)
- RO31. South-Muntenia
- RO32. Bucharest-Ilfov
- RO41. South-West Oltenia
- RO42. West (Romania)

Slovakia
- SK01. Bratislava
- SK02. West Slovakia
- SK03. Central Slovakia
- SK04. East Slovakia

Slovenia
- SI03. East Slovenia
- SI04. West Slovenia

Spain
- ES11. Galicia
- ES12. Asturias
- ES13. Cantabria
- ES21. Basque Country
- ES22. Navarre
- ES23. Rioja
- ES24. Aragon
- ES30. Madrid
- ES41. Castile and Leon
- ES42. Castile-La Mancha
- ES43. Extremadura
- ES51. Catalonia
- ES52. Valencia
- ES53. Balearic Islands
- ES61. Andalusia
- ES62. Murcia
- ES63. Ceuta
- ES64. Melilla
- ES70. Canary Islands

Sweden
- SE11. Stockholm
- SE12. East-Central Sweden
- SE21. Småland and islands
- SE22. South Sweden
- SE23. West Sweden
- SE31. North-Central Sweden
- SE32. Central Norrland
- SE33. Upper Norrland

Annex 2: Full names of 88 NACE 2-digit sectors and their codes

A01 - Crop and animal production, hunting and related service activities
A02 - Forestry and logging
A03 - Fishing and aquaculture
B05 - Mining of coal and lignite
B06 - Extraction of crude petroleum and natural gas
B07 - Mining of metal ores
B08 - Other mining and quarrying
B09 - Mining support service activities
C10 - Manufacture of food products
C11 - Manufacture of beverages
C12 - Manufacture of tobacco products
C13 - Manufacture of textiles
C14 - Manufacture of wearing apparel
C15 - Manufacture of leather and related products
C16 - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
C17 - Manufacture of paper and paper products
C18 - Printing and reproduction of recorded media
C19 - Manufacture of coke and refined petroleum products
C20 - Manufacture of chemicals and chemical products
C21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations
C22 - Manufacture of rubber and plastic products
C23 - Manufacture of other non-metallic mineral products
C24 - Manufacture of basic metals
C25 - Manufacture of fabricated metal products, except machinery and equipment
C26 - Manufacture of computer, electronic and optical products
C27 - Manufacture of electrical equipment
C28 - Manufacture of machinery and equipment n.e.c.
C29 - Manufacture of motor vehicles, trailers and semi-trailers
C30 - Manufacture of other transport equipment
C31 - Manufacture of furniture
C32 - Other manufacturing
C33 - Repair and installation of machinery and equipment
D35 - Electricity, gas, steam and air conditioning supply
E36 - Water collection, treatment and supply
E37 - Sewerage
E38 - Waste collection, treatment and disposal activities; materials recovery
E39 - Remediation activities and other waste management services
F41 - Construction of buildings
F42 - Civil engineering
F43 - Specialised construction activities
G45 - Wholesale and retail trade and repair of motor vehicles and motorcycles
G46 - Wholesale trade, except of motor vehicles and motorcycles
G47 - Retail trade, except of motor vehicles and motorcycles
H49 - Land transport and transport via pipelines
H50 - Water transport
H51 - Air transport
H52 - Warehousing and support activities for transportation
H53 - Postal and courier activities
I55 - Accommodation
I56 - Food and beverage service activities
J58 - Publishing activities
J59 - Motion picture, video and television programme production, sound recording and music publishing activities
J60 - Programming and broadcasting activities

J61 - Telecommunications
J62 - Computer programming, consultancy and related activities
J63 - Information service activities
K64 - Financial service activities, except insurance and pension funding
K65 - Insurance, reinsurance and pension funding, except compulsory social security
K66 - Activities auxiliary to financial services and insurance activities
L68 - Real estate activities
M69 - Legal and accounting activities
M70 - Activities of head offices; management consultancy activities
M71 - Architectural and engineering activities; technical testing and analysis
M72 - Scientific research and development
M73 - Advertising and market research
M74 - Other professional, scientific and technical activities
M75 - Veterinary activities
N77 - Rental and leasing activities
N78 - Employment activities
N79 - Travel agency, tour operator and other reservation service and related activities
N80 - Security and investigation activities
N81 - Services to buildings and landscape activities
N82 - Office administrative, office support and other business support activities
O84 - Public administration and defence; compulsory social security
P85 - Education
Q86 - Human health activities
Q87 - Residential care activities
Q88 - Social work activities without accommodation
R90 - Creative, arts and entertainment activities
R91 - Libraries, archives, museums and other cultural activities
R92 - Gambling and betting activities
R93 - Sports activities and amusement and recreation activities
S94 - Activities of membership organisations
S95 - Repair of computers and personal and household goods
S96 - Other personal service activities
T97 - Activities of households as employers of domestic personnel
T98 - Undifferentiated goods- and services-producing activities of private households for own use
U99 - Activities of extraterritorial organisations and bodies

Annex 3: Methodology for calculating statistical cluster mapping indicators

The statistical data that has been analysed for this report is a complete matrix of values covering each of the 88 NACE 2.0 2-digit categories in each of the 201 regional units of analysis, for the following indicators:

- Number of persons employed (V16110)
- Gross value added at basic prices (V12140)
- Apparent labour productivity: Calculated as Gross value added per person employed (V12140/V16110)
- Specialisation on employment (V00001)

The specialisation indicator is calculated as a location quotient (LQ), that is, the ratio between the industry's share of total employment in each region and the industry's share of total employment in the EU-27:

$$LQ_{r,s} = \frac{V_{r,s} \Big/ \sum_s V_{r,s}}{\sum_r V_{r,s} \Big/ \sum_{r,s} V_{r,s}}$$

The LQ measures, therefore, how much a sector is over-represented in a region, and for our analysis a cut-off ratio of 1.5 is used to denote a region that can be considered 'highly specialised' in any given sector.[45] This specialisation variable is transformed into a Boolean variable for the segmentation analysis, and for other elements of the analysis we also use a continuous LQ variable capped at 5, thus ranging from 0 to 5.

The data processing methodology to arrive at these indicators took several steps. Firstly, to obtain a solid grounding for analysis at sufficient sectoral and administrative disaggregation, data on employment, number of enterprises (local units) and value-added were collected from a range of different sources:

1. Public data from SBS, regional economic accounts and LFS databases available at EUROSTAT.
2. High-detail bespoke data from the LFS, via request to EUROSTAT.
3. Public domain data from the websites of national statistical offices.
4. Bespoke data from national statistical offices.

In each case, the data was collected at the highest level of territorial disaggregation (from national to NUTS2) and activity level (up to NACE 4-digit categories). Data from such a wide range of sources presents significant challenges concerning consistency, coverage, and missing values. After the initial collection process, the data was homogenized and prepared to serve as an input for an algorithm that has been developed to make estimations for missing values based on logic, interpolation, self-calculated ratios, and several other features.

The complete process is explained in further detail below in three steps: data collection, data import, and data processing.

[45] This indicates that the prevalence of employees in this sector in this region is 1.5 times the prevalence that would be expected across Europe as a whole.

Data Collection

The first step was to collect the raw data for employment, gross value added, following these steps:

- Download available regional and industry data from EUROSTAT database. These datasets are not fully complete and the public industry disaggregation is lower than we require but they serve as a starting and reference point for the rest of the data process.
- Contact Eurostat for data disaggregated at NUTS2 regional level and different NACE 2.0 levels from conducted surveys as the LFS or the SBS.
- Exploring the website of the national statistical office, looking for the "Statistical Database". Usually, the required data is under the heading of "Business Statistics", "Enterprises" or "Industry", etc. Most countries do not have it online, but many do.
- If the website does not have the required data, the next step is directly contacting national statistical offices by email and/or phone.

Data Import

When the data has been identified, it usually arrives in the format of an Excel file structured for viewing by humans (e.g. multiple sheets, regions or years as columns, etc). The first processing job is to import it into a common database. The approach used was to make minimal changes to the structure of the file in Excel itself, preferring to make all transformation within the database (where it is more easily documented and can be applied to analogous files in the future). The outcome of the import process is such that all the relevant data is consolidated in a final table.

1. The first step in the data import process is to create all the relevant metadata for each data batch. We identify each data batch with a code and add information regarding the data supplier and obtained indicators.

2. Once the metadata is in place, we conduct the data import:
   - We import the received file or files with the original format.
   - We apply all necessary transformations to the supplied tables to obtain a final table (or view) with a common structure that can be added to the master table with the rest of the batches. These transformations may imply the following steps, depending on the original structure and format of the data:
     - Convert the shape of the table to obtain a "tidy" or "long" format table by unpivoting some columns. For example, annual data can be presented in columns and for data processing purposes is better to have it in rows.
     - Convert classification codes regarding regions, industries and indicators to a common nomenclature.
       - NUTS2016 for region codes
       - NACE 2.0 for industry codes
       - Own defined indicator codes (that align with Eurostat codes).
     - Convert all monetary values into nominal Euros (i.e. convert currency and transform from thousands/millions to Euros).
     - Add the necessary meta columns identifying each for batch.

3. Once every batch is in place, we consolidate all the data in the master table where it will be processed to fill the missing values. This consolidated table ensures there are no conflicting sources for the same region and we have a single source per region-year-indicator-industry

in order to avoid introducing any double-counting (e.g. only one source that could be used to infer agriculture from the hierarchy of industries).

Data Processing

Once we have consolidated all the data in a single table, we can proceed to process it with a unified algorithm to harmonise and estimate values as needed. This consolidated data can be considered semi-raw or mildly pre-processed and follow different classifications for industries that are only available for some years, indicators, and regions. Our goal is to create as full a matrix as possible that will provide a value for each indicator for every year within the relevant range for NACE 2.0 4-digit industry and a NUTS2 equivalent region. This process consists of the following steps:

1. The first and by far most complex step computationally is to translate the data from the available values into the data on the lowest disaggregation level for a given classification. Taking NACE as an example, we could have data on 4-, 3-, 2-digit and letter levels with the industries forming a hierarchy. We want data at the 2-digit and 4-digit levels, so when it is missing in the raw data, we try to get the value from the industries at the higher level. Specifically, we subtract the value of all known children from the parent and then split it among the industries for which it is the closest parent. For example, in a case in which the data for industries 30, 30.1, 30.13, and 30.22 is available, but 30.11, 30.12, 30.2, and 30.21 not, we would infer 30.11 and 30.12 from (30.1 – 30.13) and 30.21 from (30 – 30.1 – 30.22). It is important to note that all of this only happens within the same "source" of data (i.e. we do not inter-mingle SBS and LFS numbers). At this point we know which industry will be split into which other ones and how much is left to be split, but we do not know the shares. To obtain these, we look at all the data available to us and try to find the two industries in question (the 4-digit one and the one that it will be split from) in the whole *consolidated* table where they are both present. We then average the shares across years and use them for all the regions where they are available. If no such shares are available for a given region, we look at its parents, and then at the whole world. If the shares are still not available, we fall back to equal splits. This results in a single number ≤ 1 used for every "child" industry. We normalize them to sum to 1 and then split the remainder we have computed in the previous step using these shares.

2. We now have a table which for each available year-region-indicator provides the value at the most detailed industry level, from which we want to convert indicators into related ones for which the data is missing. At this step we may not have values for all the indicators, but we have values for other indicators that can be used to infer values for those missing. We apply ratios to available indicators to obtain a fuller set of indicators within each region.
    a. Using national data from the SBS we calculate the ratios shown "Employees in FTE / Employees", "Employees in FTE / Persons employed", and "Employees / Persons employed" at different resolution levels, in order of preference:
        i. Average ratio for region, industry and time period
        ii. Average ratio for region and time period
        iii. Average ratio for industry and time period
    b. These ratios are applied in cascade, from higher NACE2.0 and NUTS levels to available source indicators, when target indicator is not available.

