ARDIA – Net

Developing an Alpine Space Research,

Development and Innovation Area

by lowering barriers for cross-regional cooperation

BIOECONOMY COOPERATION POTENTIAL IN THE ALPINE SPACE

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Work Package T1

A.T1.2. Development of Thematic Scope for Demonstrator Calls
D.T1.2.1 Identification of cross-regional S3 cooperation potential

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Disclaimer

Content

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PP7 - Haute école spécialisée de Suisse occidentale – Haute école d'ingénierie et d'architecture de Fribourg, Suisse

PP8 - Lombardy Green Chemistry Association, Italy

Abbreviations used

EC	European Commission
ECO	European Cluster Observatory
EIB	European Investment Bank
EU	European Union
FTE	full-time equivalent
FSO	Federal Statistics Office
IFC	institutions for collaboration
IPC	International Patent Classification
LQ	location quotient
MNE	multinational enterprise
NUTS	Nomenclature of Territorial Units for Statistics
OECD	Organization for Economic Co-operation and Development
p.	page
pp.	pages
PP	project partners
R&D	research and development
RTA	revealed technological advantage
S3	Smart Specialisation Strategy
TEG	Technical Expert Group
TL	territorial level
WIPO	World Intellectual Property Organization

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1. Introduction

For the last few years, the European Commission (EC) has been encouraging the bioeconomy as a driver for a more sustainable and environmental-friendly Europe. The Interreg VB project ARDIA-Net, is contributing to this objective by lowering the barriers for cross-regional and cross-sectoral cooperation in bioeconomy value chains across the Alpine Space. In particular, it aims at developing a multilevel Alpine RDI Area for cross-regional and interdisciplinary cooperation. On a technical level, propositions will be made for increased cooperation among regional funding schemes (cf. Keller et al, 2020). In parallel, the eight project partners (PP) *(Business Upper Austria (AT), Innovation and Technology Transfer Salzburg (AT), University of Applied Sciences and Arts Western Switzerland – School of Engineering and Architecture of Fribourg (CH), Bavarian Research Alliance (DE), BIOPRO Baden-Württemberg (DE) , Lombardy Green Chemistry Association (IT), SC Sviluppo chimica (IT) and Poly4EmI (SI))* will work towards the identification of transformative RDI projects related to the bioeconomy, which can form the basis for a first wave of cooperation financed through coordinated funding among the participating regions. It is therefore the objective of this report to give a first overview on capacities and opportunities related to the bioeconomy in the regions participating in the ARDIA-Net project and to hint at cross-sectoral and cross-regional cooperation potentials and synergies.

The report is divided into 3 main chapters. The first chapter defines the bioeconomy topics of most relevance for the ARDIA-Net project, with a particular perspective on developments linked to *the European Green Deal* promoted by the EC[1]. The second chapter gives an in-depth analysis of the selected topics to highlight regional strengths and opportunities. First, the methodology will be introduced and give an overview on data, formula and metrics used. The regional capacities and opportunities will then be assessed both on a quantitative and qualitative level, *inter alia* through employment statistics, patent application data, and analysis of regional policies and institutional entities in the ARDIA-Net regions. The last chapter provides a concluding overview of potential cross-regional synergies and regional testimonials from the different project partners (PP).

[1] Note that the topics targeted by the ARDIA-Net project are defined as “bioeconomy and health economy”. For this particular report, with the aim to unearth concrete synergy potential between the participating regions, the consortium has decided to apply a specific focus on “bioeconomy” and to include “health economy” only as far as it is included in the relevant topics introduced in section 2.1.1.

2. The bioeconomy

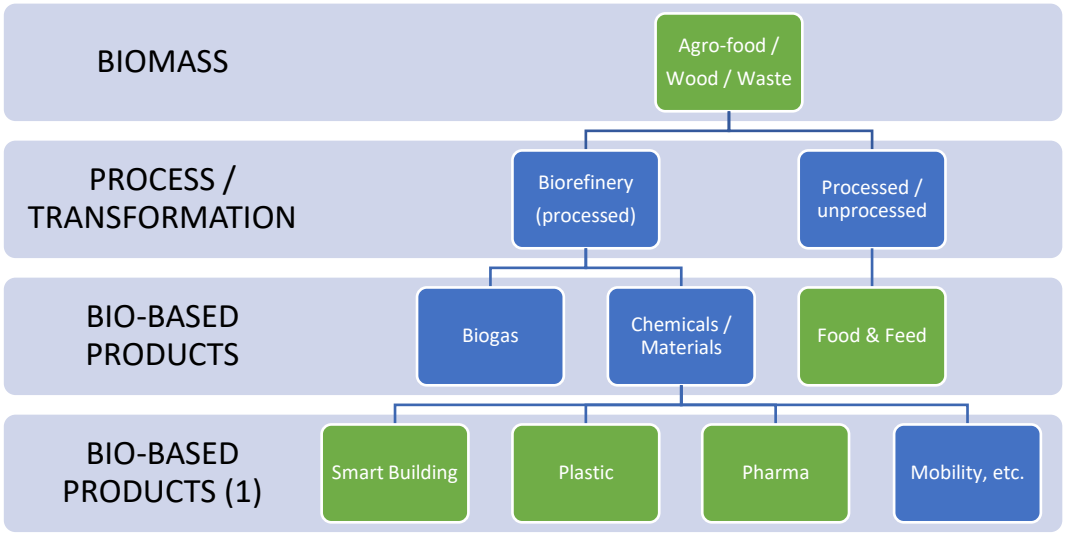
2.1. Definition

The relevant literature on bioeconomy definitions is abundant and eclectic. The *Bioeconomy Council* defines it as "the knowledge-based production and use of biological resources to provide products, processes and services in all economic sectors within the frame of a sustainable economic system" (Bioeconomy BW, 2020). Another explanation portrays the bioeconomy as a transversal industry covering "all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles. It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services (except biomedicines and health biotechnology)" (EC, 2020). Moreover, the bioeconomy is often defined in way that complements circular economy concepts by incentivizing the use of renewable materials and energies and by enhancing biodiversity thanks to the modernization of production systems and the protection of the environment.

2.1.1. The bioeconomy and its subsections

Since the bioeconomy includes a broad range of industries and subsectors, the choice of the topics retained for this study relies on the specific emphasis and focus encountered in the strategic orientations of the ARDIA-Net regions.

Figure 1 - The bioeconomy and relevant topics for potential cross-regional cooperation



Note: Green represents the topics further studied throughout the paper.

Source: Author's elaboration based on documentation provided by project partners.

As shown in Figure 1, the bioeconomy can be explained through a top-down organization chart with three main layers: *biomass*; *process / transformation* and *bio-based products. Biomass* is composed of organic resources such as wood, agriculture crops, food, animal manure and various waste (wood, food, human sewage) and constitutes an important source of renewable energy. Biomass is directly linked to industries such as forestry, agriculture and fishery. In addition to its function as a direct energy source, biomass is also used as organic mass for various outputs and industries, such as construction and building, pharmaceuticals, biogas, chemistry, plastics, mobility, etc. The second layer – *process / transformation* - links biomass to bio-based products (food, feed, chemicals, materials, etc.) and energy (biofuels, biogas) e.g. through biorefineries. In this process inputs (raw materials) are fractioned and/or transformed (via few or numerous stages) into intermediate or final outputs (food, feed, chemicals, new materials, etc.). *Bio-based products* can be linked to a large range of industries, but this report limits its focus on those of particular importance for the ARDIA-Net regions (derived e.g. from regional natural endowments or specific technological expertise). The choice of topics for this report were collected from *Regional Reports* provided by PP and from a common *SharePoint platform* where PP could add relevant documentation regarding their regional strategic orientations in the bioeconomy. PP shared various documents and graphics assessing regional strengths and advantages regarding their policy, economic environment, business opportunities, industrial expertise and relevant firms and projects. Based on all the documentation and reports provided by PP, five broad topics have been retained for an in-depth analysis. One of them on the input side (biomass) and four at the level of bio-based products (food & feed, smart building, plastics and pharmaceuticals). These topics were discussed and confirmed in their relevance by the project consortium. As will be shown in the subsequent chapters of this report, the analysis further confirms the significance of the five topics as fields of huge cooperation potential for the seven regions of the ARDIA-Net project.

2.2. The *European Green Deal*, a support for the bioeconomy

In December 2019, the EC launched the *European Green Deal* as a new driver to promote and shift the European Union into a more modern, competitive and resource-efficient economy. In this regard, Ursula von der Leyen, President of the EC, stated that “The European Green Deal is our new growth strategy. It will help us cut emissions while creating jobs.” (EC, 2020). With the financial help of the European Investment Bank (EIB), the EC wants Europe to become the first climate neutral continent by 2050. To achieve this objective, the EC relies upon developing zero pollution solutions, affordable and secure energies, smarter transportation and high-quality food. In consequence, the EC takes action in promoting projects investing in environmentally-friendly technologies; supporting industry to innovate; rolling out cleaner, cheaper and healthier forms of private and public transport; decarbonizing the energy sector; ensuring buildings are more

energy efficient and finally working with international partners to improve global environmental standards (EC, 2020).

Figure 2 - The European Green Deal

Source: EC (2019), *The European Green Deal*, p. 3.

Figure 2 provides a graphic display of the EU's strategy to promote and enhance the EU economy into a more sustainable and prosperous economy. Indeed, the European Green Deal incentivizes policies converging into a "supplying clean, affordable and secure energy, biodiversity, zero pollution, a circular economy and sustainable food production" (TEG, 2020, p. 8). The Green Deal is reflected in a *EU Taxonomy* outlining specific economic activities qualified as "environmentally sustainable". As such, the Taxonomy is a "tool to help investors, companies, issuers and project promoters navigate the transition to a low-carbon, resilient and resource-efficient economy" (TEG, 2020, p. 9). For this report, the *EU Taxonomy* will be used as a foundational framework to ensure a correspondence between our quantitative analysis and the terminology and classification underlying the Green Deal. E.g., patent applications will be classified according to the activities provided by the Taxonomy.

3. Capacities and opportunities in the topics identified for cross-regional cooperation

3.1. Methodology

This chapter will provide an in-depth evaluation of the 5 topics selected for the study (biomass, food & feed, smart building, plastics, pharmaceuticals). Each topic will be assessed on a quantitative and qualitative level. For each topic, a quantitative review will first be performed to determine regional existing capacities through an analysis of employment data in relevant industry clusters. Then, opportunities will be highlighted through an evaluation of patent application data. A qualitative assessment will follow, in which relevant national and regional strategies and institutions for collaboration (IFC) will be listed.

The analysis of relevant regional existing capacities and opportunities is crucially dependent on availability and quality of data. Consequently, in the following subchapters, an overview of all databases, formula, methods and regional metrics used will be presented. Overall, it has to be noted that data availability on specific bioeconomy topics remains a critical bottleneck. It has therefore been necessary to rely on approximations and somewhat old datasets. The results presented in this report should be considered rather as a first sketch of regional capacities and opportunities than as a precise, tailor-made measurement.

3.1.1. Employment

Regarding the employment, the analysis will be based on full-time equivalent (FTE) employment numbers of selected clusters provided by the European Cluster Observatory and Eurostat. The timeframe of the data available ranges from 2001 to 2013. For the study, figures and tables will be elaborated for the year 2011 since 2012 and 2013 are not providing complete employment statistics for all ARDIA-Net regions.

Mathematical formula used to asses specialization patterns (Location Quotient, LQ - cf. Formula) will use the sum of the five countries of partner regions (Austria, Germany, Italy, Slovenia and Switzerland) as its base unit. This means that specialization will always refer to a specific region's situation in relation to the total of the five concerned countries. This empirical strategy is conditioned by the absence of comparable employment data for many countries of the European Union, which makes the definition of other potential base units (e.g. European Union as a whole) difficult. The fact that the topics under study are all pre-confirmed to be relevant at strategic regional levels in the five participating countries gives additional significance to the choice of the latter as total base unit. The indicated results can thus be interpreted as specialization patterns with respect to an already specialized overall base region.

The European Cluster Observatory provides employment data for 61 clusters, of which 51 are included in the category "New Clusters Definitions" and 10 fall into the "Emergings Industries Definitions" classification. In order to select clusters relevant for the five main topics under study in this report, we compared the NACE

activities included in each cluster (cf. Appendix D) with the activities of the *EU Green Deal Taxonomy*. Based on this, we selected 19 clusters of relevance for the five topics according to the distribution in table 1.

Table 1 - Clusters linked to the bioeconomy

Clusters	Biomass	Food & Feed	Smart Building	Plastics	Pharma
Agricultural Inputs and Services	X	X			X
Biopharmaceuticals *(New Cluster)*					X
Construction Products and Services			X		
Downstream Chemical Products					X
Education and Knowledge Creation	X	X	X	X	X
Electric Power Generation and Transmission	X				
Environmental Services	X				
Fishing and Fishing Products	X	X			
Food Processing and Manufacturing	X	X			
Forestry	X		X		
Furniture			X		
Livestock Processing	X	X			
Plastics				X	
Tobacco	X	X			X
Upstream Chemical Products		X		X	X
Wood Products	X		X		
Advanced Packaging *(Emerging Industries)*				X	
Biopharmaceuticals *(Emerging Industries)*					X

Environmental Industries *(Emerging Industries)*	X	X	X	X	X

Note: detailed NACE activities (4 digits) for each cluster can be found in the Appendix D.
Source: authors' elaboration based on data from The European Cluster Observatory (2020).

From the 19 clusters selected for the quantitative study, two clusters are included in all topics: *Education and Knowledge Creation* and *Environmental Industries (Emerging Industries).* The cluster *Education and Knowledge Creation* notably includes the NACE activity "Research and experimental development on biotechnology". The same is true for the cluster *Environmental Industries (Emerging Industries)* which includes a broad list of activities related to the bioeconomy.