3. We then conduct an exercise like the splits from parents above, but we now convert from all the industry classifications into NACE 2.0. This is a simple many-to-many match where, by default, we assume that each source industry is split equally into the target industries unless we have explicit shares (which are available only for NACE1.1 -> NACE 2.0 conversion, but by extension also covers all NACE1.1-like industries). The values in source classification are then

simply multiplied by these shares and re-aggregated using the NACE 2.0 codes. The outcome is a table which has the value for each available year, region, and indicator at 2-digit and 4-digit NACE 2.0 industry that will be subsequently aggregated into 2-digit codes.

4. The penultimate processing step is an extension of the data in time. We pick the set of years for which we want the imputed values (by default, all years present in the dataset) and do a simple imputation: if there are values in both older and more recent years, we use linear interpolation, otherwise we use the closest year available. This is done on a per-industry basis. The output is the as-complete-as-possible matrix of the values for all indicators. The primary reason why we do the imputation across time is that the specialisation indicators (LQ) are global in a sense that each value in a year depends on every other value in a year via aggregates. Thus, even if the value for LQ itself in the region with missing data is unlikely to be reliable, we want the baseline used in all *other* LQ computations to be as close as possible to correctness and for that purpose having imputed data is much better than having missing data.

5. The final step before the analysis and publication of the data is to adjust the values obtained after all the previous processing to match those published by Eurostat at a higher aggregation level of industries. The primary reason for this final step is that if we aggregate the values at NACE 2-digit and 4-digit levels we can end up with values that may differ from those published at A10/A*10/A11 level in Eurostat. The resulting values are going to be published and we want that if values are aggregated the result to be the same as in Eurostat's data. To do this we establish a target dataset for each of the variables used. These target datasets have data at NACE A10/A*10/A11 level and thus, we aggregate our values at the same level as the target dataset to be able to obtain the difference ratios at region-industry-timeperiod between our "source" dataset and the "target" dataset.

   The target datasets may combine regional and country data to obtain the most complete target dataset at regional level. For that, country data is used to estimate values at regional level. The base target datasets used are:
   - V16110 - Number of persons employed.
     - We use:
       - [nama_10r_3empers] Employment (thousand persons) by NUTS 3 regions
       - [nama_10_a10_e] Employment by A*10 industry breakdowns
   - V12140 - GVA at basic prices
     - We use a combination of regional and national data:
       - [nama_10r_3gva] Gross value added at basic prices by NUTS 3 regions
       - [nama_10_a64] National accounts aggregates by industry (up to NACE A*64)

   We apply these ratios to the "source" values and in this way, if we aggregate the values at a lower industry level (2, 3 or 4 digits), we obtain the same values as published in Eurostat.

At the end of this process, we obtain the first two indicators listed at the start of this Annex (employment and value added), from which we can calculate the other two indicators (productivity and specialisation).

Annex 4: List of cluster organisations with updated ECCP profiles on 29/11/2021 (by country and region)

Cluster Organisations by Country & Region

Austria

AT12. Lower Austria

ecoplus. The Business Agency of Lower Austria, Food Cluster

AT13. Vienna

Social Entrepreneurship Network Austria

AT21. Carinthia

Silicon Alps

Silicon Alps Cluster

AT22. Styria

Austrian Centre of Industrial Biotechnology (acib)

BioNanoNet Forschungsgesellschaft mbH

Green Tech Cluster Styria GmbH

Human.technology Styria GmbH

Photonics Austria

AT31. Upper Austria

Furniture & Timber Construction Cluster @Business Upper Austria - OÖ Wirtschaftsagentur GmbH

Mechatronics Cluster @ Business Upper Austria - OÖ Wirtschaftsagentur

Belgium

BE1. Brussels Region

circlemade

European Association of Remote Sensing Companies

Flanders' FOOD

Flux50 vzw

hospitality.brussels

lifetech.brussels

BE2. Flemish Region

Blue Cluster

DSP Valley

flanders.bio

flanders.healthTech

LSEC - Leaders In Security

Strategisch Initiatief Materialen - Flam3D

BE3. Walloon Region

BioWin

CAP Construction

Logistics in Wallonia

Pôle MecaTech

TWEED

TWIST Cluster

Wagralim, the agri-food innovation cluster of Wallonia, Belgium

Bulgaria

BG32. North-Central (Bulgaria)

Specialized Cluster and Institute for Apparel and Textile - Danube

BG33. North-East (Bulgaria)

Bulgarian Fashion Association

BG34. South-East (Bulgaria)

Cluster of information and communication technologies Burgas

BG41. South-West (Bulgaria)

Automotive Cluster Bulgaria

Bulgarian Branch Association Polymers

Bulgarian Fintech Association

Bulgarian Furniture Cluster

Cluster Aero-Space Technologies, Research and Applications/CASTRA

Cluster for Digital Transformation and Innovations

Cluster Green Transport

Cluster Information and Communication Technologies Blagoevgrad

DIGITAL HEALTH AND INNOVATION CLUSTER BULGARIA

ICT Cluster

Renewable Energy Sources Cluster

BG42. South-Central (Bulgaria)

Green Synergy Cluster

Croatia

HR03. Adriatic Croatia

Cluster for Eco Social Innovation and Development CEDRA Split

Kvarner Health Tourism Cluster

HR04. Continental Croatia

3D grupa

Croatian Defense Industry Competitiveness Cluster

Cyprus

CY. Cyprus

Shopkeepers Artisans and Production Marketing Cooperative

Czechia

CZ03. South-West (Czechia)

Klastr Mechatronika, z.s.

CZ05. North-East (Czechia)

Czech Hemp Cluster

Nanoprogress z.s.

CZ06. South-East (Czechia)

Cluster of Czech Furniture Manufacturers

CZ07. Central Moravia

Czech Optical Cluster

Moravian Aerospace Cluster, z.s.

Plastics Cluster

CZ08. Moravian Silesia

Autoklastr

Czech Machinery Cluster

Denmark

DK01. Capital (region)

Danish Life Science Cluster

WE BUILD DENMARK

DK03. South Denmark

CLEAN

Danish Materials Network

DK04. Central Jutland

Center for Defence, Space & Security (CenSec)

Danish Sound Cluster

DigitalLead

DK05. North Jutland

Energy Cluster Denmark

Estonia

EE. Estonia

Estonian Aviation Cluster

Estonian Digital Construction Cluster

Estonian ICT Cluster

Tehnopol Greentech Cluster

Finland

FI19. West Finland

DIMECC Ltd.

Robocoast Cluster

Tampere Imaging Ecosystem

Tampere Region Safety and Security Cluster

FI1B. Helsinki-Uusimaa

Finnish Water Forum

Green Net Finland

FI1C. South Finland

HealthTurku

FI1D. North and East Finland

Arctic Design Cluster, University of Lapland

Arctic Development Environments, Lapland University of Applied Sciences

Blue Economy Mikkeli

Energy Cluster North Savo

Kuopio Water Cluster

North Savo Agri-Food Cluster

The Arctic Smart Industry and Circular Economy Cluster - Kiertotalouskeskus Digipolis Oy

Water Cluster Finland

France

FR1. Île-de-France

Cap Digital

Descartes Sustainable City cluster

Finance Innovation

GENOPOLE

MEDICEN PARIS REGION

NEXTMOVE (MOV'EO)

Systematic Paris-Region

FRB. Centre-Val de Loire

COSMETIC VALLEY

FRC. Burgundy-Franche-Comté

Pôle Véhicule du Futur

VITAGORA

FRD. Normandy

AQM NORMANDY

ARIA NORMANDY

NAE (Normandie AeroEspace - Defense)

FRE. Hauts-de-France

Eurasante/Clubster NHL

Hauts-de-France Automotive Cluster

MEDEE

FRF. Grand Est

HYDREOS

Materalia

FRG. Loire Region

EMC2

VEGEPOLYS VALLEY

- **FRH. Brittany**
  - *Pôle Mer Bretagne Atlantique*
  - *VALORIAL*
- **FRI. New Aquitaine**
  - *ALPHA-RLH Route des Lasers et des Hyperfréquences*
  - *European Cluster of Ceramics*
  - *INNO'VIN*
  - *POLE AVENIA*
- **FRJ. Occitania**
  - *Aerospace Valley*
  - *Agri Sud-Ouest Innovation*
  - *Digital 113*
  - *France Water Team*
  - *Pôle Aqua-Valley*
- **FRK. Auvergne-Rhône-Alpes**
  - *AXELERA*
  - *CARA*
  - *CIMES, Creating Integrated MEchanical Systems*
  - *Cluster Eco-Bâtiment*
  - *CLUSTER LUMIERE*
  - *Cluster Montagne*
  - *Lyon Auvergne Rhône-Alpes Cancer cluster*
  - *Minalogic*
  - *Polymeris*
  - *TECHTERA*
  - *TENERRDIS*
- **FRL. Provence-Alpes-Côte d'Azur**
  - *Capenergies Association*
  - *EUROBIOMED*
  - *Photonics cluster OPTITEC*
  - *Pôle SCS*
  - *SAFE Cluster*
  - *SYSTEM FACTORY*

Germany

- **DE1. Baden-Württemberg**
  - *BioLAGO e.V. the health network*
  - *BioRegio STERN Management GmbH*
  - *BioRN - Life Science Cluster Rhine-Neckar*
  - *Cluster Electric Mobility South-West*
  - *cyberLAGO e.V. - digital competence network*
  - *food.net:z*
  - *Metall/KunststoffDIALOG*
  - *NanoMat*
  - *Photonics BW e.V.*
  - *Rhine-Neckar Metropolitan Region Ltd.*
  - *ROBONOM - AUTONOMOUS SERVICE ROBOTS*
- **DE2. Bavaria**
  - *Bavarian Food Cluster*
  - *BioM Biotech Cluster Development GmbH*
  - *BioPark Regensburg GmbH / BioRegio Regensburg*
  - *Center Digitisation.Bavaria*
  - *Chemistry Cluster Bavaria / Chemie-Cluster Bayern*
  - *Cluster Sensor technology Bavaria / Strategic Partnership for Sensor Technologies*
  - *E-Mobility Cluster (mobility and logistics)*
  - *Franconian Plastics Network (KNF)*
  - *IT-Security Cluster*
  - *Power Electronics Cluster within ECPE e.V.*
  - *Silicon Vilstal*
  - *Umweltcluster Bayern*
- **DE3. Berlin**
  - *HealthCapital - Cluster Healthcare Industries Berlin Brandenburg*
- **DE4. Brandenburg**
  - *Cluster Energy Technology Berlin-Brandenburg*
  - *CURPAS*
- **DE6. Hamburg**
  - *Hamburg Aviation e.V.*
  - *Life Science Nord*
  - *Logistics-Initiative Hamburg Managment GmbH*
- **DE7. Hessen**
  - *Bioeconomy in the metropolitan area*
- **DE8. Mecklenburg-Western Pomerania**
  - *BalticNet-PlasmaTec e.V.*
  - *BioCon Valley GmbH®*
- **DE9. Lower Saxony**
  - *ITS mobility e. V.*
- **DEA. North Rhine-Westphalia**
  - *CLIB - Cluster Industrial Biotechnology*
  - *Food-Processing Initiative e.V.*
  - *InnoZent OWL e.V.*
- **DEB. Rhineland-Palatinate**
  - *Cluster for Individualized Immune Intervention (Ci3)*
  - *Commercial Vehicle Cluster - Nutzfahrzeug GmbH*
  - *Ecoliance Rhineland-Palatinate*
  - *Optence e.V. / Photonics Hub*
- **DED. Saxony**
  - *Geo Competence Centre Freiberg*
  - *Netzwerk Energie und Umwelt e.V. (NEU)*
  - *Organic Electronics Saxony (OES)*
  - *SACHSEN!TEXTIL*
  - *Silicon Saxony*
- **DEF. Schleswig-Holstein**
  - *Bioeconomy at Marine Sites (BaMS)*
  - *foodRegio*
- **DEG. Thuringia**
  - *medways e.V.*
  - *SpectroNet c/o Technologie- und Innovationspark Jena GmbH*
  - *Thurigian Renewable Energies Network (ThEEN)*

Greece

- **EL30. Attica**
  - *gi-Cluster*
  - *Hellenic BioCluster*
  - *Hellenic Digital Health Cluster*
  - *Hellenic Emerging Technologies Industry Association*
  - *si-Cluster*
- **EL43. Crete**
  - *Hellenic Association of Innovative Small and Medium Enterprises Innovation Greece*
- **EL64. Central Greece**
  - *Strategis Maritime ICT Cluster*

Hungary

- **HU11. Budapest**
  - *OMNIPACK First Hungarian Cluster of Packaging Technology*
- **HU21. Central Transdanubia**
  - *INNOSKART Digital Cluster*
- **HU23. South Transdanubia**
  - *Cluster of Applied Earth Sciences*
  - *South West Hungarian Engineering Cluster*
- **HU32. North Great Plain**
  - *MSE Hungarian Sport and Lifestyle Development ClusterCo.*
  - *Thermal-Health Industrial Cluster*
- **HU33. South Great Plain**
  - *Hungarian Open Innovation Cluster for Construction Industry*

Ireland

- **IE05. Southern (Ireland)**
  - *AgriTech Ireland*
  - *Circular Bioeconomy Cluster South-West*
  - *Ireland South East Financial Services Cluster at South East Economic Development Office*
  - *Irish Digital Engineering and Advanced Manufacturing*
- **IE06. Eastern and Midland (Ireland)**
  - *Connected Health & Wellbeing Cluster - DKIT*

Italy

- **ITC1. Piedmont**
  - *bioPmed / Bioindustry Park*
  - *Cleantech and energy Innovation Cluster*
  - *Fondazione Torino Wireless*
  - *Italian Technology Cluster for Smart Communities*
  - *MESAP Innovation Cluster - Smart Products and Manufacturing*
  - *POINTEX - Textile Innovation Cluster*
  - *PROPLAST*
  - *Torino Social Impact*
- **ITC4. Lombardy**
  - *AFIL - Lombardy Intelligent Factory Association*
  - *Lombardy Green Chemistry Cluster*
  - *Lombardy Life Sciences Cluster*
  - *SPRING - Italian Circular Bioeconomy Cluster*
- **ITF3. Campania**
  - *Blue Italian Growth Technology Cluster (BIG TC)*
  - *Campania Bioscience - Cluster on Life Sciences*
  - *DAC, Campania Aerospace District*
  - *STRESS Scarl - High Tecnology District on Sustainable Construction*
- **ITF4. Apulia**
  - *Regional Agri-food District - D.A.Re. scrl*
  - *Aerospace Technology District*
  - *Creative Apulia Cluster Association*
- **ITF5. Basilicata**
  - *Basilicata Creativa - CCI*
  - *Basilicata Creativa CCI*
  - *Technologies for Earth Observation and Natural Risks*
- **ITF6. Calabria**
  - *Green HoMe - Pole of Innovation for Sustainable Building*
- **ITG1. Sicily**
  - *Ecodomus District*
- **ITH2. Autonomous Province of Trento**
  - *Habitech - Trentino Technological District S.c.a.r.l.*
- **ITH3. Veneto**
  - *RETE DI IMPRESE LUCE IN VENETO*
  - *Venetian Cluster*
- **ITH4. Friuli-Venezia Giulia**
  - *Cluster COMET*
  - *Distretto Industriale delle Tecnologie Digitale - Cluster ICT FVG*

- *Wood Furniture Home Cluster FVG*

ITH5. Emilia-Romagna

- *Clust-ER Build - Emilia-Romagna*
- *Clust-ER Health - Emilia Romagna*
- *Clust-ER Innovate - Emilia-Romagna*
- *Clust-ER Meccatronica e Motoristica*
- *Create - Cultural and creative industries*
- *Energy and Sustainable development Clust-ER Association*

ITI1. Tuscany

- *DID -technological Cluster on Interiors and Design*
- *DITECFER District for Rail Technologies, High Speed, Networks' Safety & Security*
- *OTIR2020-TFC - Next Technology Tecnotessile*
- *Tuscany Life Sciences Cluster*

ITI3. Marche

- *ACMM- Marche Manufacturing Cluster Association*

ITI4. Lazio

- *National Energy Technology Cluster*

Latvia

LV. Latvia

- *CLEANTECH LATVIA*
- *Food Products Quality Cluster*
- *Green and Smart Technology Cluster*
- *Green Tech HUB*
- *Latvian Electrical Engineering and Electronics Industry Association*
- *Latvian Health tourism cluster*
- *Latvian IT Cluster*

Lithuania

LT01. Vilnius County

- *Smart Digital Solutions cluster*
- *AgriFood Lithuania DIH*
- *Baltic Film & Creative Tech Cluster*
- *Cleantech Cluster Lithuania*
- *Food Technologies Digitalization LT*
- *Information Technologies in Medicine (MedIT)*
- *Laser & Engineering Technologies Cluster*
- *Laser Micromachining Cluster*
- *Life Sciences Digital Innovation Hub*
- *Lithuanian Photovoltaic Technology Cluster*
- *Lithuanian Plastics Cluster*
- *Lithuanian Prefabricated Wooden House Cluster - PrefabLT*
- *Lithuanian Social Innovation Cluster (LSIC)*
- *SMART food cluster*

LT02. Cultural regions of Lithuania

- *Maritime cluster*
- *Baltic Automotive Components Cluster (BACC)*
- *BCCS (Blockchain Cybersecurity and Compliance Solutions) Cluster*
- *Digital Rocket LT*
- *Health technology cluster iVita*
- *National Food Cluster Lithuania*

Netherlands

NL11. Groningen

- *Chemical Cluster Delfzijl*
- *Impact Noord*

NL12. Friesland

- *Water Alliance*

NL22. Gelderland

- *FoodValleyNL*
- *Health Valley Netherlands*

NL33. South Holland

- *Greenport West-Holland*

NL41. North Brabant

- *Cluster Sports & Technology*
- *High Tech NL*
- *LifetecZONe*
- *RAI Automotive Industry NL*

Poland

PL21. Małopolskie

- *Polish Cluster of Composite Technologies*

PL22. Śląskie

- *Silesian Aviation Cluster*
- *SINOTAIC - Silesian IoT Cluster*

PL41. Wielkopolskie

- *Food Cluster of Southern Greater Poland - association*

PL42. Zachodniopomorskie

- *Association Natureef*
- *Media Dizajn*
- *The Association West Pomeranian Chemical Cluster "Green Chemistry"*

PL43. Lubuskie

- *Metal Cluster of Lubuskie Voivodeship*

PL51. Dolnośląskie

- *Centre for Energy Technologie Cluster - Free Enterprise Association*
- *NUTRIBIOMED Cluster*

PL61. Kujawsko-pomorskie

- *Bydgoszcz Industrial Cluster (BIC)*

PL63. Pomorskie

- *BALTIC SEA & SPACE CLUSTER*
- *Cluster of Hydrogen Technologies / Regional Pomeranian Chamber of Commerce /*
- *North South Logistics & Transport Cluster*

PL81. Lubelskie

- *Cluster for Photonics and Fiber Optics*
- *Lublin Eco-Energy Cluster*
- *Lublin Enterprise Cluster*
- *Lublin Medicine- Medical and Wellness Cluster*

PL82. Podkarpackie

- *Aviation Valley / Dolina Lotnicza*
- *Polish Automotive Group PGM*

PL84. Podlaskie

- *Cluster of Business Environment Institutions/Klaster Instytucji Otoczenia Biznesu*
- *Polish Construction Cluster*

PL91. Warsaw-Capital

- *COP Cluster*
- *Digital Knowledge Cluster*
- *Mazovia Cluster ICT*

PL92. Mazowieckie-Regional

- *Agrofood and Bioeconomy Cluster*

Portugal

PT11. North (Portugal)

- *Fórum Oceano - Association of Maritime Economy*
- *MOBINOV - portuguese automotive cluster*
- *PortugalFoods*
- *Portuguese Textile Cluster (CITEVE)*
- *PRODUTECH - Production Technologies Cluster*

PT16. Centre (Portugal)

- *Associação para o Pólo das Tecnologias de Informação, Comunicação e Electronica TICE.PT*
- *Chemical, Petrochemical and Refining Cluster*
- *Cluster Habitat Sustentável*
- *InovCluster - Agroindustrial Cluster Association of Centro Portugal*
- *POOL-NET*

PT17. Lisbon Metropolitan Area

- *Madan Parque*

PT18. Alentejo

- *ASSOCIAÇÃO CLUSTER PORTUGAL MINERAL RESOURCES*

Romania

RO11. North-West (Romania)

- *AgroTransilvania Cluster*
- *Cluj IT Cluster*
- *Romanian New Materials Cluster*
- *Transilvania IT Cluster*
- *Transylvania Energy Cluster*
- *Transylvanian Furniture Cluster - legally represented by Hygia Consult*

RO12. Centre (Romania)

- *ETREC Cluster - Electro-Technical Regional Cluster*
- *Green Energy Romanian Innovative Biomass Cluster*

RO21. North-East (Romania)

- *Alaturi de Voi Romania Foundation (ADV Romania) / Accelerator of Social Enterprises Cluster*
- *ASTRICO NORD-EST TEXTILE CLUSTER*
- *ICONIC Cluster*
- *North-East Innovative Regional Cluster for Structural and Molecular Imaging (IMAGO-MOL)*

RO22. South-East (Romania)

- *Green Solutions Low Danube*
- *INNOVATIVE CLUSTER FOR HEALTH*
- *IT&C Cluster "Lower Danube"*
- *Open Hub Creative Cluster*
- *ROMANIAN RIVER TRANSPORT CLUSTER*

RO31. South-Muntenia

- *Danube Engineering Hub*

RO32. Bucharest-Ilfov

- *Asociatia Cluster Pro-nZEB*
- *DANUBE FURNITURE CLUSTER*
- *Electronic Innovation Cluster (ELINCLUS)*
- *Green Technology Cluster*
- *ROHEALTH- The Health and Bioeconomy Cluster*
- *Romanian Textile Concept*
- *Smart Alliance Cluster*
- *Technology Enabled Construction Cluster - TEC*

RO42. West (Romania)

- *Banat Software Cluster by ARIES-TM*

Slovakia

SK01. Bratislava

- *Council of Slovak Exporters*

- *House of events innovation*
- *Industry Innovation Cluster Slovakia*
- *SAPI - renewable energy cluster*
- *Slovak Electric Vehicle Association (SEVA)*
- *Slovak National Hydrogen Associatio - Claster*
- *Slovak Plastic Cluster*

SK02. West Slovakia

- *Bioeconomy Cluster*
- *INOVATO CLUSTER*
- *Regional Development Cluster*

SK03. Central Slovakia

- *Cybersecurity Cluster*
- *HEMP CLUSTER*
- *Ipel Energy Environmental Cluster*
- *REGIONALNY PRIEMYSELNY INOVACNY KLASTER RIMAVSKA KOTLINA REPRIK*
- *SME BOOSTER & INNOVATIONS CLUSTER*

SK04. East Slovakia

- *BITERAP*
- *Energy Cluster of Presov Region*
- *Kosice IT Valley*
- *Slovak Smart City Cluster*

Slovenia

SI03. East Slovenia

- *ITC - Innovation Technology Cluster Murska Sobota*
- *SiEnE, Slovenian Energy and Environment Partnership in Defence*
- *SRIP PSIDL, Strategic Research and Innovation Partnership on Smart Buildings and Home with Wood Chain*
- *TECES, Slovenian Energy Cluster*

SI04. West Slovenia

- *CONSTRUCTION CLUSTER OF SLOVENIA*
- *GIZ ACS Automotive cluster of Slovenia*
- *Slovenian Innovation Hub, European Economic Interest Grouping (SIH EEIG)*
- *SRIPToP*
- *Wood Industry Cluster Slovenia*

Spain

ES11. Galicia

- *ASOCIACION DE EMPRESAS DE TECNOLOGIA DE GALICIA (INEO)*
- *Galicia Food Cluster*
- *GALICIAN AUDIOVISUAL CLUSTER*
- *Galician Automotive Cluster (CEAGA)*
- *Galician ICT Cluster*