Concerning the biomass topic, it involves clusters linked to agriculture and fishing (*Agricultural Inputs and Services; Fishing and Fishing Products; Food Processing and Manufacturing; Livestock Processing; Tobacco*), the environment in general (*Environmental Services; Forestry; Wood Products; Environmental Industries (Emerging Industries)*) and industries for which bio-mass can be a direct energy source (*Electric Power Generation and Transmission*).

The food & feed's topic involves clusters related to agriculture and fishing (*Agricultural Inputs and Services; Fishing and Fishing Products; Tobacco),* and related processes and manufacture activities *(Food Processing and Manufacturing; Livestock Processing; Upstream Chemical Products).*

Smart building is related to the construction cluster *(Construction Products and Services)* and to the wood industry *(Forestry; Furniture; Wood Products).*

The plastics topic is represented by the *Plastics* cluster and clusters linked to chemistry and related processes *(Upstream Chemical Products; Advanced Packaging (Emerging Industries)).*

Finally, pharmaceuticals within the bioeconomy are linked to agriculture as potential source of phytopharmaceutical inputs *(Agricultural services and inputs / Tobacco)*, chemical goods and processes *(Downstream Chemical Products; Upstream Chemical Products)* and biologic medical products *(Biopharmaceuticals (New Cluster); Biopharmaceuticals (Emerging Industries)).*

3.1.2. Patents

A patent is a legal protection defending the owner's invention from competitors' exploitation. Patents statistics represent a relevant metric for measuring and comparing the innovative capacity of a region or country. In fact, a patent reports useful information for an innovative analysis like the name and address of the applicant (entity which has the right of the patent), the name and address of the inventor (person(s) from whom the invention was discovered), the priority date (date of first filing for a patent), the application date ("date on which a patent is filed at a specific patent office") and the technology field of the invention

(International Patent Classification - IPC)[2]. Therefore, the patent is a useful and precise tool to measure innovation tendencies of a region (Maraut et al., 2008, p.17). Furthermore, thanks to a homogeneous technological classification (IPC) between regions and precise addresses, patents become also a reliable and precise medium of national and regional comparison. Concerning the IPC classes selected for each bioeconomy topic, they are based mostly on the tables of the *EU Green Deal Taxonomy* provided by the EU Technical Expert Group (TEG) on Sustainable Finance and on the authors considerations (TEG, 2020, pp. 56-63). A detailed list of selected IPC classes can be found in Appendix A. To summarize, patent applications grant a good overview of the regional innovative opportunities for future potential collaborations. The patent analysis will be based on legal protections filed at the EPO (European registration office for patents) at the priority date and based on the applicants' address(es) (owner of the patent) for the year 2016.

3.1.3. Regions

For patent statistics, the OECD uses the Territorial Level (TL) as the metric unit for sub-national regions. The higher the number of TL, the more precise the nomenclature goes (e.g. major regions equal TL2 regions). OECD's metric is equal to the Nomenclature of Territorial Units for Statistics (NUTS) used by Eurostat and to the nomenclature used by the Swiss Federal Statistical Office (FSO) (Maraut et al., 2008, p.7). Employment data is available at the level of the ARDIA-regions and results will in this case always refer both to national levels and to the NUTS regions covered in the project (Baden-Württemberg, Bavaria, Salzburg, Upper Austria, Slovenia, Lombardy, Espace Mittelland). For patent applications, data is not available at regional level for all covered region. Results will therefore only be reported at national level (Germany, Austria, Slovenia, Italy and Switzerland) for patent data.

3.1.4. Formula

The set of ARDIA-Net regions covered in this report are quite inhomogeneous, e.g. in terms of the number of inhabitants or the total number of employments. In terms of the territorial unit classification (NUTS), not all covered regions are classified at the same level. In order to allow for a meaningful comparison between regions, we therefore homogenize data and do not only report absolute, but also specialization metrics: Location Quotients (LQ) for employment and Revealed Technological Advantage (RTA) for patent applications.

[2] The technological classification IPC has different divisions: no digit (IPC-0) depicting the sections (e.g. (A) Human necessities), then 1 digit (IPC-1) exhibiting the subsections (e.g. (A0) Agriculture) and, finally with 2 digits (IPC-2) are the classes (e.g. (A01) Agriculture, forestry, animal husbandry, hunting, trapping, fishing). Since the patents' study will be based on the terminology IPC, it is strongly recommended to have a look at the complete table in the Appendix A.

For employment, the divergence of the employment basis between regions will be homogenized through the LQ:

$$LQ_{ir} = \frac{E_{i,r}/E_{n,r}}{E_{i,c}/E_{n,c}} \tag{3.2}$$

$E_{i,r}$ corresponds to the employment of the cluster *i* in region *r* and $E_{i,c}$ is the employment of that same cluster in the country *c*. For our study, country *c* will correspond to the sum of the 5 countries represented in ARDIA-Net (Austria, Germany, Italy, Slovenia and Switzerland). $E_{n,r}$ and $E_{n,c}$ are the overall employment of region *r*, respectively country *c* (Austria, Germany, Italy, Slovenia and Switzerland). An LQ taking a value above one indicates that the employment in this cluster is over-represented in the region in relation to the total of the 5 countries.

For patent application statistics, the OECD and many authors suggest to report regional inventive activity, through the Revealed Technological Advantage (RTA) (OECD, 2019; Tinguely, 2013, pp.193-4). This index of concentration allows to indicate the relative specialization of a region in a technological field.

$$RTA_{ij} = \frac{Y_{ij}}{\sum_{i=1}^{n} Y_{ij}} : \frac{\sum_{j=1}^{m} Y_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{m} Y_{ij}} \tag{3.1}$$

Y_{ij} designates the total number of patents filed in the technological field j by applicants located in the country i. $\sum_{i=1}^{n} Y_{ij}$ corresponds to the total number of patent applications in the IPC j from Europe[3]. $\sum_{j=1}^{m} Y_{ij}$ equals the number of patents applied by applicants in all technological fields in the country i. $\sum_{i=1}^{n}\sum_{j=1}^{m} Y_{ij}$ represents the number of patents filed by applicants in all IPC in Europe. A score greater than 1 signifies that the country i has a relative specialization in the IPC j within Europe.

[3] For the study the formula will be based on the Europe Union (EU-28) and Switzerland.

3.2. Biomass

3.2.1. Quantitative analysis

3.2.1.1. Employment

Table 2 - Regional distribution of employment in clusters related to biomass, 2011

Country	Regions	Agricultural Inputs and Services	Education and Knowledge Creation	Electric Power Generation and Transmission	Environmental Services	Fishing and Fishing Products	Food Processing and Manufacturing	Forestry	Livestock Processing	Tobacco	Wood Products	Environmental Industries
Austria		**3 480**	**63 359**	**8 882**	**4 805**	**383**	**28 207**	**8 769**	**13 808**	**1 055**	**29 034**	**135 323**
	Upper Austria	1 374	6 074	741	1 000	132	6 095	667	3 881	-	6 179	29 829
	Salzburg	182	3 414	1 575	277	-	2 388	670	1 099	-	2 928	9 596
Germany		**27 322**	**551 263**	**90 104**	**86 144**	**9 918**	**267 151**	**17 836**	**136 132**	**589**	**108 569**	**2 064 042**
	Baden-Württemberg	1 596	71 250	14 493	8 300	821	30 583	2 038	17 899	-	18 520	343 209
	Bavaria	2 467	72 456	15 879	8 331	723	50 087	3 590	26 677	-	24 687	345 412
Italy		**60 473**	**102 935**	**66 777**	**139 777**	**55 087**	**497 828**	**15 790**	**129 931**	**1 151**	**237 838**	**2 162 339**
	Lombardy	7 131	23 438	10 619	18 891	1 999	91 430	1 326	25 970	-	46 191	589 708
Slovenia		**722**	**53 052**	**9 351**	**17 208**	**558**	**18 171**	**4 749**	**11 400**	**-**	**24 267**	**198 926**
Switzerland		**2 066**	**105 956**	**13 830**	**5 825**	**546**	**43 670**	**5 479**	**16 098**	**2 508**	**40 889**	**193 339**
	Espace Mittelland	855	14 621	3 987	1 148	241	8 839	1 388	5 066	1 796	10 013	33 912
Total*		**94 062**	**876 565**	**188 943**	**253 758**	**66 493**	**855 027**	**52 623**	**307 369**	**5 302**	**440 596**	**4 753 969**

Note: Total* equals the sum of countries' employment numbers.

Source: authors' elaboration based on data from The European Cluster Observatory (2020).

Table 3 - Regional specialization (LQ) of employment in clusters related to biomass, 2011

Country	Regions	Agricultural Inputs and Services	Education and Knowledge Creation	Electric Power Generation and Transmission	Environmental Services	Fishing and Fishing Products	Food Processing and Manufacturing	Forestry	Livestock Processing	Tobacco	Wood Products	Environmental Industries
Austria		**0,65**	**1,27**	**0,83**	**0,33**	**0,10**	**0,58**	**2,93**	**0,79**	**3,50**	**1,16**	**0,50**
	Upper Austria	1,46	0,69	0,39	0,39	0,20	0,71	1,27	1,26	0,00	1,40	0,63
	Salzburg	0,51	1,03	2,20	0,29	0,00	0,74	3,37	0,94	0,00	1,76	0,53
Germany		**0,53**	**1,16**	**0,88**	**0,62**	**0,27**	**0,57**	**0,62**	**0,81**	**0,20**	**0,45**	**0,80**
	Baden-Württemberg	0,23	1,09	1,03	0,44	0,17	0,48	0,52	0,78	0,00	0,56	0,97
	Bavaria	0,29	0,92	0,94	0,37	0,12	0,65	0,76	0,97	0,00	0,63	0,81
Italy		**2,03**	**0,37**	**1,11**	**1,74**	**2,61**	**1,84**	**0,95**	**1,33**	**0,68**	**1,70**	**1,43**
	Lombardy	1,30	0,46	0,96	1,27	0,51	1,83	0,43	1,44	0,00	1,79	2,12
Slovenia		**0,58**	**4,61**	**3,77**	**5,16**	**0,64**	**1,62**	**6,87**	**2,82**	**0,00**	**4,19**	**3,18**
Switzerland		**0,32**	**1,77**	**1,07**	**0,34**	**0,12**	**0,75**	**1,52**	**0,77**	**6,92**	**1,36**	**0,59**
	Espace Mittelland	0,60	1,11	1,40	0,30	0,24	0,69	1,75	1,09	22,49	1,51	0,47
Total		**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**

Note: LQ > 1 are highlighted in green (only for regions and Slovenia).

Source: authors' elaboration based on data from The European Cluster Observatory (2020).

From the 19 clusters linked to the bioeconomy, (cf. Employment), eleven clusters potentially reflect capacities relevant for biomass valorization. Clusters included in this topic cover agriculture and fishing and subsequent value chains (*Agricultural Inputs and Services; Fishing and Fishing Products; Food Processing and Manufacturing; Livestock Processing; Tobacco*), the environment in general (*Environmental Services; Forestry; Wood Products; Environmental Industries (Emerging Industries)*), industries directly using biomass as an energy source (*Electric Power Generation and Transmission*) and education and research activities *(Education and Knowledge Creation*) (exhaustive list of NACE activities available for each cluster in Appendix D).

Table 2 exhibits the national and regional employment distribution for clusters linked to biomass.

Table 3 lists the regional and national specialization rates (LQ).

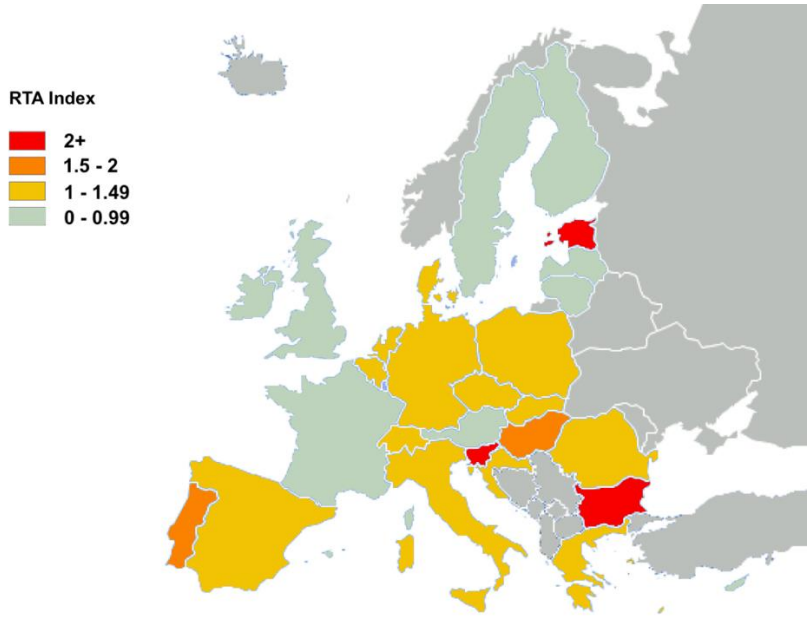
With respect to absolute employment numbers (cf. Table 2), the cluster *Environmental Industries* is most significant, followed by the cluster *Education and Knowledge Creation* and *Food Processing and Manufacturing.*

In terms of specialization patterns, Slovenia exhibits Location Quotients superior to one in 8 out of 11 biomass-related clusters, Lombardia and Espace Mittelland in 6, and Upper Austria and Salzburg in 4.