ES12. Asturias

- *ASINCAR Agrifood Cluster of Asturias / ASINCAR*
- *METAINDUSTRY4. CLUSTER OF ADVANCED MANUFACTURING OF METAL INDUSTRY IN ASTURIAS.*
- *Steel Innovation Cluster / Polo del Acero*

ES21. Basque Country

- *Basque Energy Cluster (Cluster de Energía)*
- *Basque Mobility and Logistics Cluster, MLC ITS Euskadi*
- *EIKEN- Basque Audiovisual and Digital Content*
- *Eraikune - Construction Cluster of the Basque Country*
- *GAIA.-Association of Knowledge and Applied Technologies industries in the Basque Country*
- *HABIC BASQUE HABITAT, WOOD, OFFICE & HOSPITALITY CLUSTER*
- *HEGAN - Basque Aerospace Cluster*
- *MAFEX*

ES22. Navarre

- *FUNCTIONAL PRINT CLUSTER*

ES23. Rioja

- *APIDIT CTCR*

ES24. Aragon

- *Aragonese Cluster of Agricultural and Livestock Production Means*
- *Cluster IDiA*
- *TECNARA - Aragón IT Cluster*
- *TSAC - SUSTAINABLE TOURISM CLUSTER OF ARAGON*
- *ZINNAE*

ES30. Madrid

- *MADRID AEROSPACE CLUSTER*
- *Madrid Capital FinTech*
- *Spanish Railways Technological Platform*

ES41. Castile and Leon

- *AEI CYBERSECURITY AND ADVANCED TECHNOLOGIES*
- *AEICE*
- *FACYL CASTILLA Y LEON AUTOMOTIVE CLUSTER*
- *Food Industry Cluster of Castilla y León*
- *Health Cluster of Castilla y León: BIOTECYL*
- *Iberian Sustainable Mining Cluster*

ES42. Castile-La Mancha

- *ITECAM, Metal-Mechanical Cluster of Castilla-La Mancha*

ES51. Catalonia

- *Advanced Materials Cluster*
- *AEI TÈXTILS*
- *Biocat (Bioregion of Catalonia)*
- *Catalan Energy Cluster*
- *CATALAN FINE FOOD CLUSTER CATALONIA GOURMET*
- *Catalan Water Partnership (CWP)*
- *CENFIM Home & Contract Furnishings Cluster*
- *CICAT: Lighting Cluster*
- *Clúster Digital Catalunya*
- *CLUSTER FOODSERVICE*
- *FUNDACIÓN BCD PARA LA PROMOCIÓN DEL DISEÑO INDUSTRIAL*
- *Habitat Cluster Barcelona*
- *INDESCAT- Catalan Sports Cluster*
- *INNOVACC*
- *INNOVI - Catalan Wine Cluster*
- *Packaging Cluster*
- *secpho deep tech innovation cluster*
- *Smartech Cluster: Home & Building Automation and Smart Cities*

ES52. Valencia

- *ASSOCIATION OF TEXTILE COMPANIES OF THE VALENCIAN REGION*
- *CLUSTER EMPRESAS INNOVADORAS VALLE DEL JUGUETE*
- *Energy Cluster of the Valencia Region*
- *FEDACOVA*
- *Innovation Footwear Cluster*

ES53. Balearic Islands

- *Balearic Marine Cluster*
- *Chemical Industry Cluster of the Balearic Islands (CliQIB)*
- *Turistec International Cluster of Information and Communication technologies applied to tourism*

ES61. Andalusia

- *Asociación Cluster Granada Plaza Tecnologica y Biotecnologica*
- *Clúster Marítimo Marino de Andalucía*
- *CTA Aerospace and Production Processes*
- *CTA Agrifood*
- *CTA Biotech*
- *CTA Construction and Civil Engineering*
- *CTA Energy and Environment*
- *CTA ICT*
- *Málaga TechPark*
- *Railway Innovation Hub*

ES62. Murcia

- *AMUEBLA*
- *Ticbiomed*

ES70. Canary Islands

- *Audiovisual Cluster of Canary Islands - CLAC*
- *Canarias Excelencia Tecnológica*
- *Canary Islands Maritime Cluster*
- *Turisfera - Cluster of Tourism Innovation of the Canary Islands*

Sweden

SE11. Stockholm

- *Findec (Findec & Decentralized AB)*

SE12. East-Central Sweden

- *IoT World*
- *STUNS Life science*

SE21. Småland and islands

- *Interior Cluster Sweden*

SE22. South Sweden

- *Game Habitat Southern Sweden AB*
- *Mobile Heights*
- *Skane Food Innovation Network*
- *Sustainable Business Hub*

SE23. West Sweden

- *Aerospace Cluster Sweden*
- *Agroväst Livsmedel AB*
- *Smart Textiles by Science Park Borås*
- *Swedish Maritime Technology Forum*

SE31. North-Central Sweden

- *Compare - Digital Innovation Hub*
- *Propell*
- *Sustainable Steel Region*
- *The Paper Province economic association*
- *Visit Dalarna*

SE32. Central Norrland

- *Bron Innovation / Govtech Sweden*

Annex 5: List of cluster organisations with updated ECCP profiles on 29/11/2021 (by industrial ecosystem)

Cluster Organisations by Industrial Ecosystem & Region

E01. Tourism

Belgium
- *hospitality.brussels*

France
- *Cluster Montagne*

Hungary
- *Thermal-Health Industrial Cluster*

Spain
- *Chemical Industry Cluster of the Balearic Islands (CliQIB)*
- *Clúster Marítimo Marino de Andalucía*
- *EIKEN- Basque Audiovisual and Digital Content*
- *INDESCAT- Catalan Sports Cluster*
- *TSAC - SUSTAINABLE TOURISM CLUSTER OF ARAGON*
- *Turisfera - Cluster of Tourism Innovation of the Canary Islands*
- *Turistec International Cluster of Information and Communication technologies applied to tourism*

Sweden
- *Visit Dalarna*

E02. Aerospace & Defence

Belgium
- *European Association of Remote Sensing Companies*

Bulgaria
- *Cluster Aero-Space Technologies, Research and Applications/CASTRA*

Croatia
- *Croatian Defense Industry Competitiveness Cluster*

Czechia
- *Czech Optical Cluster*
- *Moravian Aerospace Cluster, z.s.*

Denmark
- *Center for Defence, Space & Security (CenSec)*

Estonia
- *Estonian Aviation Cluster*

Finland
- *Tampere Region Safety and Security Cluster*

France
- *Aerospace Valley*
- *ALPHA-RLH Route des Lasers et des Hyperfréquences*
- *EMC2*
- *NAE (Normandie AeroEspace - Defense)*
- *Photonics cluster OPTITEC*
- *SAFE Cluster*
- *SYSTEM FACTORY*

Germany
- *Hamburg Aviation e.V.*

Greece
- *si-Cluster*

Ireland
- *Irish Digital Engineering and Advanced Manufacturing*

Italy
- *Aerospace Technology District*
- *DAC, Campania Aerospace District*
- *Technologies for Earth Observation and Natural Risks*

Lithuania
- *Laser & Engineering Technologies Cluster*

Poland
- *Aviation Valley / Dolina Lotnicza*
- *Silesian Aviation Cluster*

Spain
- *AEI CYBERSECURITY AND ADVANCED TECHNOLOGIES*
- *CTA Aerospace and Production Processes*
- *HEGAN - Basque Aerospace Cluster*
- *MADRID AEROSPACE CLUSTER*

Sweden
- *Aerospace Cluster Sweden*

E03. Agri-food

Austria
- *Austrian Centre of Industrial Biotechnology (acib)*

Belgium
- *Flanders' FOOD*
- *Wagralim, the agri-food innovation cluster of Wallonia, Belgium*

Cyprus
- *Shopkeepers Artisans and Production Marketing Cooperative*

Finland
- *North Savo Agri-Food Cluster*

France
- *Agri Sud-Ouest Innovation*
- *INNO'VIN*
- *Pôle Aqua-Valley*
- *VALORIAL*
- *VEGEPOLYS VALLEY*
- *VITAGORA*

Germany
- *Bavarian Food Cluster*
- *Bioeconomy at Marine Sites (BaMS)*
- *CLIB - Cluster Industrial Biotechnology*
- *food.net:z*
- *Food-Processing Initiative e.V.*
- *foodRegio*

Hungary
- *INNOSKART Digital Cluster*
- *OMNIPACK First Hungarian Cluster of Packaging Technology*

Ireland
- *AgriTech Ireland*
- *Circular Bioeconomy Cluster South-West*

Italy
- *Regional Agri-food District - D.A.Re. scrl*

Latvia
- *Food Products Quality Cluster*

Lithuania
- *National Food Cluster Lithuania*
- *SMART food cluster*

Netherlands
- *FoodValleyNL*
- *Greenport West-Holland*
- *Water Alliance*

Poland
- *Food Cluster of Southern Greater Poland - association*
- *NUTRIBIOMED Cluster*

Portugal
- *InovCluster - Agroindustrial Cluster Association of Centro Portugal*
- *PortugalFoods*

Romania
- *AgroTransilvania Cluster*

Slovakia
- *Bioeconomy Cluster*
- *Council of Slovak Exporters*

Slovenia
- *ITC - Innovation Technology Cluster Murska Sobota*

Spain
- *Aragonese Cluster of Agricultural and Livestock Production Means*
- *ASINCAR Agrifood Cluster of Asturias / ASINCAR*
- *CATALAN FINE FOOD CLUSTER CATALONIA GOURMET*
- *CLUSTER FOODSERVICE*
- *CTA Agrifood*
- *FEDACOVA*
- *Food Industry Cluster of Castilla y León*
- *Galicia Food Cluster*
- *INNOVACC*
- *INNOVI - Catalan Wine Cluster*
- *ITECAM, Metal-Mechanical Cluster of Castilla-La Mancha*
- *Packaging Cluster*
- *ZINNAE*

Sweden
- *Agroväst Livsmedel AB*
- *Skane Food Innovation Network*

E04. Construction

Austria
- *Furniture & Timber Construction Cluster @Business Upper Austria - OÖ Wirtschaftsagentur GmbH*

Belgium
- *CAP Construction*

Denmark
- *WE BUILD DENMARK*

Estonia
- *Estonian Digital Construction Cluster*

France
- *Cluster Eco-Bâtiment*
- *CLUSTER LUMIERE*
- *Descartes Sustainable City cluster*

- **Hungary**
  - *Hungarian Open Innovation Cluster for Construction Industry*
- **Italy**
  - *Clust-ER Build - Emilia-Romagna*
  - *Ecodomus District*
  - *Green HoMe - Pole of Innovation for Sustainable Building*
  - *Habitech - Trentino Technological District S.c.a.r.l.*
  - *STRESS Scarl - High Tecnology District on Sustainable Construction*
  - *Wood Furniture Home Cluster FVG*
- **Poland**
  - *COP Cluster*
  - *Lublin Enterprise Cluster*
  - *Metal Cluster of Lubuskie Voivodeship*
- **Portugal**
  - *Cluster Habitat Sustentável*
- **Romania**
  - *Asociatia Cluster Pro-nZEB*
  - *Technology Enabled Construction Cluster - TEC*
- **Slovenia**
  - *CONSTRUCTION CLUSTER OF SLOVENIA*
  - *Wood Industry Cluster Slovenia*
- **Spain**
  - *AEICE*
  - *CENFIM Home & Contract Furnishings Cluster*
  - *CTA Construction and Civil Engineering*
  - *Eraikune - Construction Cluster of the Basque Country*
  - *Habitat Cluster Barcelona*

E05. Creative & Cultural Industries

- **Belgium**
  - *TWIST Cluster*
- **Bulgaria**
  - *Bulgarian Furniture Cluster*
  - *Specialized Cluster and Institute for Apparel and Textile - Danube*
- **Czechia**
  - *Cluster of Czech Furniture Manufacturers*
- **Finland**
  - *Arctic Design Cluster, University of Lapland*
- **France**
  - *COSMETIC VALLEY*
- **Greece**
  - *gi-Cluster*
- **Italy**
  - *Basilicata Creativa - CCI*
  - *Basilicata Creativa CCI*
  - *Create - Cultural and creative industries*
  - *Creative Apulia Cluster Association*
  - *RETE DI IMPRESE LUCE IN VENETO*
  - *Venetian Cluster*
- **Lithuania**
  - *Baltic Film & Creative Tech Cluster*
  - *Lithuanian Social Innovation Cluster (LSIC)*
- **Poland**
  - *Media Dizajn*
- **Portugal**
  - *Portuguese Textile Cluster (CITEVE)*
- **Romania**
  - *ICONIC Cluster*
  - *Open Hub Creative Cluster*
- **Slovakia**
  - *House of events innovation*
  - *Ipel Energy Environmental Cluster*
  - *Regional Development Cluster*
- **Spain**
  - *Audiovisual Cluster of Canary Islands - CLAC*
  - *CLUSTER EMPRESAS INNOVADORAS VALLE DEL JUGUETE*
  - *FUNDACIÓN BCD PARA LA PROMOCIÓN DEL DISEÑO INDUSTRIAL*
  - *GALICIAN AUDIOVISUAL CLUSTER*
  - *HABIC BASQUE HABITAT, WOOD, OFFICE & HOSPITALITY CLUSTER*
  - *Innovation Footwear Cluster*
- **Sweden**
  - *Game Habitat Southern Sweden AB*
  - *Interior Cluster Sweden*

E06. Digital

- **Austria**
  - *Mechatronics Cluster @ Business Upper Austria - OÖ Wirtschaftsagentur*
- **Belgium**
  - *DSP Valley*
  - *LSEC - Leaders In Security*
  - *Pôle MecaTech*
- **Bulgaria**
  - *Bulgarian Fashion Association*
  - *Bulgarian Fintech Association*
  - *Cluster Information and Communication Technologies Blagoevgrad*
  - *Cluster of information and communication technologies Burgas*
  - *ICT Cluster*
- **Denmark**
  - *DigitalLead*
- **Estonia**
  - *Estonian ICT Cluster*
- **Finland**
  - *Arctic Development Environments, Lapland University of Applied Sciences*
  - *DIMECC Ltd.*
  - *Robocoast Cluster*
  - *Water Cluster Finland*
- **France**
  - *Cap Digital*
  - *Digital 113*
  - *Finance Innovation*
  - *France Water Team*
  - *HYDREOS*
  - *Minalogic*
  - *Pôle SCS*
- **Germany**
  - *Center Digitisation.Bavaria*
  - *cyberLAGO e.V. - digital competence network*
  - *IT-Security Cluster*
  - *SpectroNet c/o Technologie- und Innovationspark Jena GmbH*
- **Greece**
  - *Hellenic Association of Innovative Small and Medium Enterprises Innovation Greece*
  - *Hellenic Emerging Technologies Industry Association*
- **Ireland**
  - *Ireland South East Financial Services Cluster at South East Economic Development Office*
- **Italy**
  - *AFIL - Lombardy Intelligent Factory Association*
  - *Cluster COMET*
  - *DID -technological Cluster on Interiors and Design*
  - *Distretto Industriale delle Tecnologie Digitale - Cluster ICT FVG*
  - *Fondazione Torino Wireless*
  - *Italian Technology Cluster for Smart Communities*
  - *MESAP Innovation Cluster - Smart Products and Manufacturing*
- **Latvia**
  - *Green Tech HUB*
  - *Latvian IT Cluster*
- **Lithuania**
  - *Smart Digital Solutions cluster*
  - *BCCS (Blockchain Cybersecurity and Compliance Solutions) Cluster*
  - *Digital Rocket LT*
- **Poland**
  - *Digital Knowledge Cluster*
  - *Mazovia Cluster ICT*
  - *SINOTAIC - Silesian IoT Cluster*
- **Portugal**
  - *Associação para o Pólo das Tecnologias de Informação, Comunicação e Electronica TICE.PT*
  - *Madan Parque*
  - *PRODUTECH - Production Technologies Cluster*
- **Romania**
  - *Banat Software Cluster by ARIES-TM*
  - *Cluj IT Cluster*
  - *Danube Engineering Hub*
  - *Green Technology Cluster*
  - *IT&C Cluster "Lower Danube"*
  - *Smart Alliance Cluster*
  - *Transilvania IT Cluster*
- **Slovakia**
  - *BITERAP*
  - *Cybersecurity Cluster*
  - *Industry Innovation Cluster Slovakia*
  - *Kosice IT Valley*
  - *Slovak Smart City Cluster*
  - *SME BOOSTER & INNOVATIONS CLUSTER*
- **Slovenia**
  - *SRIPToP*
- **Spain**
  - *AMUEBLA*
  - *Asociación Cluster Granada Plaza Tecnologica y Biotecnologica*
  - *ASOCIACION DE EMPRESAS DE TECNOLOGIA DE GALICIA (INEO)*
  - *Canarias Excelencia Tecnológica*
  - *Clúster Digital Catalunya*
  - *Cluster IDiA*
  - *CTA ICT*
  - *FUNCTIONAL PRINT CLUSTER*
  - *GAIA.-Association of Knowledge and Applied Technologies industries in the Basque Country*
  - *Galician ICT Cluster*
  - *Madrid Capital FinTech*
  - *Málaga TechPark*
  - *secpho deep tech innovation cluster*
  - *Smartech Cluster: Home & Building Automation and Smart Cities*
  - *TECNARA - Aragón IT Cluster*
- **Sweden**
  - *Bron Innovation / Govtech Sweden*

- *Compare - Digital Innovation Hub*
- *Findec (Findec & Decentralized AB)*
- *IoT World*
- *Mobile Heights*

E07. Electronics

Austria
- *Silicon Alps*

Czechia
- *Klastr Mechatronika, z.s.*

Germany
- *Cluster Sensor technology Bavaria / Strategic Partnership for Sensor Technologies*
- *InnoZent OWL e.V.*
- *Organic Electronics Saxony (OES)*

Latvia
- *Latvian Electrical Engineering and Electronics Industry Association*

Romania
- *Electronic Innovation Cluster (ELINCLUS)*
- *ETREC Cluster - Electro-Technical Regional Cluster*

Slovenia
- *TECES, Slovenian Energy Cluster*

Spain
- *CICAT: Lighting Cluster*

E08. Energy Intensive Industries

Belgium
- *Strategisch Initiatief Materialen - Flam3D*

Czechia
- *Czech Machinery Cluster*

France
- *Polymeris*

Italy
- *National Energy Technology Cluster*

Lithuania
- *Maritime cluster*

Romania
- *DANUBE FURNITURE CLUSTER*
- *Transylvania Energy Cluster*

Slovakia
- *Energy Cluster of Presov Region*

Spain
- *METAINDUSTRY4. CLUSTER OF ADVANCED MANUFACTURING OF METAL INDUSTRY IN ASTURIAS.*
- *Steel Innovation Cluster / Polo del Acero*

Sweden
- *The Paper Province economic association*

E09. Health

Austria
- *Human.technology Styria GmbH*
- *Photonics Austria*

Belgium
- *BioWin*
- *flanders.bio*
- *flanders.healthTech*
- *lifetech.brussels*

Bulgaria
- *DIGITAL HEALTH AND INNOVATION CLUSTER BULGARIA*

Croatia
- *Kvarner Health Tourism Cluster*

Denmark
- *Danish Life Science Cluster*

Finland
- *HealthTurku*

France
- *Eurasante / Clubster NHL*
- *EUROBIOMED*
- *GENOPOLE*
- *Lyon Auvergne Rhône-Alpes Cancer cluster*
- *MEDICEN PARIS REGION*

Germany
- *BioCon Valley GmbH®*
- *BioLAGO e.V. the health network*
- *BioM Biotech Cluster Development GmbH*
- *BioPark Regensburg GmbH / BioRegio Regensburg*
- *BioRegio STERN Management GmbH*
- *BioRN - Life Science Cluster Rhine-Neckar*
- *Cluster for Individualized Immune Intervention (Ci3)*
- *HealthCapital - Cluster Healthcare Industries Berlin Brandenburg*
- *Life Science Nord*
- *medways e.V.*

Greece
- *Hellenic BioCluster*
- *Hellenic Digital Health Cluster*

Hungary
- *MSE Hungarian Sport and Lifestyle Development ClusterCo.*

Ireland
- *Connected Health & Wellbeing Cluster - DKIT*

Italy
- *bioPmed / Bioindustry Park*
- *Campania Bioscience - Cluster on Life Sciences*
- *Clust-ER Health - Emilia Romagna*
- *Lombardy Life Sciences Cluster*
- *Tuscany Life Sciences Cluster*

Latvia
- *Latvian Health tourism cluster*

Lithuania
- *Health technology cluster iVita*
- *Information Technologies in Medicine (MedIT)*

Netherlands
- *Cluster Sports & Technology*
- *Health Valley Netherlands*
- *LifetecZONe*

Poland
- *Lublin Medicine- Medical and Wellness Cluster*

Romania
- *INNOVATIVE CLUSTER FOR HEALTH*
- *North-East Innovative Regional Cluster for Structural and Molecular Imaging (IMAGO-MOL)*
- *ROHEALTH- The Health and Bioeconomy Cluster*

Slovenia
- *Slovenian Innovation Hub, European Economic Interest Grouping (SIH EEIG)*

Spain
- *Biocat (Bioregion of Catalonia)*
- *CTA Biotech*
- *Health Cluster of Castilla y León: BIOTECYL*
- *Ticbiomed*

Sweden
- *STUNS Life science*

E10. Mobility-Transport-Automotive

Belgium
- *Logistics in Wallonia*

Bulgaria
- *Automotive Cluster Bulgaria*
- *Cluster for Digital Transformation and Innovations*

Czechia
- *Autoklastr*

Finland
- *Tampere Imaging Ecosystem*

France
- *ARIA NORMANDY*
- *CIMES, Creating Integrated MEchanical Systems*
- *NEXTMOVE (MOV'EO)*
- *Pôle Véhicule du Futur*

Germany
- *CURPAS*
- *E-Mobility Cluster (mobility and logistics)*
- *Franconian Plastics Network (KNF)*
- *ITS mobility e. V.*
- *Logistics-Initiative Hamburg Managment GmbH*
- *ROBONOM - AUTONOMOUS SERVICE ROBOTS*

Greece
- *Strategis Maritime ICT Cluster*

Italy
- *Clust-ER Meccatronica e Motoristica*
- *DITECFER District for Rail Technologies, High Speed, Networks' Safety & Security*

Latvia
- *Green and Smart Technology Cluster*

Lithuania
- *Baltic Automotive Components Cluster (BACC)*

Netherlands
- *RAI Automotive Industry NL*

Poland
- *BALTIC SEA & SPACE CLUSTER*
- *Bydgoszcz Industrial Cluster (BIC)*
- *North South Logistics & Transport Cluster*
- *Polish Automotive Group PGM*

Portugal
- *MOBINOV - portuguese automotive cluster*

Slovakia
- *Slovak Electric Vehicle Association (SEVA)*
- *Slovak Plastic Cluster*

Spain
- *Advanced Materials Cluster*
- *Basque Mobility and Logistics Cluster, MLC ITS Euskadi*
- *FACYL CASTILLA Y LEON AUTOMOTIVE CLUSTER*
- *Galician Automotive Cluster (CEAGA)*
- *MAFEX*
- *Railway Innovation Hub*
- *Spanish Railways Technological Platform*

Sweden
- *Swedish Maritime Technology Forum*

E11. Proximity & Social Economy

Austria
- *Social Entrepreneurship Network Austria*

Croatia
- *Cluster for Eco Social Innovation and Development CEDRA Split*

Germany
- *Silicon Vilstal*

Italy
- *Torino Social Impact*

- **Romania**
  - *Alaturi de Voi Romania Foundation (ADV Romania)/ Accelerator of Social Enterprises Cluster*