Five out of seven regions are specialized (LQ > 1) in the cluster *Wood Products*. 4 regions in the clusters *Education and knowledge Creation*, *Electric Power Generation and Transmission,* and *Forestry* and *Livestock Processing*. The clusters *Agricultural Inputs and Services, Environmental Services, Food Processing and Manufacturing* and *Environmental Industries* are of particular relevance for two regions each. Finally, only Espace Mittelland is specialize in the cluster *Tobacco*, unsurprisingly, no region in *Fishing and Fishing Products*.

3.2.1.2. Patent applications

Figure 3 - National specialization in biomass, patent applications, 2016



Note: IPC included for the measurement - A01, A23, B09, C02, C07, E03, F23, F24, H02; RTA: revealed technological advantage.

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Table 4 - Patent applications linked to biomass, 2016

Ranking (pat. appl.)	Country	Patent appl.	Perc. of national patent appl.	RTA
1	Germany	2023,6	10,3%	1,02
2	Switzerland	693,2	14,1%	1,39
3	France	599,9	8,0%	0,79
4	United Kingdom	401,0	10,0%	0,98
5	Netherlands	375,7	11,0%	1,08
6	Italy	375,5	10,1%	1,00
7	Belgium	219,0	14,8%	1,46
8	Sweden	201,8	6,7%	0,66
9	Denmark	153,0	12,4%	1,22
10	Spain	134,9	11,4%	1,13
11	Austria	109,8	6,7%	0,66
12	Finland	86,6	6,4%	0,63
13	Ireland	42,9	9,2%	0,91
14	Poland	33,2	10,4%	1,03
15	Czech Republic	25,9	14,6%	1,44
16	Portugal	21,7	16,0%	1,58
17	Slovenia	16,8	20,3%	2,01
18	Luxembourg	14,9	4,6%	0,45
19	Hungary	12,0	15,5%	1,53
20	Bulgaria	8,3	35,1%	3,46
21	Estonia	7,8	22,4%	2,21
22	Greece	6,3	10,8%	1,07
23	Slovak Republic	5,7	14,3%	1,41
24	Croatia	3,3	14,8%	1,46
27	Cyprus	2,3	6,6%	0,65
28	Romania	2,1	10,4%	1,02
29	Lithuania	2,1	8,6%	0,85
30	Latvia	0,3	2,9%	0,29
31	Malta	0,0	0,0%	0,00
	EU28 & CH	5579,5	10,1%	1,00
	Mean	192,4		
	Median	25,9		

Note: IPC included for the measurement - A01, A23, B09, C02, C07, E03, F23, F24, H02; RTA: revealed technological advantage.

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Patent applications

Figure 3 exhibits the national distribution of patent application specialization in Europe (the 28 countries of the European Union (EU) & Switzerland) in the IPC classes related to biomass (cf. Appendix B). The IPC classes identified for this topic are:

- A01 – Agriculture, forestry, animal husbandry, hunting, trapping and fishing
- A23 – Foods or foodstuffs, their treatment
- B09 – Disposal of solid waste, reclamation of contaminated soil
- C02 – Treatment of water, wastewater, sewage or sludge
- C07 – Organic chemistry
- E03 – Water supply, sewerage
- F23 – Combustion apparatus, combustion process
- F24 – Heating, ranges, ventilating
- H02 – Generation, conversion or distribution of electric power

Table 4 represents the innovative performance of European countries (and Switzerland) in the IPC classes linked to biomass for the year 2016. In addition to the absolute number of patent applications, the table also includes the weight of biomass-related applications relative to overall national patent applications and the rate of specialization (RTA) of the country relative to Europe. Countries are ranked by the total number of patent applications.

As it can be seen, with the exception of Austria, all countries represented in the project are specialized in biomass-related patents (RTA > 1). Germany is the country with most of the patent applications in the covered fields, with over 2000 patent applications in 2016, which nevertheless only account for 10.3% of the overall patent applications in the country. With a rate of specialization two times superior to Europe, Slovenia represents the country ARDIA-Net with the highest specialization in biomass-related patents, with an RTA of 2.01. A more detailed analysis, broken down by individual IPCs is available in the Appendix C.

3.2.2. Qualitative analysis

Table 5 - Strategies and institutions in biomass, 2020

Regions	National and regional strategies/ policy instruments	Institutions for collaboration	
		Research center(s), universities, foundation(s)	Cluster(s), collaboration(s), association(s)
Upper Austria	- National: Sustainable use of resources (biomass, renewable energy) - Regional: Energy - resource efficiency and integration of biomass and renewable energy sources (e.g. energy from organic secondary raw materials)	- Wood K Plus (research institute)	- Food Cluster - CleanTech Cluster - (Furniture and Timber Construction cluster)
Salzburg	- National: Sustainable use of resources (biomass, renewable energy) - Regional: Zero fossil energy (use of biomass)	- University of Applied Sciences, Salzburg (Kuchl Campus) – Wood center / Forest Products Technology & Biogenic Technology, - Salzburg Center for Smart Materials - Wood Technology Centre (Holztechnikum) - University of Salzburg, Department of Chemistry and Physics of Materials	- Ressourcenforum Austria - Holzcluster Salzburg - Netzwerk Alpines Bauen (Network Alpine Construction)

Espace Mittelland	- Regional: Promotion of entrepreneurship, support for start-ups, promotion of entrepreneurship, development of regional clusters, transfer of knowledge and technology and inter-firm research collaborations	- University of Applied Sciences and Arts Western, Fribourg – Institute for Applied Research into Energy Systems (ENERGY) & Institute of Chemical Technology (ChemTech)	- Energy Cluster - Food & Nutrition Cluster - Collaboration with Food & Nutrition Cluster
Baden-Württemberg	- *National:* Promotion of energy sources based on biomass - *National:* Transition to an economy based on renewable resources and efficient use of raw materials - *Regional:* Environmental technologies, renewable energies and resource efficiency - Sustainable energy generation and based on biological resources	- University of Hohenheim, Department of Farm Management	- proHolz BW GmbH - Allianz Faserbasierte Werkstoffe Baden-Württemberg e.V. - Fachagentur Nachwachsende Rohstoffe; RegioHOLZ Nordschwarzwald - Clusterinitiative Forst und Holz Baden-Württemberg - Biomastec: neue BiomasseEffizienz
Bavaria	- National: Promotion of energy sources based on biomass - National: Transition to an economy based on renewable resources and efficient use of raw materials - Regional: Clean Technology - Renewable energy, energy saving technology, waste management, recycling, secondary raw material	- Bavarian Research Foundation: FOREnergy (concepts and solutions for the energy-elastic factory), BAYBIOTECH (focused on resource saving biotechnology)	- Cluster Energy Engineering - Cluster Environmental Technology - Cluster Forestry and Timber - Bavarian Alliance for Energy and Technology Research
Lombardy	- National: Promotion of the renewable energy sector towards low-emission models	- University of Milan - InnovHub - Istituto Sperimentale Italiano Lazzaro Spallanzani	- Lombardy Energy and Cleantech Cluster - Consorzio Italbiotec

	- National: Production of energy from biomass and waste sources (biogas, biomethane) - Regional: Green Industry - Development of biomass and renewable energies		- Collaboration between Chemistry and Biomass: alternative energy inputs (S3CHEM)
Slovenia	- S4 - Slovenian Smart Specialization Strategy, Strategic priority 4 ("smart use of resources"). - Framework Program for the Transition to a Green Economy (2016). - Operational Program for reducing greenhouse gas emissions by 2020 - addresses wood biomass and raw hinterland represented by forests as one of important elements for the transition to a green economy. - Action plan to increase the competitiveness of the forest-wood chain in Slovenia (MKO and MGRT 2012). - Renewable Energy Action Plan for the period 2010-2020 (AN OVE).	- University of Ljubljana, Biotechnical faculty - University of Maribor, Faculty of Chemistry and Chemical Engineering - The National Institute of Chemistry - Slovenian Forestry Institute - CP – Pulp and Paper Institute - Institut Jožef Stefan - Agricultural Institute of Slovenia	- SRIP Networks towards Circular Economy – focus fields: 1) Sustainable energy, 2) Biomass and alternative raw materials and 3) secondary raw materials. Focus on ligno-cellulose biomass. • GZS ZLPI - Association of the Wood and Furniture Industry at CCI

Source: authors' elaboration based on documentation from project partners (cf. Bibliography – PP documentation).

Table 5 displays national and regional strategies but also relevant regional institutional entities and associations related to biomass. The national and regional programs and institutions for collaboration (IFC) displayed in Table 5 were listed from regional reports provided by PP and from a common SharePoint platform where PP could add relevant documentation regarding their regional strengths.

All regions taking part in the ARDIA-Net project stress the importance of the biomass topic. In fact, all national and regional strategies aim at reducing the use and emission of pollutant components (low carbon footprint) and at promoting renewable energy sources such as biomass as one of the most sustainable power sources. Each region has clusters dedicated to energy and/or cleantech.

The source of biomass can be different between the covered regions. On one hand, regions like Upper Austria, Salzburg, Espace Mittelland, Baden-Württemberg, Bavaria and Slovenia highlight the value of using wood and its related components (wood chips, wood pellets) as a biomass source, reflecting a general trend in the Alpine macro-region with its large forest area. On the other hand, the regions of Upper Austria, Espace Mittelland, Baden-Württemberg, Bavaria, Lombardy and Slovenia also stress food and waste (energy and food crop, human waste, food processing, animal farming) as biomass sources. Since the primary sector represents one of the major sectors in the regions, agrofood actors are major players for the biomass topic.

3.3. Food & feed

3.3.1. Quantitative analysis

3.3.1.1. Employment

Table 6 - Regional distribution of employment in clusters related to food and feed, 2011

Country	Regions	Agricultural Inputs and Services	Education and Knowledge Creation	Fishing and Fishing Products	Food Processing and Manufacturing	Livestock Processing	Tobacco	Upstream Chemical Products	Environmental Industries
Austria		**3 480**	**63 359**	**383**	**28 207**	**13 808**	**1 055**	**3 554**	**135 323**
	Upper Austria	1 374	6 074	132	6 095	3 881	-	1 664	29 829
	Salzburg	182	3 414	-	2 388	1 099	-	61	9 596
Germany		**27 322**	**551 263**	**9 918**	**267 151**	**136 132**	**589**	**101 708**	**2 064 042**
	Baden-Württemberg	1 596	71 250	821	30 583	17 899	-	7 173	343 209
	Bavaria	2 467	72 456	723	50 087	26 677	-	15 539	345 412
Italy		**60 473**	**102 935**	**55 087**	**497 828**	**129 931**	**1 151**	**56 669**	**2 162 339**
	Lombardy	7 131	23 438	1 999	91 430	25 970	-	20 327	589 708
Slovenia		**722**	**53 052**	**558**	**18 171**	**11 400**	**-**	**4 902**	**198 926**
Switzerland		**2 066**	**105 956**	**546**	**43 670**	**16 098**	**2 508**	**6 548**	**193 339**
	Espace Mittelland	855	14 621	241	8 839	5 066	1 796	358	33 912
Total*		**94 062**	**876 565**	**66 493**	**855 027**	**307 369**	**5 302**	**173 382**	**4 753 969**

Note: Total* equals the sum of countries' employment numbers.

Source: authors' elaboration based on data from The European Cluster Observatory (2020).

Table 7 - Regional specialization (LQ) of employment in clusters related to food and feed, 2011

Country	Regions	Agricultural Inputs and Services	Education and Knowledge Creation	Fishing and Fishing Products	Food Processing and Manufacturing	Livestock Processing	Tobacco	Upstream Chemical Products	Environmental Industries
Austria		**0,65**	**1,27**	**0,10**	**0,58**	**0,79**	**3,50**	**0,36**	**0,50**
	Upper Austria	1,46	0,69	0,20	0,71	1,26	0,00	0,96	0,63
	Salzburg	0,51	1,03	0,00	0,74	0,94	0,00	0,09	0,53
Germany		**0,53**	**1,16**	**0,27**	**0,57**	**0,81**	**0,20**	**1,08**	**0,80**
	Baden-Württemberg	0,23	1,09	0,17	0,48	0,78	0,00	0,56	0,97
	Bavaria	0,29	0,92	0,12	0,65	0,97	0,00	1,00	0,81
Italy		**2,03**	**0,37**	**2,61**	**1,84**	**1,33**	**0,68**	**1,03**	**1,43**
	Lombardy	1,30	0,46	0,51	1,83	1,44	0,00	2,00	2,12
Slovenia		**0,58**	**4,61**	**0,64**	**1,62**	**2,82**	**0,00**	**2,15**	**3,18**
Switzerland		**0,32**	**1,77**	**0,12**	**0,75**	**0,77**	**6,92**	**0,55**	**0,59**
	Espace Mittelland	0,60	1,11	0,24	0,69	1,09	22,49	0,14	0,47
Total		**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**

Note: LQ > 1 are highlighted in green (only for regions and Slovenia).

Source: authors' elaboration based on data from The European Cluster Observatory (2020).

From the 19 clusters linked to the bioeconomy, (cf. Employment), eight clusters potentially display relevant capacities for the food & feed thematic. Clusters involved for this thematic entail to the agriculture and fishing (*Agricultural Inputs and Services; Fishing and Fishing Products; Tobacco)* and subsequent value chains *(Food Processing and Manufacturing; Livestock Processing; Upstream Chemical Products)* besides both clusters common to the bioeconomy's thematic: *Education and Knowledge Creation* and *Environmental Industries* (exhaustive list of NACE activities available for each cluster in Appendix D).

Table 6 exhibits the national and regional employment's distribution for clusters linked to the food & feed. Table 7 lists the regional and national specialization rates (LQ).

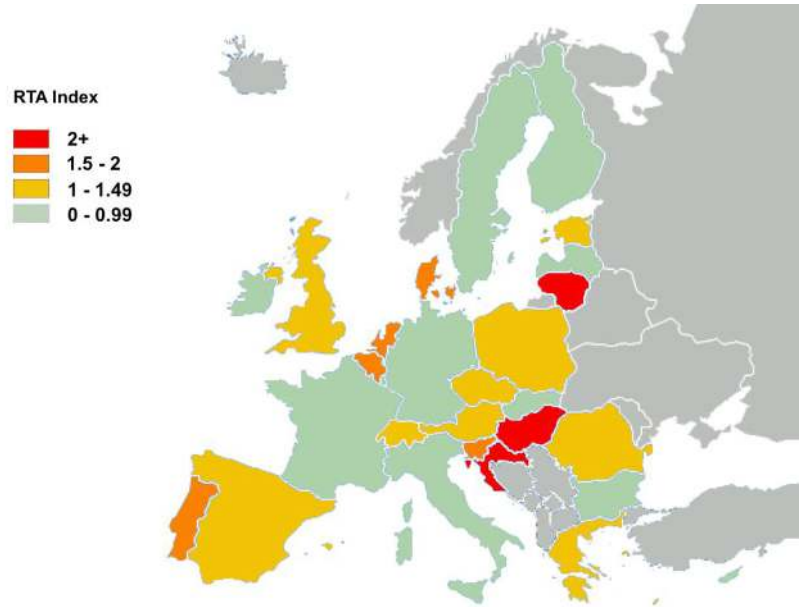
With respect to absolute employment numbers (cf. Table 6), the cluster *Environmental Industries* is most significant, followed by the cluster *Education and Knowledge Creation* and *Food Processing and Manufacturing.*

In terms of specialization patters (cf. Table 7), Slovenia and Lombardy exhibit LQ superior to one in 5 out of the 8 food and feed-related clusters. The regions of Espace Mittelland has a concentration in 3 clusters followed by Upper Austria (2) and finally the regions of Salzburg, Baden-Württemberg and Bavaria account for (1) specialized cluster. Furthermore, by highlighting potential synergies between regions, Lombardy and Slovenia present strong convergences in the clusters of *Food Processing and Manufacturing; Livestock Processing; Upstream Chemical Products* and *Environmental Industries.*

For the clusters *Livestock Processing* and *Education and knowledge Creation,* 4 out of 7 regions are specialized (LQ > 1) while other clusters *Upstream Chemical Products* (3/7), *Agricultural Inputs and Services* (2/7), *Food Processing and Manufacturing* (2/7) and *Environmental Industries* (2/7) report fewer potential synergies between regions. The clusters *Tobacco* (1/7) and *Fishing and Fishing Products* (0/7) have no potential synergies (no LQ > 1).

3.3.1.2. Patent applications

Figure 4 - National specialization in food & feed, 2016



Note: IPC included for the measurement - A01, A22, A23, B09, C05, C07, C08, C12, C13; RTA: revealed technological advantage.

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Table 8 - Patent applications linked to food & feed, 2016

Ranking (pat. appl.)	Country	Number of patent appl.	Perc. of national patent appl.	RTA
1	Germany	1673,2	8,5%	0,90
2	Switzerland	599,6	12,2%	1,30
3	France	584,7	7,8%	0,82
4	Netherlands	497,1	14,5%	1,54
5	United Kingdom	379,7	9,4%	1,00
6	Italy	323,8	8,7%	0,93
7	Belgium	259,8	17,6%	1,87
8	Denmark	175,2	14,2%	1,50
9	Austria	163,7	9,9%	1,05
10	Sweden	141,9	4,7%	0,50
11	Spain	139,9	11,9%	1,26
12	Finland	65,4	4,9%	0,51
13	Poland	40,5	12,7%	1,35
14	Ireland	32,1	6,9%	0,73
15	Portugal	20,3	15,0%	1,59
16	Czech Republic	18,5	10,4%	1,10
17	Luxembourg	17,9	5,5%	0,58
18	Hungary	16,3	21,1%	2,23
19	Slovenia	11,9	14,5%	1,54
20	Greece	6,1	10,5%	1,11
21	Estonia	4,8	13,8%	1,46
22	Lithuania	4,7	19,6%	2,08
23	Croatia	4,3	19,3%	2,05
24	Slovak Republic	3,7	9,3%	0,98
25	Romania	2,5	12,2%	1,29
26	Bulgaria	2,0	8,5%	0,90
27	Malta	0,6	1,4%	0,15
28	Latvia	0,3	2,9%	0,31
29	Cyprus	0,1	0,3%	0,03
	EU28 & CH	5190,6	9,4%	1,00
	Mean	179,0		
	Median	20,3		

Note: IPC included for the measurement - A01, A22, A23, B09, C05, C07, C08, C12, C13; RTA: revealed technological advantage.

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Figure 5 exhibits the national distribution of patent applications among Europe (EU28 & Switzerland) in the IPC classes related to food & feed (cf. Appendix B). The IPC classes included for this topic are:

- A01 – Agriculture, forestry, animal husbandry, hunting, trapping and fishing
- A22 – Butchering, meat treatment, processing poultry or fish
- A23 – Foods or foodstuffs, their treatment
- B09 – Disposal of solid waste, reclamation of contaminated soil
- C05 – Fertilizers, manufacture thereof
- C07 – Organic chemistry
- C08 – Organic macromolecular compounds, their preparation or chemical working-up, compositions based thereon
- C12 – Biochemistry, beer, spirits, wine, vinegar, microbiology, enzymology, mutation or genetic engineering
- C13 – Sugar industry

Table 8 represents the innovative performance of EU countries (and Switzerland) in the IPC classes linked to the food & feed for the year 2016. In addition to the absolute number of patent applications, the table also includes the weight of food & feed-related patent applications and the degree of specialization (RTA) of countries relative to Europe. Countries are ranked by the number of patent applications.

As Figure 5 and Table 8 display, 3 (Switzerland, Austria, Slovenia) out of the 5 countries - taking part in the project - show an innovative strength in the food and feed (RTA > 1). Germany is the European country applying for the greater number of legal protections with a result of 1673 patents. Nevertheless, the country has a low specialization (RTA < 1) since the food & feed IPCs-related only account for 8.5% of its overall patent applications. On the other hand, Switzerland, Austria and Slovenia display potential opportunities in this area since their RTA is superior to one. A more detailed analysis, broken down by individual IPCs is available in the Appendix C.

3.3.2. Qualitative analysis

Table 9 - Strategies and institutions in food & feed, 2020

Regions	National and regional strategies/ policy instruments	Institutions for Collaboration	
		Research center(s), universities, foundation(s)	Cluster(s), collaboration(s), association(s)
Upper Austria	- Regional: Food | Nutrition - Sustainable production and marketing of high-quality food to meet various individual's needs (thanks to innovation, latest technology and security)	- University of Applied Sciences Upper Austria (FH OÖ) – Program in food technology and nutrition	- Food Cluster - Collaboration between Food Cluster & FFoQSI (Austrian competence center for food and feed safety, security and innovation)
Salzburg	- Regional: Life Sciences: pharmaceuticals, biotech and medical technology	- University of Salzburg, Centre for Gastrosophy; - University of Salzburg, Ecology and Evolution - Transferzentrum für Extracellular Vesicles Theralytic Technologies (EV-TT) - Institut for Ecomedicine at Paracelsus Medical University Salzburg	- Three-monthly experience round table in cooperation with Upper Austria's Food Cluster (FFoQSI) - FoodNet

		- Austrian competence center for food and feed safety, security and innovation (FFoQSI) - Nutrient Academy Salzburg - State of Salzburg's University Clinics (SALK)	
Espace Mittelland	- Regional: Promotion of entrepreneurship, support for start-ups, promotion of entrepreneurship, development of regional clusters, transfer of knowledge and technology and inter-firm research collaborations	- University of Applied Sciences and Arts Western, Fribourg	- Food & Nutrition Cluster - Collaboration with Plastic Innovation Competence Center (PICC)
Baden-Württemberg	- *National*: Sustainable agricultural production - *National*: Develop the agriculture & fishery	- University of Hohenheim, Department of Natural Sciences - Fraunhofer-Gesellschaft, research institute	- Food.net:z – Lebensmittelnetzwerk Rhein-Neckar e.V. - BioLAGO e.V. - BioRegio Freiburg / BioValley Plattform Deutschland - BIOPRO Baden-Württemberg GmbH
Bavaria	- National: Sustainable agricultural production - Regional: Funding programme **BioRegio2020** (double organic farming from 2012 to 2020) and successor BioRegio 2030 // Sonderprogramm Landwirtschaft (BaySL) // Sonderprogramm Landwirtschaft Digital (BaySL Digital)	- Ludwig-Maximilians University (LMU) - Technical University of Munich (TUM) - University of Applied Science Wiehenstephan/Triesdorf (HSWT)	- Cluster Nutrition - Compentence Center Nutrition (Kompetenzzentrum Ernährung KErn) - Cluster Biotechnology - Cluster MedTech

	- EU: agricultural European Innovation Partnership (EIP-AGRI)		
Lombardy	- Regional: Agro-food - Sustainable and competitive agro-food supply chain (e.g. systems of advanced production, micro and nano electronics) - Regional: Development of new solutions for healthy ageing through food, supplements and nutraceuticals		- Lombardy High-Tech Agrofood Cluster (CAT.AL) - Lombardy Green Chemistry Association - Lombardy Life Science Cluster - Collaboration between Chemistry and Agrofood: alternative feedstock from chemistry (S3CHEM)
Slovenia	- S4 - Slovenian Smart Specialization Strategy, Strategic priority 4 (“smart use of resources”). - SRIP Sustainable Food Production Strategy. - Resolution on strategic directions for the development of Slovenian agriculture and food until 2020 - " Zagotovimo.si food for tomorrow" - Resolution on the National Program on Strategic Directions for the Development of Slovenian Agriculture and Food "Our Food, Rural and Natural Resources from 2021"	- The University of Ljubljana (17 actively involved faculties) - The University of Maribor (5 actively involved faculties) - The University of Primorska (1 actively involved faculty) - Jozef Stefan Institute - National Institute of Biology - National Institute of Chemistry - Agricultural Institute of Slovenia - Consortium of Biotechnical schools of Slovenia, Scientific Research Centre Bistra Ptuj, NUTRIS, Scientific Research Centre Koper and Slovenian	- SRIP Sustainable Food Production, Action pillar 1: Ingredients and sustainable use of resources. - Chamber of Commerce and Industry of Slovenia - Chamber of Agricultural and Food Enterprises (over 200 agricultural and food enterprises) - Chamber of Agriculture and Forestry of Slovenia (over 1.400 agricultural holdings) - Cooperative Association of Slovenia (64 cooperatives)

		Institute of Hop Research and Brewing, IOS.	

Source: authors' elaboration based on documentation from project partners (cf. Bibliography – PP documentation).

Table 9 displays national and regional strategies but also relevant regional institutional entities and associations. The national and regional programs and IFC displayed in the table were listed from regional reports and documentation provided by PP and from a common SharePoint platform where PPs could add relevant documentation regarding their regional strengths.

All regions taking part in the ARDIA-Net project display strong policies and institutions for the food and feed-related industries. Indeed, all regions have policies/strategies promoting the food and more generally the nutrition. In addition, from an entrepreneurial standpoint, all regions involve clusters and institutional entities food & feed related.

Nevertheless, regional strategies and policies can be somewhat split into two camps. On one hand, regions like Salzburg, Espace Mittelland, Baden-Württemberg, Bavaria, Lombardy and Slovenia focus on a more sustainable production's process. On the other hand, regions such as Upper Austria and Lombardy concentrate in the output, with healthy and natural pharmaceutical products. From a broad viewpoint, all regions aim at promoting a more sustainable process of food production in order to decrease the pollution and waste but also to increase the quality of the products and ingredients.

As stated previously, from an institutional perspective, all regions possess at least one cluster dedicated to the food and nutrition. Holding a cluster from a sector suggests a relevant specialization of the region in the industry. Indeed, regions from Alpine Space benefit from vast natural territories with an essential part of it dedicated to the agriculture. Notwithstanding, when it comes to the industries collaborating with food and feed sector regions differentiate themselves. States like Salzburg, Baden-Württemberg, Bavaria and Lombardy use the food and feed industry as a utilitarian sector for their research and production in the chemistry and pharmaceuticals area with products such as cosmetics, supplements, household products, etc. Additionally, Upper Austria, Espace Mittelland and Lombardy exploit the food and feed industry with purposes in developing new materials more sustainable and environmentally friendly (e.g. green packaging). To summarize, all regions have potential collaborations in the food and feed area with some additional specificities.

3.4. Smart building

3.4.1. Quantitative analysis

3.4.1.1. Employment

Table 10 - Regional distribution of employment in clusters related to the smart building, 2011

Country	Regions	Construction Products and Services	Education and Knowledge Creation	Forestry	Furniture	Wood Products	Environmental Industries
Austria		**24 002**	**63 359**	**8 769**	**24 002**	**29 034**	**135 323**
	Upper Austria	6 220	6 074	667	7 798	6 179	29 829
	Salzburg	1 413	3 414	670	1 573	2 928	9 596
Germany		**153 880**	**551 263**	**17 836**	**110 684**	**108 569**	**2 064 042**
	Baden-Württemberg	16 246	71 250	2 038	18 877	18 520	343 209
	Bavaria	27 531	72 456	3 590	19 252	24 687	345 412
Italy		**308 608**	**102 935**	**15 790**	**303 496**	**237 838**	**2 162 339**
	Lombardy	67 539	23 438	1 326	58 678	46 191	589 708
Slovenia		**23 535**	**53 052**	**4 749**	**20 985**	**24 267**	**198 926**
Switzerland		**16 446**	**105 956**	**5 479**	**11 843**	**40 889**	**193 339**
	Espace Mittelland	3 055	14 621	1 388	2 169	10 013	33 912
Total*		**526 471**	**876 565**	**52 623**	**471 010**	**440 596**	**4 753 969**

Note: Total* equals the sum of countries' employment numbers.