E12. Renewable Energy

- **Belgium**
  - *Blue Cluster*
  - *Flux50 vzw*
  - *TWEED*
- **Bulgaria**
  - *Cluster Green Transport*
  - *Green Synergy Cluster*
  - *Renewable Energy Sources Cluster*
- **Czechia**
  - *Nanoprogress z.s.*
- **Denmark**
  - *Energy Cluster Denmark*
- **Estonia**
  - *Tehnopol Greentech Cluster*
- **Finland**
  - *Energy Cluster North Savo*
- **France**
  - *Materalia*
  - *MEDEE*
  - *Pôle Mer Bretagne Atlantique*
- **Germany**
  - *BalticNet-PlasmaTec e.V.*
  - *Ecoliance Rhineland-Palatinate*
  - *Power Electronics Cluster within ECPE e.V.*
  - *Rhine-Neckar Metropolitan Region Ltd.*
  - *Thurigian Renewable Energies Network (ThEEN)*
- **Hungary**
  - *Cluster of Applied Earth Sciences*
  - *South West Hungarian Engineering Cluster*
- **Italy**
  - *Energy and Sustainable development Clust-ER Association*
  - *SPRING - Italian Circular Bioeconomy Cluster*
- **Latvia**
  - *CLEANTECH LATVIA*
- **Lithuania**
  - *Cleantech Cluster Lithuania*
  - *Lithuanian Photovoltaic Technology Cluster*
- **Poland**
  - *Centre for Energy Technologie Cluster - Free Enterprise Association*
  - *Cluster of Business Environment Institutions/Klaster Instytucji Otoczenia Biznesu*
- **Portugal**
  - *Chemical, Petrochemical and Refining Cluster*
  - *Fórum Oceano - Association of Maritime Economy*
- **Romania**
  - *Green Energy Romanian Innovative Biomass Cluster*
  - *Green Solutions Low Danube*
- **Slovakia**
  - *REGIONALNY PRIEMYSELNY INOVACNY KLASTER RIMAVSKA KOTLINA REPRIK*
  - *SAPI - renewable energy cluster*
- **Slovenia**
  - *SiEnE, Slovenian Energy and Environment Partnership in Defence*
- **Spain**
  - *Basque Energy Cluster (Cluster de Energía)*
  - *Canary Islands Maritime Cluster*
  - *CTA Energy and Environment*
  - *Energy Cluster of the Valencia Region*
- **Sweden**
  - *Sustainable Business Hub*

E14. Textile

- **France**
  - *TECHTERA*
- **Germany**
  - *SACHSEN!TEXTIL*
- **Italy**
  - *OTIR2020-TFC - Next Technology Tecnotessile*
  - *POINTEX - Textile Innovation Cluster*
- **Poland**
  - *Polish Cluster of Composite Technologies*
- **Romania**
  - *ASTRICO NORD-EST TEXTILE CLUSTER*
- **Spain**
  - *AEI TÈXTILS*
  - *ASSOCIATION OF TEXTILE COMPANIES OF THE VALENCIAN REGION*
- **Sweden**
  - *Smart Textiles by Science Park Borås*

Annex 6: Cluster organisation data summary tables

Table A6.1: EU-27 cluster organisations by sector (and size profile), top 25 sectors

Industry Activity	1-100	101-200	201-300	301-400	401-500	Above 500	Grand Total
S94: Membership org.	37	14	6	1	4	3	65
M72: Scientific research & development	39	14	4	2	1	2	62
J62: Computer programming, consultancy	40	7	3	1		4	55
C28: Manuf. of machinery & equipment	21	8	5	3			37
C10: Manuf. of food products	16	11	1	2	1	2	33
J63: Information services	23	4	1	1		2	31
Q86: Human health	15	8	3	2	1	2	31
F41: Construction of buildings	15	8	2	2	1		28
M74: Other prof., scientific, techn. act.	17	5	3			2	27
A01: Crop & animal production	13	5		1	2	2	23
C26: Manuf. of electronic & optical products	14	2	3	2		2	23
C27: Manuf. of electrical equipment	16	5	2				23
C22: Manuf. of rubber & plastic products	13	4	1		1	1	20
C13: Manuf. of textiles	16	2	1	1			20
C21: Manuf. of pharmaceuticals	10	6		2		1	19
J61: Telecommunications	12	3	2			2	19
C25: Manuf. of fabricated metal products	8	5	1	3		1	18
D35: Electricity, gas & steam	10	6	1			1	18
C20: Manuf. of chemical products	9	5		1	1	1	17
C11: Manuf. of beverages	7	6	1	1		1	16
F43: Specialised construction act.	9	6	1				16
E38: Waste activities	7	4	2	1			14
R90: Arts & entertainment	11	3					14
C30: Manuf. of other transport equipment	7	4	1	1		1	14
C31: Manuf. of furniture	8	4			1	1	14
Grand Total	393	149	44	27	13	31	657

Source: ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

Table A6.2: EU-27 cluster organisations by industrial ecosystem (and size profile)

Ecosystem	1-100	101-200	201-300	301-400	401-500	Above 500	Grand Total
E01. Tourism	8	1	1			1	11
E02. Aerospace & Defence	17	7	2	1	1	1	29
E03. Agri-food	28	13	4	2	2	2	51
E04. Construction	15	9	1	1		1	27
E05. Creative & Cultural Industries	23	5				2	30
E06. Digital	46	14	6	4	3	8	81
E07. Electronics	9	1					10
E08. Energy Intensive Industries	8	2			1		11
E09. Health	27	11	4	4	1	3	50
E10. Mobility-Transport-Automotive	19	8	3	1	2	3	36
E11. Proximity & Social Economy	3	2					5
E12. Renewable Energy	27	8	3	1			39
E13. Retail							
E14. Textile	6		1	1	1		9
Grand Total	236	81	25	15	11	21	389

Source: ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

Table A6.3: Size profile of EU-27 cluster organisations

Country	1-100	101-200	201-300	301-400	401-500	Above 500	Grand Total
Austria	4	5	1	1			11
Belgium	2	9	3	4		1	19
Bulgaria	13		2				15
Croatia	4						4
Cyprus		1					1
Czechia	9						9
Denmark		3	3	1		1	8
Estonia	3	1					4
Finland	9	5				1	15
France	5	9	12	6	7	9	48
Germany	27	12	4	3	1	3	50
Greece	7						7
Hungary	7						7
Ireland	4	1					5
Italy	20	13	2	2	2	3	42
Latvia	6	1					7
Lithuania	20						20
Netherlands	4	3	3				10
Poland	17	7	1	1			26
Portugal	6	6					12
Romania	27						27
Slovakia	18	1					19
Slovenia	9						9
Spain	48	18	3	1	1	4	75
Sweden	13	4				1	18
Grand Total	282	99	34	19	11	23	468

Source: ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

Table A6.4: Management team size and number of members of EU-27 cluster organisations

Size	1-100	101-200	201-300	301-400	401-500	Above 500	Grand Total
1-5	222	52	6	2	1	2	285
6-10	45	33	14	5	2	5	104
11-20	15	11	10	9	5	10	60
21-30		2	3	3	3	1	12
Over 30		1	1			5	7
Grand Total	282	99	34	19	11	23	468

Source: ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

Table A6.5: Types of members of EU-27 cluster organisations by industrial ecosystem

Ecosystem	Research Organisations		SMEs		Large firms		Other		Total #
	#	%	#	%	#	%	#	%	
E01. Tourism	72	5%	1,262	84 %	46	3%	129	9%	1,509
E02. Aerospace & Defence	485	12%	2,513	61%	548	13%	567	14%	4,113
E03. Agri-food	640	7%	6,592	76%	883	10%	571	7%	8,686
E04. Construction	227	5%	4,165	83%	234	5%	368	7%	4,994
E05. Creative & Cultural Industries	234	7%	2,444	78%	187	6%	280	9%	3,145
E06. Digital	1,033	5%	13,521	70%	1,596	8%	3,227	17%	19,377
E07. Electronics	91	14%	458	69%	60	9%	53	8%	662
E08. Energy Intensive Industries	177	19%	522	55%	151	16%	106	11%	956
E09. Health	757	9%	6,226	73%	638	8%	883	10%	8,504
E10. Mobility-Transport-Automotive	535	8%	4,016	62%	1,306	20%	650	10%	6,507
E11. Proximity & Social Economy	14	5%	161	54%	5	2%	119	40 %	299
E12. Renewable Energy	473	14%	2,065	59%	564	16%	376	11%	3,478
E13. Retail									
E14. Textile	86	6%	1,172	87%	47	3%	49	4%	1,354
Grand Total	4,824	8%	45,117	71%	6,265	10%	7,378	12%	63,584

Source: ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

Table A6.6: Cluster-labelling activity by industrial ecosystem

Ecosystem	none		bronze		silver		gold		other		Total #
	#	%	#	%	#	%	#	%	#	%	
E01. Tourism	5	38%	4	31%		0%	1	8%	3	23%	13
E02. Aerospace & Defence	13	30%	7	16%	1	2%	7	16%	15	35%	43
E03. Agri-food	16	22%	20	28%	4	6%	8	11%	24	33%	72
E04. Construction	12	32%	10	27%	1	3%	1	3%	13	35%	37
E05. Creative & Cultural Industries	14	35%	14	35%	2	5%	2	5%	8	20%	40
E06. Digital	37	35%	21	20%	9	8%	12	11%	27	25%	106
E07. Electronics	1	8%	3	23%	6	46%		0%	3	23%	13
E08. Energy Intensive Industries	4	27%	4	27%	1	7%	2	13%	4	27%	15
E09. Health	22	33%	12	18%	9	13%	5	7%	19	28%	67
E10. Mobility-Transport-Automotive	11	22%	11	22%	6	12%	6	12%	16	32%	50
E11. Proximity & Social Economy	2	29%		0%	1	14%		0%	4	57%	7
E12. Renewable Energy	18	35%	13	25%	5	10%	3	6%	12	24%	51
E13. Retail											
E14. Textile	3	27%	4	36%	1	9%	1	9%	2	18%	11
Grand Total	158	30%	123	23%	46	9%	48	9%	150	29%	525

Source: ECCP profile data; sample of 468 cluster organisations with updated profiles on 29/11/2021.