Source: authors' elaboration based on data from The European Cluster Observatory (2020).

Table 11 - Regional specialization (LQ) of employment in clusters related to the smart building, 2011

Country	Regions	Construction Products and Services	Education and Knowledge Creation	Forestry	Furniture	Wood Products	Environmental Industries
Austria		**0,80**	**1,27**	**2,93**	**0,90**	**1,16**	**0,50**
	Upper Austria	1,18	0,69	1,27	1,65	1,40	0,63
	Salzburg	0,71	1,03	3,37	0,88	1,76	0,53
Germany		**0,54**	**1,16**	**0,62**	**0,43**	**0,45**	**0,80**
	Baden-Württemberg	0,41	1,09	0,52	0,54	0,56	0,97
	Bavaria	0,58	0,92	0,76	0,46	0,63	0,81
Italy		**1,85**	**0,37**	**0,95**	**2,03**	**1,70**	**1,43**
	Lombardy	2,19	0,46	0,43	2,13	1,79	2,12
Slovenia		**3,40**	**4,61**	**6,87**	**3,39**	**4,19**	**3,18**
Switzerland		**0,46**	**1,77**	**1,52**	**0,37**	**1,36**	**0,59**
	Espace Mittelland	0,39	1,11	1,75	0,31	1,51	0,47
Total		**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**

Note: LQ > 1 are highlighted in green (only for regions and Slovenia).

Source: authors' elaboration based on data from The European Cluster Observatory (2020).

From the 19 clusters linked to the bioeconomy, (cf. Employment), six clusters potentially reflect capacities relevant for smart building valorization. Clusters identified for this topic cover the wood industry (*Forestry; Furniture, Wood Products),* related value chains *(Construction Products and Services)* and common clusters

for the bioeconomy (*Education and Knowledge Creation* and *Environmental Industries)* (exhaustive list of NACE activities available for each cluster in Appendix D).

Table 10 lists the national and regional employment's distribution for clusters linked to the smart building. Table 11 exhibits the regional and national specialization rate (LQ) in relation to the aggregate employment of the 5 Alpine space's countries.

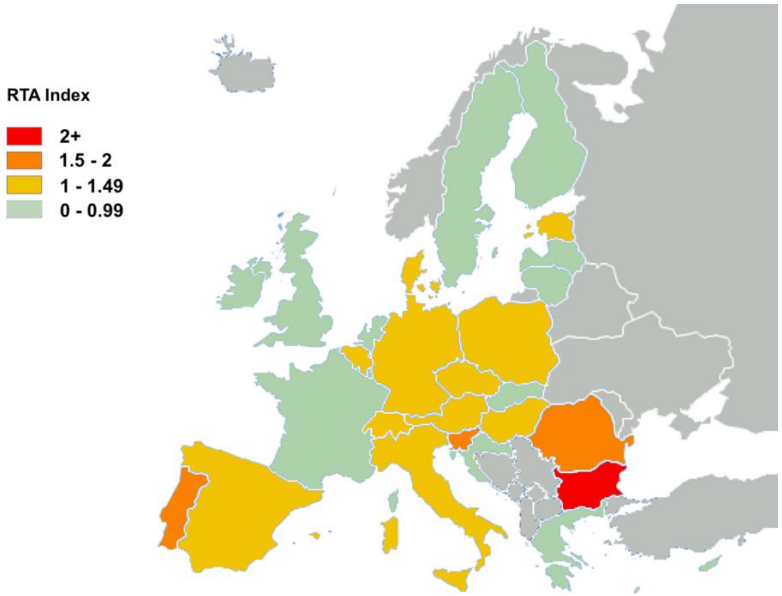
With respect to absolute employment numbers (cf. Table 10), the cluster *Environmental Industries* is the most significant. Then, comes the cluster *Education and Knowledge Creation*, followed by the clusters *Construction Products and Services, Furniture, Wood Products* and finally *Forestry.*

In terms of specialization patterns, Slovenia (6/6) displays a concentration of employment in all building-related clusters. In second place comes Upper Austria with a concentration in 4 clusters. The regions of Salzburg, Lombardy and Espace Mittelland entails 3 specialized clusters out of 6 clusters. Finally, German regions Baden-Württemberg (1) and Bavaria (0) bring up the rear of the ranking with 1 and 0 specialized cluster.

The cluster *Wood Products* involves 5 regions out of 7 while other clusters - *Education and Knowledge Creation* (4/7), *Forestry* (4/7), *Construction Products and Services* (3/7), *Furniture* (2/7) and *Environmental Industries* (2/7) - report fewer potential synergies between regions.

3.4.1.2. Patent applications

Figure 5 - National specialization in the smart building, 2016



Note: IPC included for the measurement - A01, A47, B27, B28, B29, C01, C02, C04, C21, E03, E04, E05, F24, H02; RTA: revealed technological advantage.

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Table 12 - Patent applications linked to the smart building, 2016

Ranking (pat. appl.)	Country	Number of patent appl.	Perc. of national patent appl.	RTA
1	Germany	3114,3	15,8%	1,14
2	France	841,0	11,2%	0,80
3	Italy	711,7	19,2%	1,38
4	Switzerland	683,3	13,9%	1,00
5	United Kingdom	397,1	9,9%	0,71
6	Netherlands	386,4	11,3%	0,81
7	Sweden	272,5	9,1%	0,65
8	Austria	258,8	15,7%	1,13
9	Belgium	244,3	16,6%	1,19
10	Denmark	180,6	14,6%	1,05
11	Spain	177,1	15,0%	1,08
12	Finland	129,4	9,6%	0,69
13	Poland	54,9	17,2%	1,24
14	Luxembourg	35,2	10,8%	0,78
15	Ireland	33,3	7,2%	0,51
16	Portugal	33,2	24,6%	1,77
17	Czech Republic	25,3	14,2%	1,02
18	Slovenia	20,7	25,2%	1,81
19	Hungary	15,4	19,9%	1,43
20	Bulgaria	8,3	35,1%	2,52
21	Estonia	6,9	19,6%	1,41
22	Greece	5,8	9,8%	0,71
23	Romania	5,1	24,9%	1,79
24	Slovak Republic	3,8	9,7%	0,70
25	Cyprus	3,6	10,0%	0,72
26	Malta	2,3	5,6%	0,41
27	Lithuania	1,1	4,8%	0,34
28	Latvia	1,0	8,7%	0,63
29	Croatia	0,0	0,0%	0,00
	EU28 & CH	7652,3	13,9%	1,00
	Mean	263,9		
	Median	33,3		

Note: IPC included for the measurement - A01, A47, B27, B28, B29, C01, C02, C04, C21, E03, E04, E05, F24, H02; RTA: revealed technological advantage.

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Figure 5 exhibits the national distribution of patent applications among Europe (EU28 & Switzerland) in the IPC classes related to smart building (cf. Appendix B). The IPC classes included for this topic are:

- A01 – Agriculture, forestry, animal husbandry, hunting, trapping and fishing
- A47 – Furniture, domestic articles or appliances, coffee mills, spice mills, suction cleaners in general
- B27 – Working or preserving wood or similar material, nailing or stapling machines
- B28 – Working cement, clay, or stone
- B29 – Working of plastics, working of substances in a plastic state
- C01 – Inorganic chemistry
- C02 – Treatment of water, wastewater, sewage or sludge
- C04 – Cements, concrete, artificial stone, ceramics, refractories
- C21 – Metallurgy of iron
- E03 – Water supply, sewerage
- E04 – Building
- E05 – Locks, keys, window or door fittings, safes
- F24 – Heating, ranges, ventilating
- H02 – Generation, conversion or distribution of electric power

Table 12 represents the innovative performance of EU countries (and Switzerland) in the IPC classes linked to the smart building for the year 2016. In addition to the absolute number of patent applications, the table also covers the weight of smart building-related applications relative to the overall national patent applications and the rate of specialization (RTA) of the country relative to Europe. Countries are ranked by the number of patent applications.

As the illustration and table expose, all 5 countries present strong concentrations in the smart building's sector. With more than 3'114.3 patent applications filled in 2016, Germany accounts for more than 40% of all Europe Union countries (EU28 & CH - 7653.2 patent appl.) which expose its considerable strength in the European region. Furthermore, Italy and Slovenia are the countries from the Alpine Space with the greatest percentage of patent applications filled in this industry relative to their total (19.2% and 25.2% respectively). As the map exhibits, this sector exposes potential collaborative opportunities between PP for the future. It must be considered that these results only display a national evaluation and regional specializations can diverge considerably from these scores. A more detailed analysis, broken down by individual IPCs is available in the Appendix C.

3.4.2. Qualitative analysis

Table 13 - Strategies and institutions in the smart building, 2020

Regions	National and regional strategies/ policy instruments	Institutions for Collaboration	
		Research center(s), universities, foundation(s)	Cluster(s), collaboration(s), association(s)
Upper Austria	- Regional: Energy – Energy-efficient buildings and building technology (sensors, control and instrumentation technology, innovative energy storage)	- University of Applied Sciences, Upper Austria (FH OÖ), Centre for smart manufacturing - Johannes-Kepler-Universität, Linz, New program for energy and building sciences	- Furniture and Timber Construction Cluster - Plastic Cluster
Salzburg	- Regional: Intelligent specialization: Intelligent construction and settlement systems - Regional: Smart materials: Development of new biomaterials (e.g. light construction), smart building, smart materials - Regional: Intelligent building and settlement systems: Wood-based construction	- Wood Technology Centre (Holztechnikum) - University of Applied Sciences, Salzburg (Kuchl Campus) – Forest Products Technology & Biogenic Technology, - University of Applied Sciences, Smart Buildings in Smart Cities, Smart Building - Center for Smart Materials, Salzburg	- Netzwerk Alpines Bauen (Network Alpine Construction)

		- Center for Alpine Construction - Competence Center Construction Research - Civil engineering test and research institute SalzburgRSA-ISpace - SIR (Salzburg Institute for Regional Planning and Housing)	
Espace Mittelland	- Regional: Promotion of entrepreneurship, support for start-ups, promotion of entrepreneurship, development of regional clusters, transfer of knowledge and technology and inter-firm research collaborations	- University of Applied Sciences, Fribourg - Institute of Construction and Environmental Technologies (iTEC) & Institute of Architecture: Heritage, Construction and Users (TRANSFORM) & Institute for Applied Research into Energy Systems (ENERGY) - Smart Living Lab (SLL) - Plastic Innovation Competence Center (PICC)	- Energy & Construction Cluster - swiss plastics cluster
Baden-Württemberg	- Regional: Environmental technologies, renewable energies and resource efficiency - Building technologies and energy efficiency in home	- University of Applied Sciences Albstadt-Sigmaringen,	- Cluster Initiative Forestry and Wood Baden-Württemberg - Cluster Umwelttechnologie - Cluster Green City Freiburg - proHolz BW GmbH

			- Innovations- und Effizienzcluster “innoEFF” der Klimapartner Oberrhein
Bavaria	- Regional: ICT – Smart construction	- Digital Planning and Building/ Smart Cities and Regions (cross-entities synergy) (Thematic platform)	- Cluster Forestry and Timber - Cluster New Materials - BIM (Building Information Management) cluster
Lombardy	- Regional: Green Industry – Energy efficiency in buildings; intelligent buildings - Regional: Program in Smart Living - (building, wood home furnishings)		- Cluster in Technologies for the Living Environment - Smart Cities and Communities - Collaboration in Smart living; Infrastructure, networks and intelligent buildings
Slovenia	- S4 - Slovenian Smart Specialization Strategy, priority area Healthy living and working	- Slovenian Forestry Institute - Institute "Jožef Stefan" - University of Maribor - The Faculty of Civil Engineering, Transportation Engineering and Architecture, The Faculty of Electrical Engineering and Computer Science, The Faculty of Mechanical Engineering - University of Primorska – Faculty of design - University of Ljubljana - Faculty of civil and geodetic engineering	- SRIP Smart buildings and homes, including wood chain. - Wood Industry Cluster. - Construction Cluster of Slovenia. - GZS ZLPI – CCI Association of wood and furniture industry.

		- Slovenian National Building and Civil Engineering Institute (ZAG) - CoE Innorenew	

Source: authors' elaboration based on documentation from project partners (cf. Bibliography – PP documentation).

Table 13 displays national and regional strategies but also relevant regional institutional entities and associations related to smart building. The national and regional programs and IFC displayed in the table were listed from regional reports provided by PP and from a common SharePoint platform where PPs could add relevant documentation regarding their regional strengths.

All regions present strong incentives and policies advocating for intelligent homes (e.g. energy efficiency). Indeed, edifices represent a significant area to improve in regard to their materials but also to the energy consumed. As regional specializations and IFC exhibit, the “smartness” of a building can be divided into three distinctive domains: the use of wood expertise for buildings and living homes, the use of new materials and homes’ energy efficiency. The regions of Salzburg, Espace Mittelland, Bavaria and Slovenia hold potential collaborations in the domain of smart materials. This specialization is partially confirmed thanks to regional smart materials center or clusters dedicated to the plastics industry. On complementarity, regions such as Upper Austria, Espace Mittelland, Baden-Württemberg, Lombardy and Slovenia have local strategies advertising for more sustainable and reduced-energy buildings. With the research and development in the biomass, the energy consumption in buildings can also have potential cross-sectorial collaborations for regions trying to concentrate in the smart building sector. Finally, thanks to their environment and long heritage, regions like Upper Austria, Salzburg, Espace Mittelland, Baden-Württemberg, Bavaria, Lombardy and Slovenia center their attention also into the wood-based buildings and living rooms. Indeed, all regions cited previously present strong IFC in the area of wood.

3.5. Plastics

3.5.1. Quantitative analysis

3.5.1.1. Employment

Table 14 - Regional distribution of employment in clusters related to plastics, 2011

Country	Regions	Education and Knowledge Creation	Plastics	Upstream Chemical Products	Advanced Packaging	Environmental Industries
Austria		**63 359**	**32 156**	**3 554**	**82 521**	**135 323**
	Upper Austria	6 074	13 292	1 664	22 797	29 829
	Salzburg	3 414	2 093	61	5 030	9 596
Germany		**551 263**	**331 898**	**101 708**	**1 094 391**	**2 064 042**
	Baden-Württemberg	71 250	52 811	7 173	234 880	343 209
	Bavaria	72 456	69 156	15 539	232 621	345 412
Italy		**102 935**	**386 425**	**56 669**	**1 563 134**	**2 162 339**
	Lombardy	23 438	129 502	20 327	457 060	589 708
Slovenia		**53 052**	**30 470**	**4 902**	**123 044**	**198 926**
Switzerland		**105 956**	**31 064**	**6 548**	**65 346**	**193 339**
	Espace Mittelland	14 621	5 442	358	16 160	33 912
Total*		**876 565**	**812 013**	**173 382**	**2 928 436**	**4 753 969**

Note: Total* equals the sum of countries' employment numbers.

Source: authors' elaboration based on data from The European Cluster Observatory (2020).

Table 15 - Regional specialization (LQ) of employment in clusters related to plastics, 2011

Country	Regions	Education and Knowledge Creation	Plastics	Upstream Chemical Products	Advanced Packaging	Environmental Industries
Austria		**1,27**	**0,70**	**0,36**	**0,50**	**0,50**
	Upper Austria	0,69	1,63	0,96	0,78	0,63
	Salzburg	1,03	0,68	0,09	0,45	0,53
Germany		**1,16**	**0,75**	**1,08**	**0,69**	**0,80**
	Baden-Württemberg	1,09	0,87	0,56	1,08	0,97
	Bavaria	0,92	0,95	1,00	0,89	0,81
Italy		**0,37**	**1,50**	**1,03**	**1,68**	**1,43**
	Lombardy	0,46	2,73	2,00	2,67	2,12
Slovenia		**4,61**	**2,86**	**2,15**	**3,20**	**3,18**
Switzerland		**1,77**	**0,56**	**0,55**	**0,33**	**0,59**
	Espace Mittelland	1,11	0,44	0,14	0,37	0,47
Total		**1,00**	**1,00**	**1,00**	**1,00**	**1,00**

Note: LQ > 1 are highlighted in green (only for regions and Slovenia).

Source: authors' elaboration based on data from The European Cluster Observatory (2020).

From the 19 clusters linked to the bioeconomy, (cf. Employment), five clusters potentially reflect capacities relevant for plastics valorization. Indeed, the plastics thematic entails a cluster related to *Plastics* and subsequent value chains and industries *(Upstream Chemical Products; Advanced Packaging (Emerging Industries))* in addition to common clusters for all topics (*Education and Knowledge Creation* and *Environmental Industries)* (exhaustive list of NACE activities available for each cluster in Appendix D).

Table 14 exhibits the national and regional employment's distribution for clusters linked to plastics. Table 15 lists the regional and national specialization rate (LQ).

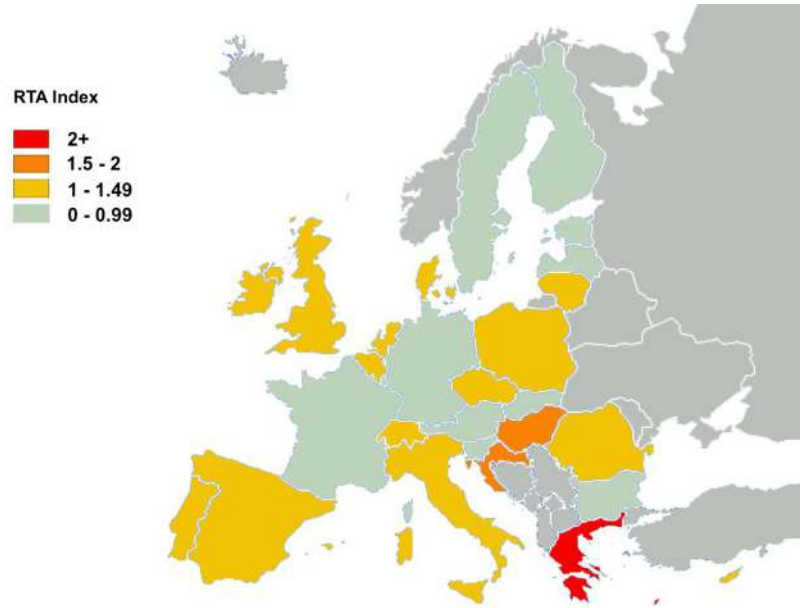
With respect to absolute employment numbers (cf. Table 14), the cluster *Environmental Industries* is the most significant, followed by the cluster *Advanced Packaging* (2'928'436 employees). *Education and Knowledge Creation* (876'565 employees), *Plastics* (812'013 employees) and finally *Upstream Chemical Products* (173'382 employees) bring up the rear of the rankings.

In terms of specialization patterns (cf. Table 15), Slovenia (5/5) displays a concentration of employment in all plastics-related clusters. On second place comes Lombardy with 4 specializations. Baden-Württemberg is concentrated in two clusters. Ending the rankings, Upper Austria, Salzburg, Bavaria and Espace Mittelland entail 1 specialized cluster out of 5 clusters.

The cluster *Education and Knowledge Creation* involves 4 out of 7 regions while remaining clusters - *Plastics* (3/7), *Upstream Chemical Products* (3/7), *Advanced Packaging* (3/7) and *Environmental Industries* (2/7) - report fewer potential synergies between regions.

3.5.1.2. Patent applications

Figure 6 - National specialization in plastics, patent applications, 2016



Note: IPC included for the measurement - A61, B29, B65, C01, C07, C08, E03; RTA: revealed technological advantage.

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Table 16 - Patent applications linked to plastics, 2016

Ranking (pat. appl.)	Country	Number of patent appl.	Perc. of national patent appl.	RTA
1	Germany	3392,5	17,3%	0,87
2	Switzerland	1363,1	27,8%	1,41
3	France	1263,1	16,8%	0,85
4	United Kingdom	946,1	23,5%	1,19
5	Italy	894,7	24,1%	1,22
6	Netherlands	887,3	26,0%	1,32
7	Sweden	317,6	10,6%	0,54
8	Belgium	315,5	21,4%	1,08
9	Spain	309,1	26,2%	1,33
10	Austria	301,2	18,3%	0,92
11	Denmark	252,1	20,4%	1,03
12	Finland	144,5	10,7%	0,54
13	Ireland	129,7	27,9%	1,41
14	Poland	80,5	25,3%	1,28
15	Luxembourg	58,0	17,8%	0,90
16	Czech Republic	52,1	29,3%	1,48
17	Portugal	31,6	23,4%	1,19
18	Hungary	25,5	33,0%	1,67
19	Greece	23,0	39,5%	2,00
20	Malta	13,9	33,5%	1,70
21	Slovenia	13,6	16,5%	0,84
22	Croatia	7,6	34,6%	1,75
23	Cyprus	7,5	21,0%	1,06
24	Lithuania	6,6	27,5%	1,39
25	Estonia	5,8	16,5%	0,84
26	Slovak Republic	5,1	12,9%	0,65
27	Romania	5,0	24,6%	1,24
28	Bulgaria	3,5	14,9%	0,75
29	Latvia	2,0	17,4%	0,88
	EU28 & CH	10857,9	19,7%	1,00
	Mean	374,4		
	Median	58,0		

Note: IPC included for the measurement - A61, B29, B65, C01, C07, C08, E03; RTA: revealed technological advantage.

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Figure 6 exhibits the national distribution of patent applications among Europe and Switzerland in the IPC classes related to plastics (cf. Appendix B). The IPC classes included for this topic are:

- A61 – Medical or veterinary science, hygiene
- B29 – Working of plastics, working of substances in a plastic state
- B65 – Conveying, packing, storing, handling thin or filamentary material
- C01 – Inorganic chemistry
- C07 – Organic chemistry
- C08 – Organic macromolecular compounds, their preparation or chemical working-up, compositions based thereon
- E03 – Water supply, sewerage

Table 16 represents the innovative performance of EU countries (and Switzerland) in the IPC classes linked to plastic for the year 2016. In addition to the absolute number of patent applications, the table also includes the weight of plastics-related applications relative to the overall national patent applications and the rate of specialization (RTA) of the country relative to Europe. Countries are ranked by the number of patent applications.

From an RTA perspective, only the countries of Switzerland and Italy have developed a specialization in the plastics industry. Austria, Germany and Slovenia scored RTA below 1 which shows a national under-concentration in this sector. Slovenia obtained the lowest result of ARDIA-Net countries with a result of 0.84. In relation to the number of patent applications, Germany is the country with most of the patent applications in the covered fields, with over 3392.5 patent applications in 2016, followed by Switzerland (1363.1 patent applications). In relation to the percentage of national patent applications, Switzerland achieved the highest percentage of PPs (27.8%) followed by Italy (24.1%). It must be considered that these results only display a national evaluation, regional specializations can diverge considerably from these scores. A more detailed analysis, broken down by individual IPCs is available in the Appendix C.

3.5.2. Qualitative analysis

Table 17 - Strategies and institutions in plastics, 2020

Regions	National and regional strategies/ policy instruments	Institutions for Collaboration	
		Research center(s), universities, foundation(s)	Cluster(s), collaboration(s), association(s)
Upper Austria	- Regional (policy instrument): Materials in the food industry	- Transfercenter für Kunststofftechnologie (TCKT) (application-oriented research and development regarding plastics engineering and technology)	- Plastics Cluster - Food Cluster - Medical Technology Cluster - A2LT Lightweight Technology Platform (joint initiative of Automotive Cluster, Mechatronics Cluster, Plastics Cluster)
Salzburg	- Regional: Intelligent specialization: Smart materials	- University of Salzburg – Department of Materials Science and Mineralogy (research in nanoparticles) - Center for Smart Materials, Salzburg	
Espace Mittelland	- Regional: Promotion of entrepreneurship, support for start-ups, promotion of entrepreneurship, development of regional clusters,	- University of Applied Sciences, Fribourg – Institute of Applied Plastics Research (iRAP) &	- swiss plastics cluster

	transfer of knowledge and technology and inter-firm research collaborations	Institute of Chemical Technology (ChemTech) - University of Fribourg - Swiss Federal Institute of Technology, Lausanne (EPFL) - Plastic Innovation Competence Center (PICC)	
Baden-Württemberg	- *Regional*: Biotechnology, resource efficiency, new materials & surface technology	- University of Stuttgart, Institut für Kunststofftechnik - Ulm University	- Cluster in biopolymers (including packaging) - INNONET Kunststoff - Packaging Valley e.V.
Bavaria		- Plastics Campus Bavaria	- Cluster New materials (additive manufacturing, lightweight construction and multi-material design & resource efficiency and sustainability) - Cluster Chemistry - Cluster Nanotechnology
Lombardy	- Regional: Circular economy: plastic and bio-based materials	- University of Milan - Innovhub	- Lombardy Green Chemistry Association - Collaboration between Chemistry and Plastic: new materials (S3CHEM)
Slovenia	- National: S4 - Slovenian Smart Specialization Strategy, Strategic priority 4 (“smart use of resources”). - Programme Potential of biomass for development of advanced materials and bio-based products. The	- Pulp and Paper Institute, Ljubljana - National Institute of Chemistry Slovenia, Ljubljana - University of Maribor, Faculty of Mechanical Engineering	- SRIP Networks towards Circular Economy Focus Area Functional materials - CEL.CYCLE consortium - Cluster Plasttehnika

	programme is placed within priority area S4 - The natural and traditional resources for the future, Networks for the transition to the circular economy.	- University of Ljubljana, Faculty of Mechanical Engineering - University of Ljubljana, Biotechnical Faculty - University of Ljubljana, Faculty of Natural Sciences and Engineering - "Jožef Stefan" Institute, Ljubljana - Slovenian National Building and Civil Engineering Institute, Ljubljana - Faculty of Polymer Technology, Slovenj Gradec	- Poly4EmI

Source: authors' elaboration based on documentation from project partners (cf. Bibliography – PP documentation).

Table 17 displays national and regional strategies but also relevant institutional entities and associations for each region in the plastics sector. The national and regional programs and IFC displayed in the table were listed from regional reports provided by PP and from a common SharePoint platform where PPs could add relevant documentation regarding their regional strengths.

The plastics industry covers a large range of products. Consequently, its purpose can vary from new materials for the building industry, lightweight plastics improving the performance of an automobile to flexible medical devices improving the surgeries. Upper Austria, Baden-Württemberg and Bavaria are known for their expertise in the automobile industry. Therefore, their concentration tends to be more focused in this area. On the contrary, Slovenia and Espace Mittelland tend to be more centered on local strengths such as building or food.