Annex 7: NACE 2.0 ecosystem weights

NACE	Weight	
	GVA	Emp.
Aerospace & Defence		
C25	0,097	0,087
C26	0,440	0,360
C27	0,230	0,200
C28	0,068	0,068
C30	0,681	0,530
C33	0,166	0,138
E36	0,017	0,017
E37	0,027	0,027
E38	0,027	0,027
E39	0,027	0,027
H51	0,093	0,060
H52	0,178	0,110
J61	0,069	0,069
M69	0,025	0,025
M70	0,025	0,025
M71	0,034	0,034
M72	0,057	0,057
N77	0,027	0,027
N78	0,027	0,027
N80	1,000	1,000
Agri-food		
A01	1,000	1,000
A02	1,000	1,000
A03	1,000	1,000
C10	1,000	1,000
C11	1,000	1,000
C12	1,000	1,000
C25	0,066	0,066
C28	0,078	0,078
C33	0,118	0,118
E36	0,122	0,122
E37	0,095	0,095
E38	0,095	0,095
E39	0,095	0,095
M69	0,077	0,077
M70	0,077	0,077
M71	0,060	0,060
M72	0,072	0,072
N77	0,082	0,082
N78	0,082	0,082

NACE	Weight	
	GVA	Emp.
Construction		
C25	0,305	0,305
C28	0,198	0,198
C31	1,000	1,000
C33	0,155	0,155
E36	0,102	0,102
E37	0,137	0,137
E38	0,137	0,137
E39	0,137	0,137
F41	1,000	1,000
F42	1,000	1,000
F43	1,000	1,000
M69	0,115	0,115
M70	0,115	0,115
M71	1,000	1,000
M72	0,104	0,104
N77	0,129	0,129
N78	0,129	0,129
N81	1,000	1,000
M74	0,340	0,387
M75	0,640	0,420
N77	0,029	0,029
N78	0,028	0,028
P85	0,100	0,100
R90	0,800	0,800
R91	0,800	0,800
R92	0,800	0,800
S94	0,020	0,020
S95	0,260	0,350

NACE	Weight	
	GVA	Emp.
Creative & Cultural Industries		
C18	1,000	1,000
C25	0,009	0,009
C28	0,013	0,013
C32	0,079	0,110
C33	0,013	0,013
E36	0,025	0,025
E37	0,019	0,019
E38	0,019	0,019
E39	0,019	0,019
G47	0,012	0,020
J58	1,000	1,000
J59	1,000	1,000
J60	1,000	1,000
J62	0,004	0,008
J63	0,004	0,008
M69	0,028	0,028
M70	0,028	0,028
M71	0,173	0,216
M72	0,027	0,027
M73	1,000	1,000
M74	0,640	0,420
M74	0,340	0,387
M75	0,640	0,420
N77	0,029	0,029
N78	0,028	0,028
P85	0,100	0,100
R90	0,800	0,800
R91	0,800	0,800
R92	0,800	0,800
S94	0,020	0,020
S95	0,260	0,350

NACE	Weight	
	GVA	Emp.
Digital		
C25	0,021	0,021
C26	0,223	0,280
C28	0,031	0,031
C33	0,033	0,033
E36	0,022	0,022
E37	0,028	0,028
E38	0,028	0,028
E39	0,028	0,028
J58	1,000	1,000
J61	0,973	0,990
J62	1,000	1,000
J63	1,000	1,000
M69	0,051	0,051
M70	0,051	0,051
M71	0,044	0,044
M72	0,069	0,069
N77	0,052	0,052
N78	0,052	0,052
S95	0,480	0,340
Electronics		
C25	0,020	0,020
C26	1,000	1,000
C28	0,123	0,123
C33	0,015	0,015
E36	0,007	0,007
E37	0,010	0,010
E38	0,010	0,010
E39	0,010	0,010
M69	0,012	0,012
M70	0,012	0,012
M71	0,015	0,015
M72	0,051	0,051
N77	0,013	0,013
N78	0,013	0,013

NACE	Weight	
	GVA	Emp.
Energy Intensive Industries		
C16	1,000	1,000
C17	1,000	1,000
C19	1,000	1,000
C20	1,000	1,000
C22	1,000	1,000
C23	1,000	1,000
C24	1,000	1,000
C25	0,036	0,036
C28	0,040	0,040
C33	0,047	0,047
E36	0,040	0,040
E37	0,086	0,086
E38	0,086	0,086
E39	0,086	0,086
M69	0,049	0,049
M70	0,049	0,049
M71	0,037	0,037
M72	0,031	0,031
N77	0,031	0,031
N78	0,031	0,031
Health		
C21	1,000	1,000
C25	0,052	0,052
C28	0,056	0,056
C32	1,000	1,000
C33	0,069	0,069
E36	0,111	0,111
E37	0,085	0,085
E38	0,085	0,085
E39	0,085	0,085
M69	0,088	0,088
M70	0,088	0,088
M71	0,076	0,076
M72	0,142	0,142
N77	0,100	0,100
N78	0,100	0,100
Q86	1,000	1,000
Q87	1,000	1,000
Q88	1,000	1,000

NACE	Weight	
	GVA	Emp.
Mobility-Transport-Automotive		
C25	0,236	0,236
C27	0,025	0,020
C28	0,278	0,278
C29	1,000	1,000
C30	0,319	0,470
C33	0,165	0,165
E36	0,058	0,058
E37	0,098	0,098
E38	0,098	0,098
E39	0,098	0,098
G45	1,000	1,000
H49	0,518	0,580
H50	0,777	0,740
H52	0,394	0,340
M69	0,086	0,086
M70	0,086	0,086
M71	0,093	0,093
M72	0,130	0,130
N77	0,086	0,086
N78	0,086	0,086
Retail		
C25	0,044	0,044
C28	0,057	0,057
C33	0,065	0,065
E36	0,074	0,074
E37	0,078	0,078
E38	0,078	0,078
E39	0,078	0,078
G46	1,000	1,000
G47	1,000	1,000
H53	1,000	1,000
M69	0,135	0,135
M70	0,135	0,135
M71	0,080	0,080
M72	0,081	0,081
N77	0,127	0,127
N78	0,127	0,127

NACE	Weight	
	GVA	Emp.
Proximity & Social Economy		
C25	0,023	0,023
C28	0,030	0,030
C33	0,036	0,036
E36	0,077	0,077
E37	0,054	0,054
E38	0,054	0,054
E39	0,054	0,054
G47	0,155	0,155
I55	0,140	0,140
I56	0,140	0,140
L68	0,084	0,084
M69	0,057	0,057
M70	0,057	0,057
M71	0,044	0,044
M72	0,047	0,047
N77	0,061	0,061
N78	0,061	0,061
N81	0,280	0,210
N82	0,110	0,110
Q87	1,000	1,000
Q88	1,000	1,000
S95	1,000	1,000
S96	1,000	1,000
T97	1,000	1,000
T98	1,000	1,000
Renewable Energy		
C25	0,016	0,016
C27	0,378	0,380
C28	0,016	0,016
C33	0,016	0,016
D35	0,290	0,280
E36	0,011	0,011
E37	0,014	0,014
E38	0,014	0,014
E39	0,014	0,014
M69	0,010	0,010
M70	0,010	0,010
M71	0,012	0,012
M72	0,008	0,008
N77	0,008	0,008
N78	0,008	0,008

NACE	Weight	
	GVA	Emp.
Retail		
Textile		
C13	1,000	1,000
C14	1,000	1,000
C15	1,000	1,000
C25	0,009	0,009
C28	0,010	0,010
C33	0,010	0,010
E36	0,013	0,013
E37	0,014	0,014
E38	0,014	0,014
E39	0,014	0,014
M69	0,012	0,012
M70	0,012	0,012
M71	0,011	0,011
M72	0,012	0,012
N77	0,010	0,010
N78	0,010	0,010
Tourism		
C25	0,037	0,037
C28	0,050	0,050
C33	0,072	0,072
E36	0,105	0,105
E37	0,071	0,071
E38	0,071	0,071
E39	0,071	0,071
H49	0,445	0,420
H50	0,222	0,350
H51	0,907	0,900
I55	1,000	1,000
I56	1,000	1,000
M69	0,068	0,068
M70	0,068	0,068
M71	0,055	0,055
M72	0,048	0,048
N77	0,083	0,083
N78	0,083	0,083
N79	1,000	1,000
N82	1,000	1,000
R90	0,660	0,660
R91	0,660	0,660
R92	0,660	0,660
R93	1,000	1,000

Note: See Annex 2 for the list of names of 88 NACE 2-digit sectors and their codes.

Annex 8: Criteria to identify cluster actors working on green or digital sectors or technologies

Green sectors and/or technologies

These are cluster organisations that have selected:

- the category "E36 - Water collection, treatment and supply", "E37 – Sewerage", "E38 - Waste collection, treatment and disposal activities; materials recovery" and/or "E39 - Remediation activities and other waste management services" under the profile field" for "sectoral industries".

  AND/OR

- the category "environmental technologies" under the profile field for "cross-sectoral industries".

  AND/OR

- the categories "Low-carbon industries", "Circular Plastics" or "Renewable Energy" under the profile field for "EU industrial priority areas (Alliances and Ecosystems)".

  AND/OR

- the categories "B09 - Disposal of solid waste; reclamation of contaminated soil", "C02 - Treatment of water, waste water, sewage, or sludge" and/or "Y02 - Technologies or applications for mitigation or adaptation against climate change" under the profile field for technology fields.

Digital sectors and/or technologies

These are cluster organisations that have selected:

- the categories "C26 - Manufacture of computer, electronic and optical products", "J61 – Telecommunications", "J62 - Computer programming, consultancy and related activities" and/or "J63 - Information service activities" under the profile field for "sectoral industries".

  AND/OR

- the category "digital-based industries" under the profile field for "cross-sectoral industries".

  AND/OR

- the category "Digital" under the profile field for "EU industrial priority areas (Alliances and Ecosystems)".

  AND/OR

- the categories "G06 - Computing; calculating; counting", "G11 - Information storage", "G16 - Information and communication technology [ICT] specially adapted for specific application fields", "H03 - Basic electronic circuitry" and/or "Y04 - Information or communication technologies having an impact on other technology areas" under the profile field for technology fields.

Annex 9: Methodology for developing a typology of regions based on industrial ecosystem specialisation

A statistical cluster analysis was initially conducted for regional specialisation in two groups of economic activities: 88 NACE 2-digit sectors on the one hand and the 14 industrial ecosystems defined by the European Commission on the other. In each case Location quotients (LQ) defined as the ratio between the industry's share of total employment in each region and the industry's share of total employment in the EU-27 are used as the basis for the analysis.

$$LQ_{r,s} = \frac{V_{r,s} / \sum_s V_{r,s}}{\sum_r V_{r,s} / \sum_{r,s} V_{r,s}}$$

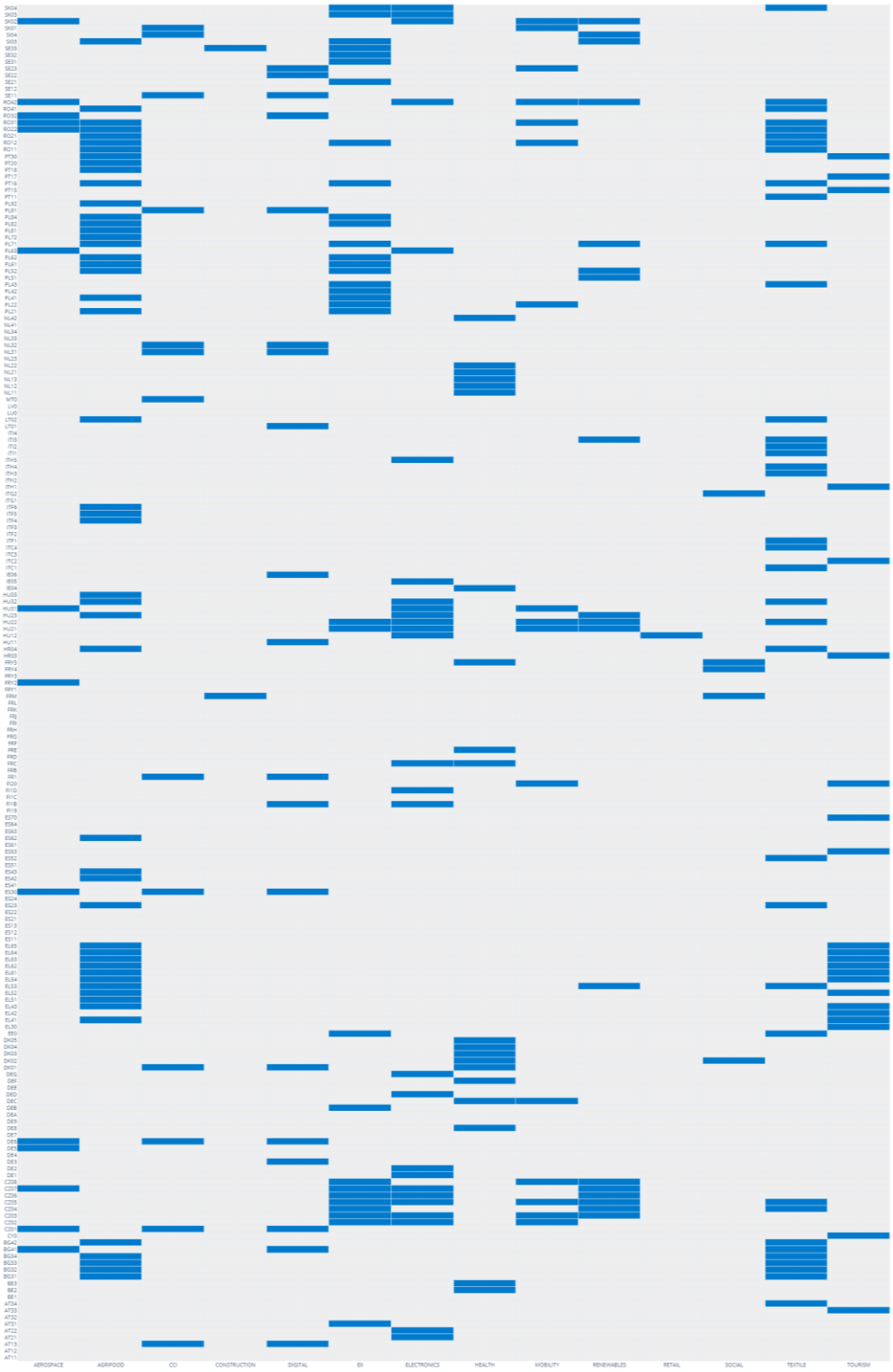
Dichotomous variables are constructed assigning a value of 1 if the region is highly specialised (LQ>1.5) and a value of 0 otherwise. This produces a boolean matrix of 201 rows (regions) and 14 columns (industrial ecosystems) visualized below. Formally,

$$LQ_{r,s} = \begin{cases} 1 \; if \; LQ_{r,s} >= 1{,}5 \\ 0 \; otherwise \end{cases}$$