3.6. Pharmaceuticals

3.6.1. Quantitative analysis

3.6.1.1. Employment

Table 18 - Regional distribution of employment in clusters related to pharmaceuticals, 2011

Country	Regions	Agricultural Inputs and Services	Biopharmaceuticals (New Cluster)	Downstream Chemical Products	Education and Knowledge Creation	Tobacco	Upstream Chemical Products	Biopharmaceuticals (Emerging Industries)	Environmental Industries
Austria		**3 480**	**11 375**	**7 759**	**63 359**	**1 055**	**3 554**	**39 982**	**135 323**
	Upper Austria	1 374	1 360	1 944	6 074	-	1 664	4 885	29 829
	Salzburg	182	105	645	3 414	-	61	1 664	9 596
Germany		**27 322**	**103 609**	**127 603**	**551 263**	**589**	**101 708**	**501 049**	**2 064 042**
	Baden-Württemberg	1 596	29 244	17 191	71 250	-	7 173	86 111	343 209
	Bavaria	2 467	13 949	15 016	72 456	-	15 539	68 267	345 412
Italy		**60 473**	**160 358**	**164 361**	**102 935**	**1 151**	**56 669**	**673 996**	**2 162 339**
	Lombardy	7 131	62 220	68 866	23 438	-	20 327	242 742	589 708
Slovenia		**722**	**16 338**	**13 338**	**53 052**	**-**	**4 902**	**69 944**	**198 926**
Switzerland		**2 066**	**38 324**	**23 063**	**105 956**	**2 508**	**6 548**	**96 126**	**193 339**
	Espace Mittelland	855	3 234	2 130	14 621	1 796	358	10 665	33 912
Total*		**94 062**	**330 004**	**336 125**	**876 565**	**5 302**	**173 382**	**1 381 097**	**4 753 969**

Note: Total* equals the sum of countries' employment numbers.

Source: authors' elaboration based on data from The European Cluster Observatory (2020).

Table 19 - Regional specialization (LQ) of employment in clusters related to pharmaceuticals, 2011

Country	Regions	Agricultural Inputs and Services	Biopharmaceuticals (New Cluster)	Downstream Chemical Products	Education and Knowledge Creation	Tobacco	Upstream Chemical Products	Biopharmaceuticals (Emerging Industries)	Environmental Industries
Austria		**0,65**	**0,61**	**0,41**	**1,27**	**3,50**	**0,36**	**0,51**	**0,50**
	Upper Austria	1,46	0,41	0,58	0,69	0,00	0,96	0,35	0,63
	Salzburg	0,51	0,08	0,51	1,03	0,00	0,09	0,32	0,53
Germany		**0,53**	**0,58**	**0,70**	**1,16**	**0,20**	**1,08**	**0,67**	**0,80**
	Baden-Württemberg	0,23	1,19	0,69	1,09	0,00	0,56	0,84	0,97
	Bavaria	0,29	0,47	0,50	0,92	0,00	1,00	0,55	0,81
Italy		**2,03**	**1,53**	**1,54**	**0,37**	**0,68**	**1,03**	**1,54**	**1,43**
	Lombardy	1,30	3,22	3,50	0,46	0,00	2,00	3,00	2,12
Slovenia		**0,58**	**3,77**	**3,02**	**4,61**	**0,00**	**2,15**	**3,85**	**3,18**
Switzerland		**0,32**	**1,70**	**1,00**	**1,77**	**6,92**	**0,55**	**1,02**	**0,59**
	Espace Mittelland	0,60	0,65	0,42	1,11	22,49	0,14	0,51	0,47
Total		**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**	**1,00**

Note: LQ > 1 are highlighted in green (only for regions and Slovenia).

Source: authors' elaboration based on data from The European Cluster Observatory (2020).

From the 19 clusters linked to the bioeconomy, (cf. Employment), eight clusters potentially reflect capacities relevant for pharmaceuticals valorization. Clusters included in this thematic cover the agriculture *(Tobacco)*, chemical goods and processes *(Downstream Chemical Products; Upstream Chemical Products)* and biologic medical products *(Biopharmaceuticals (New Cluster); Biopharmaceuticals (Emerging Industries))* (exhaustive list of NACE activities available for each cluster in Appendix D).

Table 18 exhibits the national and regional employment distribution for clusters linked to pharmaceuticals. Table 19 lists the regional and national specialization rate (LQ).

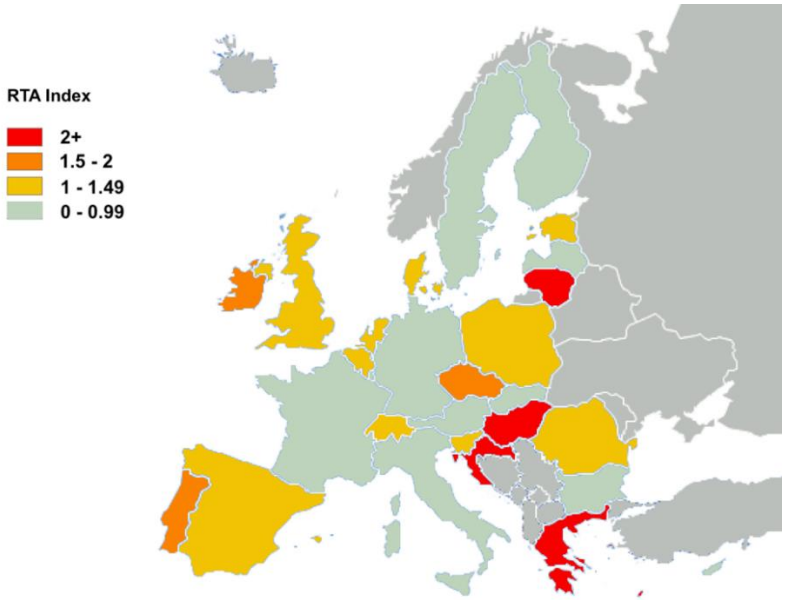
With respect to the absolute employment numbers (cf. Table 18), the cluster *Environmental Industries* (4'753'969 employees) is the most significant, followed by the cluster *Biopharmaceuticals (Emerging Industries))* (1'381'097 employees)*, Education and Knowledge Creation* (876'565 empl.), *Downstream Chemical Products* (336'125 empl.), *Biopharmaceuticals (New Cluster)* (330'004 empl.), *Upstream Chemical Products* (173'382 empl.), *Agricultural Inputs and Services* (94'062 empl.) and finally *Tobacco* (5'302 empl.).

In terms of specialization patterns, Lombardy and Slovenia are specialized in 6 out of 8 pharmaceuticals-related clusters. Baden-Württemberg and Espace Mittelland have a LQ superior to one in two clusters and Upper Austria, Salzburg and Bavaria close the ranking with one cluster.

The cluster *Education and knowledge Creation* involves 4 out of 7 regions. Next, the clusters *Biopharmaceuticals (New Cluster)* and *Upstream Chemical Products* contain 3 regions. The clusters *Agricultural Inputs and Services, Downstream Chemical Products, Biopharmaceuticals (Emerging Industries)* and *Environmental Industries* encompass 2 regions. Finally, the cluster *Tobacco* has Espace Mittelland has its unique specialized region.

3.6.1.2. Patent applications

Figure 7 - National specialization in pharmaceuticals, patent applications, 2016



Note: IPC included for the measurement – A01, A23, A61, B82, C01, C05, C07, C08, C11, C12; RTA: revealed technological advantage.

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Table 20 - Patent applications linked to pharmaceuticals, 2016

Ranking (pat. appl.)	Country	Number of patent appl.	Perc. of national patent appl.	RTA
1	Germany	3204,3	16,3%	0,82
2	Switzerland	1361,3	27,8%	1,39
3	France	1262,6	16,8%	0,84
4	United Kingdom	1048,7	26,1%	1,31
5	Netherlands	1003,0	29,4%	1,47
6	Italy	706,6	19,1%	0,96
7	Belgium	430,3	29,2%	1,46
8	Denmark	351,8	28,4%	1,43
9	Sweden	337,5	11,2%	0,56
10	Spain	317,5	26,9%	1,35
11	Austria	274,7	16,6%	0,83
12	Finland	152,6	11,3%	0,57
13	Ireland	140,7	30,2%	1,52
14	Poland	90,6	28,4%	1,42
15	Luxembourg	54,6	16,8%	0,84
16	Czech Republic	53,7	30,2%	1,51
17	Portugal	41,1	30,4%	1,52
18	Hungary	34,6	44,7%	2,24
19	Greece	23,4	40,1%	2,01
20	Slovenia	20,6	25,0%	1,25
21	Malta	13,8	33,2%	1,66
22	Lithuania	9,6	40,2%	2,01
23	Croatia	9,3	42,4%	2,13
24	Estonia	8,8	25,1%	1,26
25	Cyprus	6,2	17,5%	0,88
26	Slovak Republic	5,6	14,1%	0,71
27	Romania	4,5	22,0%	1,10
28	Bulgaria	3,0	12,8%	0,64
29	Latvia	1,0	8,7%	0,44
	EU28 & CH	10971,9	19,9%	1,00
	Mean	378,3		
	Median	54,6		

Note: IPC included for the measurement – A01, A23, A61, B82, C01, C05, C07, C08, C11, C12; RTA: revealed technological advantage.

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Figure 7 exhibits the national distribution of patent applications among Europe and Switzerland in the IPC classes related to pharmaceuticals (cf. Appendix B). The IPC classes included for this topic are:

- A01 – Agriculture, forestry, animal husbandry, hunting, trapping and fishing
- A23 – Food or foodstuffs, their treatment
- A61 – Medical or veterinary science, hygiene
- B82 – Nanotechnology
- C01 – Inorganic chemistry
- C05 – Fertilizers, manufacture thereof
- C07 – Organic chemistry
- C08 – Organic macromolecular compounds, their preparation or chemical working-up, compositions based thereon
- C11 – Animal or vegetable oils, fats, fatty substances or waxes, fatty acids therefrom, detergents, candles
- C12 – Biochemistry, beer, spirits, wine, vinegar, microbiology, enzymology, mutation or genetic engineering

Table 20 represents the innovative performance of EU countries (and Switzerland) in the IPC classes linked to pharmaceuticals for the year 2016. In addition to the absolute number of applications, the table also includes the weight of pharmaceuticals relative to the overall national patent applications and the rate of specialization (RTA) of the country relative to Europe. Countries are ranked by the number of patent applications.

As it can be seen in Figure 7, only 2 countries (Switzerland and Slovenia) expose a significant specialization in pharmaceuticals (RTA of 1.39 and 1.25 respectively). On the other hand, Germany, Italy and Austria total RTA below the “EU 28 & Switzerland” result. A more detailed analysis, broken down by individual IPCs is available in the Appendix C.

3.6.2. Qualitative analysis

Table 21 - Strategies and institutions in pharmaceuticals, 2020

Regions	National and regional strategies/ policy instruments	Institutions for Collaboration	
		Research center(s), universities, foundation(s)	Cluster(s), collaboration(s), association(s)
Upper Austria	- Regional: Health | Ageing Society - individualized medicine (personalised diagnostics, prevention, therapy) - Regional: Systems and technologies for people	- RTI initiatives and funding programs in the health area (e.g. OÖ Forschungsförderung)	- Medical Technology Cluster - Collaboration between Plastics and CleanTech cluster in the area of medical waste
Salzburg	- Regional: Life Sciences - pharmaceuticals, biotech and medical technology (personalised medicine)	- University of Salzburg (PLUS) – Natural Sciences Faculty - Paracelsus Private Medical University (PMU) - State of Salzburg's University Clinics (SALK) - University of Applied Sciences, Salzburg - GMP-Laboratory (Good Manufacturing Practice) in the Centre for Cross-Sectional and Tissue Regeneration Salzburg	- Regional area of cross-regional cooperation: Regenerative biology, personalized medicine

		- Center for Extracellular Vesicles Theralytic Technologies (EV-TT) - Biomed Center Salzburg - Immuno-oncological drug validation - Cancer Cluster Salzburg	
Espace Mittelland	- Regional: Promotion of entrepreneurship, support for start-ups, promotion of entrepreneurship, development of regional clusters, transfer of knowledge and technology and inter-firm research collaborations	- University of Applied Sciences, Fribourg – Institute of Chemical Technology (ChemTech) - Important firms in pharma (Vifor Pharma and UCB Pharma)	- Food & Nutrition cluster
Baden-Württemberg	- *Regional*: Strategy priority #3: Health care	- Karlsruher Institut für Technologie - University of Tübingen - Universität Ulm - Research institutes (Max Planck Institutes, German Cancer Research Center, Fraunhofer Institutes)	- Cluster Medizintechnologie - CyberForum e.V. - Medi_NETZ im Wvib Wirtschaftsverband Industrieller Unternehmen Baden e.V. - microTEC Südwest e.V. - Biopharma Cluster South Germany
Bavaria	- *Regional*: Life Science - Medical engineering and personalized medicine // Bavarian Pharma Summit (Bayerischer Pharma Gipfel) of the Ministry of Economics and resulting strategies for pharma industry in Bavaria	- Ludwig-Maximilians University (LMU) - Technical University of Munich (TUM) - Private institutions: Helmholtz Association and the Max Planck and Fraunhofer Societies	- Cluster Biotechnology - Cluster Chemistry - Cluster Nanotechnology - Cluster MedTech

Lombardy	- National: Biotech drugs (vaccines, monoclonal antibodies, recombinant proteins, cell/gene therapy, regenerative medicine); pharmaceutical active ingredients - Regional: Health industry - Innovative therapeutic policies, biotechnologies, micro-nano electronics, advanced materials and photonics	- FIIRV – Fondazione Istituto Insubrico Ricerca per la Vita - Biomedical Research Regional Foundation (personalized medicine)	- Lombardy Green Chemistry Association - Lombardy Life Science Cluster - Consorzio Italbiotec - Collaboration in Smart healthcare (SCC6)
Slovenia	- *National:* S4 - Slovenian Smart Specialization Strategy, priority area Industry 4.0	- Jozef Stefan Institute - National Institute of Chemistry - National Institute of Biology - Various Faculties (Universities of Ljubljana, Maribor and Nova Gorica) - University of Ljubljana, Faculty of Pharmacy - National Institute of Chemistry, Ljubljana - Slovenian Institute of Hop Research and Brewing - Slovenian Innovation Hub	- SRIP Health – Medicine: area Herbal medicine and natural cosmetics (herbal medicine, dietary supplements, natural cosmetics)

Source: authors' elaboration based on documentation from project partners (cf. Bibliography – PP documentation).