Segmentation techniques are then applied to find similarities between the components (in our case regions) of the database of dichotomous variables, that can be represented by a Boolean matrix. Several techniques have been tested for this study, and an agglomerative hierarchical clustering ("bottom-up") has been applied to group the 201 EU regions. Statistical cluster analysis is based on similarity between cases, indicated as distance, and different criteria can be used to calculate distances among cases and group the cases. Several alternatives were considered, taking into account the different number of variables in the two typologies (88 vs 14), their variability and their nature (dichotomous or continuous). For the typology based on industrial ecosystem specialisation reported here the Euclidean distance and Ward's method for linkage were used. Finally, the number of groups in the typology was chosen looking at the resulting dendrogram chart and using the Elbow method based on the within cluster sum of squared distances. The following graphs present the boolean matrix, dendrogram and Elbow that have defined the 7 groups of regions from the industrial ecosystem LQs of the 201 regions.

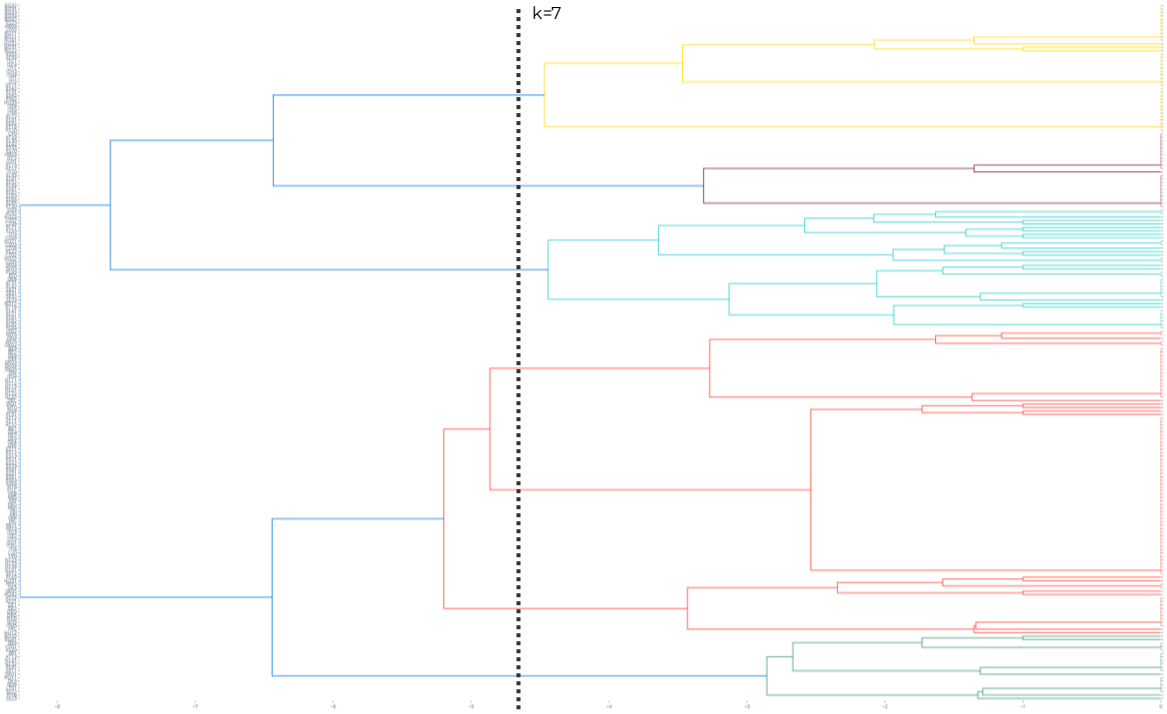
Boolean matrix

This matrix contains 1 (blue) when a region exhibits a high specialization in an ecosystem, and 0 (grey) otherwise.



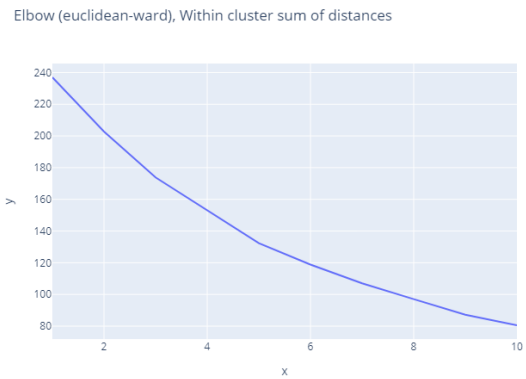
Dendrogram

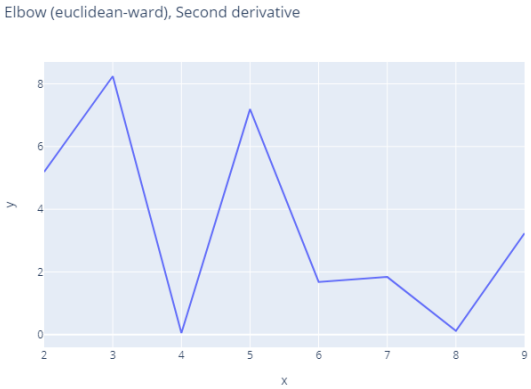
This dendrogram is a tree-like visualization of how regions are grouped into clusters based on the closeness calculated between regions. The closeness is represented by the length of the lines in the x-axis. The clusters are determined by the vertical cut-off line. The position of this line is chosen by the "Elbow method" described below.



Elbow charts

The elbow method for determining the number of clusters is based on the "within cluster sum of distances" calculated for different numbers of clusters "k". This value is lower the more clusters we take, and the optimal "k" is the point where the curve starts to decrease more slowly. To show this we calculate the second derivative of the curve and take the maximum value greater than 5. A "k" value of **7** was chosen because 3 and 5 clusters didn't show enough differentiation between cluster regions and 9 was too close to 14, adding low value to the clustering.





Annex 10: List of regions in each typology group based on industrial ecosystem specialisation

1 Agri-Textile (37 regions)	2 Agri-Tourism (22 regions)	3 Energy / Industry (35 regions)	4 Creative / Digital / Capitals (19 regions)	5 Health / Local (21 regions)	6 Electronics / Mobility (17 regions)	7 Non-specialised / Diversified (50 regions)
AT34	AT33	AT31	AT13	BE2	AT21	AT11
BG31	CY0	CZ02	BG41	BE3	AT22	AT12
BG32	EL30	CZ03	CZ01	DE8	DE1	AT32
BG33	EL41	CZ04	DE3	DEC	DE2	BE1
BG34	EL42	CZ05	DE6	DEF	DE5	DE4
BG42	EL43	CZ06	DK01	DK02	DED	DE7
EL51	EL52	CZ07	ES30	DK03	DEG	DE9
ES23	EL54	CZ08	FI1B	DK04	FI1D	DEA
ES42	EL61	DEB	FR1	DK05	FRC	DEE
ES43	EL62	EE0	HU11	FRE	FRY2	ES11
ES52	EL63	EL53	IE06	FRM	HU12	ES12
ES62	EL64	HU21	LT01	FRY4	HU31	ES13
HR04	EL65	HU22	NL31	FRY5	IE05	ES21
HU32	ES53	HU23	NL32	IE04	ITH5	ES22
HU33	ES70	ITI3	PL91	ITG2	PL63	ES24
ITC1	FI20	PL21	RO32	NL11	RO42	ES41
ITC4	HR03	PL22	SE11	NL12	SK02	ES51
ITF1	ITC2	PL41	SE22	NL13		ES61
ITF4	ITH1	PL42	SE23	NL21		ES63
ITF5	PT15	PL43		NL22		ES64
ITF6	PT17	PL52		NL42		FI19
ITH3	PT30	PL61				FI1C
ITH4		PL62				FRB
ITI1		PL71				FRD
ITI2		PL82				FRF
LT02		PL84				FRG
PL72		PT16				FRH
PL81		RO12				FRI
PL92		SE21				FRJ
PT11		SE31				FRK
PT18		SE32				FRL
PT20		SE33				FRY1
RO11		SI03				FRY3
RO21		SK03				ITC3
RO22		SK04				ITF2
RO31						ITF3
RO41						ITG1
						ITH2
						ITI4
						LU0
						LV0
						MT0
						NL23
						NL33
						NL34
						NL41
						PL51
						SE12
						SI04
						SK01

Note: See Annex 1 for the list of regions codes and names.

Annex 11: Description of regional competitiveness performance indicators

Dimension	Indicator	Unit	Source
Outcome indicators	GDP per capita (PPP) or Disposable income (PPP)	PPP	Eurostat [nama_10r_2gdp] [nama_10r_2hhinc]
	Air pollution (pm2.5, population weighted)	Micrograms per cubic meter	European Environmental Agency and DG Regio own computations (ad-hoc request) /OECD (Regional database)
	Population satisfied with efforts to preserve the environment	% of total population	OECD (Local SDG Database-based on Gallup)
	Population at risk of poverty and exclusion	% of total population	Eurostat [ilc_peps11]
	Long-term unemployment	% of active population	Eurostat [lfst_r_lfu2ltu]
Intermediate performance indicators	Apparent labour productivity	€	Eurostat [nama_10r_2lfe2emp] and [nama_10r_2gdp]
	Employment rate	% of total population	Eurostat [lfsi_emp_a]
	PCT patents per million population	Num.	OECD-Regpat
	PCT patents in ICT	% of total patents	OECD-Regpat
	Green PCT patents	% of total patents	OECD-Regpat
	CO_2 emissions per electricity production	tons of CO_2 eq. per gigawatt hours	OECD (Local SDG Database)
Drivers of competitiveness: Firms' behavior	Business R&D expenditure	% of GDP	Eurostat [rd_e_gerdreg]
	PCT Patent co-invention	% of total patents	OECD-Regpat
	Gross fixed capital formation	% of GDP	Eurostat [nama_10r_2gfcf]
Drivers of competitiveness: Business environment	Electricity production that comes from renewable sources	% of total electricity production	OECD (Local SDG Database)
	Public R&D expenditure	% of GDP	Eurostat [rd_e_gerdreg]
	Human resources in science and technology	% of total population	Eurostat [hrst_st_rcat]
	Population aged 25-64 with upper secondary or tertiary education	% of population aged 25-64	Eurostat [edat_lfse_04]
	Lifelong learning	% of population aged 25-64	Eurostat [trng_lfse_04] & [lfst_r_lfsd2pop]
	Households with broadband access	% of households	Eurostat [isoc_r_broad_h]
	Individuals who ordered goods or services over the internet	% of individuals	Eurostat [isoc_r_blt12_i]
	Digital engagement (frequency of internet access)	% of individuals	Eurostat [isoc_r_iuse_i]
	Quality of Government	Index	Quality of Government Institute (University of Gothenburg)

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