Table 21 displays national and regional strategies but also relevant institutional entities and associations for each region in pharmaceuticals. The national and regional programs and IFC displayed in the table were listed from regional reports provided by PPs and from a common SharePoint platform where PPs could add relevant documentation regarding their regional strengths.

Alpine Space regions exhibit strategies and policy instruments moving towards a more personalized and natural medicine but also an increase usage of nano- and micro-materials when it comes to medical devices. Indeed, since human have different needs and reactions against medication, pharmaceutical firms and institutions have moved towards an individualization of their products but also more natural and sustainable-oriented products. As an example, research institutions from Upper Austria, Salzburg and Bavaria are essentially focusing in developing personalized medicine. In addition to it, regions like Upper Austria, Salzburg, Baden-Württemberg, Bavaria and Lombardy are also developing new medical materials thanks to their expertise in the plastic industry and nano- and micro-components.

4. Potential cross-regional synergies

4.1. Methodology

After having determined regional opportunities and existing capacities for the bioeconomy-related topics, the aim of this chapter will be to summarize the results from the previous chapters and to point towards potential cross-regional synergies. For each topic, a table will summarize the most important results presented in the previous subchapters (employment and patent application data, strategies and institutions for each region). Particular strengths will be highlighted using the classification system presented below:

For "Employment" and "Patent applications" stars will be allocated (✻, ✻✻ or ✻✻✻) to the regions depending on their LQ ("Employment") and RTA ("Patent applications") in the fields related to the topic in question. For "Employment", ✻✻✻ represent a strong regional specialization in the clusters related to the topic (LQ>1 in 70% or more of the covered clusters). Two symbols (✻✻) will attest a promising regional specialization in the field (LQ>1 in 50-70% of the total number of clusters). ✻ will correspond to regions with an LQ>1 in less than 50% of the covered clusters, but still specialized in at least one cluster, while regions with an LQ>1 for none of the covered clusters will be marked by a yellow square.

For the patent applications[4], ✻✻✻ will be awarded to regions from countries with an RTA superior to 2 in the topic, ✻✻ to regions from countries with an RTA between 1.5 and 2, ✻ to regions from countries scoring an RTA between 1 and 1.49 and a yellow square to regions from countries with no national specialization (RTA<1).

The columns "Strategy" and "IFC" will report regional strengths based on a binary option (✓ or ✕) depending on the quantity and quality of the reported regional strategies and institutions.

The tables will be complemented by a graphic comprising thematic foci within each topic, encountered in the quantitative and qualitative analysis. This will illustrate dynamics identified within each of the 5 topics. Finally, testimonials and comments from PP will conclude the report with a regional perspective on each topic.

[4] While employment data is available at regional levels, patent application results are provided at national level (no regional data publicly available).

4.2. Biomass

4.2.1. Results

As stated in subchapter 2.1.1, biomass is a major component of the bioeconomy. It can be used as renewable energy and sourced from different organic resources such as wood, agricultural crops, food, animal manure and various waste streams (wood, food, human sewage). It also forms the basis for multiple bio-based applications and products. Biomass heavily relies on forestry, agriculture and fishery industries.

Table 22 - Regional strengths in biomass

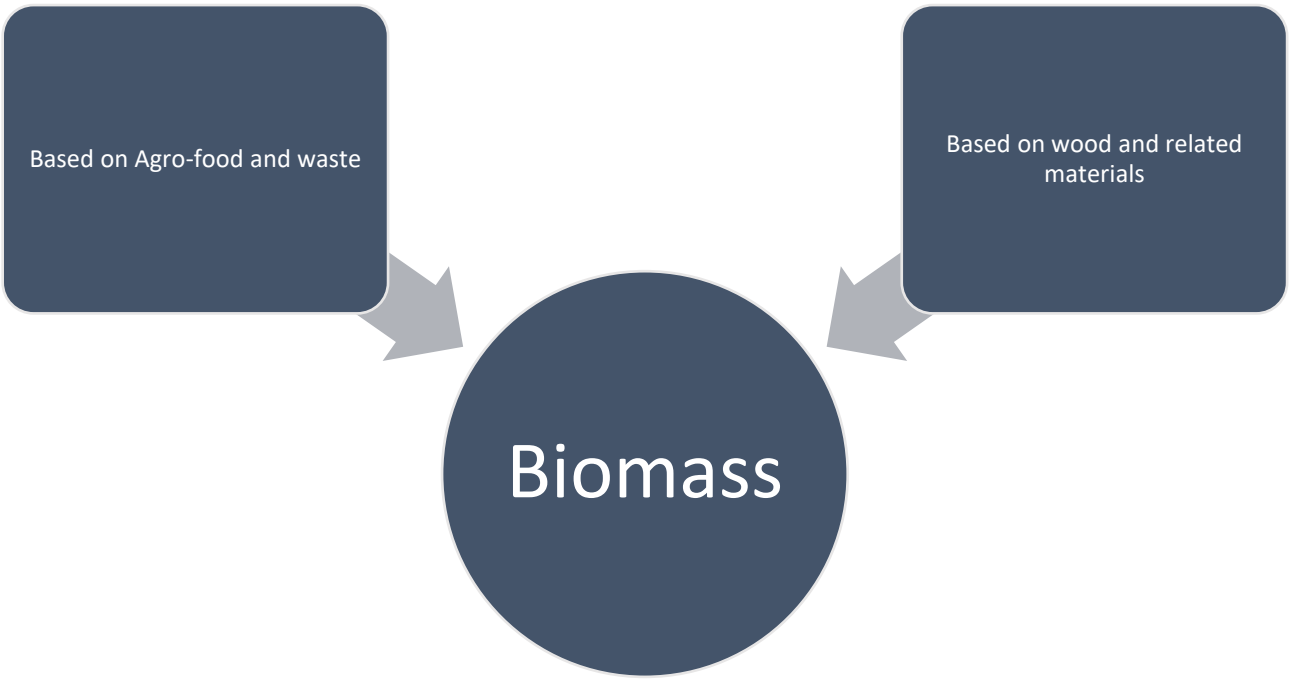
	Quantitative analysis		Qualitative analysis	
Regions	Employment	Patent applications	Strategy	IFC
Upper Austria	✻		✓	✓
Salzburg	✻		✓	✓
Baden-Württemberg	✻	✻	✓	✓
Bavaria		✻	✓	✓
Lombardy	✻✻	✻	✓	✓
Slovenia	✻✻✻	✻✻✻	✓	✓
Espace Mittelland	✻✻	✻	✓	✓

Note: IFC: institutions for collaboration; Employment$_{(2011)}$: ✻✻✻ = LQ > 1 in 70%+ of the related clusters, ✻✻ = LQ > 1 in the second tier (50%-69%) of related clusters, ✻ = LQ >1 in at least one related cluster, but in less than 49%, yellow square = no related cluster with LQ>1; Patent applications$_{(2016)}$: ✻✻✻ = RTA superior to 2 at national level, ✻✻ = RTA between 1.5 and 2 at national level, ✻ = RTA between 1 and 1.49 at national level , and yellow square = RTA below 1 (no specialization).

Source: authors' elaboration based on data from The European Cluster Observatory (2020) for "Employment", based on data from OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020 for "Patent applications" and based on documentation provided by PP.

Table 22 shows the overall results of the previous quantitative and qualitative evaluations. In general, strong existing capacities and opportunities are confirmed for all regions in the biomass topic. Indeed, regional strategies consistently address biomass and relevant institutions are present in all regions. Also, the ARDIA-Net regions can count on a pool of specialized workforce (employment numbers) in multiple clusters related to biomass and specialization in patent applications in related fields is rather strong. The Alpine Space provides dense natural forests and expertise in wood as biomass source. In addition, agri-food and waste materials are also important sources for biomass among the covered regions (cf. Figure 8).

Figure 8 – Potential cross-regional collaborations in biomass



Source: authors' elaboration based on documentation provided by project partners.

4.2.2. Regional perspectives

For the biomass availability the forestry sector in particular plays a major role in Baden-Württemberg region. Strengths of the forestry landscape are high-tech applications for forestry and the well-connected industry in general. Chances of the forestry sector are sustainable economy, side streams usage as separate business model and new applications of wooden biomass in construction. For pulp and paper, general economic upswing enhances the industry. Bio-based refineries are not implemented in Baden-Württemberg on an industrial scale but there are efforts to obtain renewable raw materials from waste.

Baden-Württemberg

In the frame of Bavaria's energy transition towards the use of renewable energies, actually biomass is the most important renewable energy source, which includes solid and liquid biogenic substances, biogas, sewage sludge and biogenic waste[5]. Beside a very rich research-oriented biomass-infrastructure, almost all regions of Bavaria count on biomass and biogas plants, wood power plants, and biomass cogeneration installations[6].

[5] Sachverständigenrats Bioökonomie Bayern (2020).

[6] Energie-Atlas Bayern (2020).

The focus is on heat and electricity production, but also biofuel production out of agricultural residues plays an important role.

By 2025 it is expected, that biomass as an energy source contributes around 16% to gross electricity generation[7].

Bavaria

The conversion of residual biomasses into bioenergy and fertilizers is a well-consolidated reality in Lombardy; in fact, the region can rely on the presence of 300 agricultural biogas plants. Lombardy region is responsible for the production of about 0,84 Mt/year of agricultural-livestock waste which includes waste from agricultural activity (corn, wheat, fruit, vegetables, rice, pomace) and livestock waste as animal manure and milking wastes, which could represent potential biomasses for the creation of high added-value products. Furthermore, Lombardy has the highest production of waste deriving from the food industry (0,56 Mt/year) and of organic fraction of municipal solid waste (0,27 Mt/year). In Lombardy, the wood industry is particularly flourishing including the Brianza furniture district, the Casalasco Viadanese wood district and the Alta Lombardia Wood consortium. The last one gathers together 17 sawmills in Valtellina, producing 13% of the wood processed in Italy.

Lombardy

Land Salzburg´s main asset is the regional availability of wood as a biogenic resource and material, that can be used in many scientific fields and industrial applications. Technologies to developed innovative surface materials for industries and to improve human machine interaction are the main research focus in Salzburg. The biogenic material wood is seen as a potential to advance improvements in the building and construction industry, using life cycle approaches that contribute to reduce waste and adapt to climate change in the long run.

Land Salzburg has numerous academic institutions with strong competencies in the creation of innovative and sustainable materials e.g. the University of Salzburg, with its competence center of smart materials and the center of human-machine interaction, which can offer industry-oriented research facilities. The University of Applied Sciences Salzburg has a strong focus on wood as a material and biogenic technologies, practicing research in the fields of biomaterials, modelling, and simulation together with local SMEs.

Salzburg

[7] StMWi (2020).

The potential exploitation of wood biomass is high in Slovenia, due to abundance of land covered with forests (58,4 % or 1,184,526 hectares of forests). Potential of wood biomass in Slovenia are in scope of 450.000 tons of wood per year from forests. In long term we can count with 1m^3 of wood biomass per ha of forest. Biomass in Slovenia refers to ligno-cellulosic biomass, other organic raw materials (whey, algae) or raw materials containing a substance of organic origin (paper sludge). The focus field Biomass and alternative raw materials is centered on the sustainable mobilization of biomass, ligno-cellulose, bio-refineries for the isolation of polymer biomass building block, extracts and bio-refineries that produce alternative raw materials for the developments of innovative bio-based products. Slovenia has good opportunities in for wood-based biomass for fueling energy sector, paper and pulp sector and civil engineering sector (eco- or bio-based material production and construction).

Slovenia

Upper Austria is in a good position to become a biomass utilization pioneer, due to the available biogenic resources, chemical and technical businesses as well as its industry-related research facilities. The Cleantech Cluster especially supports research and innovation projects which are carried out in close cooperation due to the complexity of biorefineries, chemical processes and economic businesses. E.g. Lenzing Group shows that economically profitable biorefineries exist and manufactures a large number of products from the sustainably produced raw material wood (pulp, paper, cellulose fibres, etc.). Upper Austria has diversified academic institutions which are able to make a valuable contribution to the topic with their know how in the fields of eco-energy, logistics, design, food technology, informatics, plastics technology, chemistry and especially in interdisciplinary cooperation. Material and energetic use of biomass and residual flows, energy from organic secondary raw materials, renewable energy technologies etc. are focal points in Upper Austria.

Upper Austria

4.3. Food & feed

4.3.1. Results

The food and livestock industry plays a major role in the national and regional landscape covered in ARDIA-Net, both as a source for biomass (see previous chapter) and as a bioeconomy topic on its own.

Table 23 - Regional strengths in food & feed

	Quantitative analysis		Qualitative analysis	
Regions	Employment	Patent applications	Strategy	IFC
Upper Austria	✻	✻	✓	✓
Salzburg	✻	✻	✓	✓
Baden-Württemberg	✻		✓	✓
Bavaria	✻		✓	✓
Lombardy	✻✻		✓	✓
Slovenia	✻✻	✻✻	✓	✓
Espace Mittelland	✻	✻	✓	✓

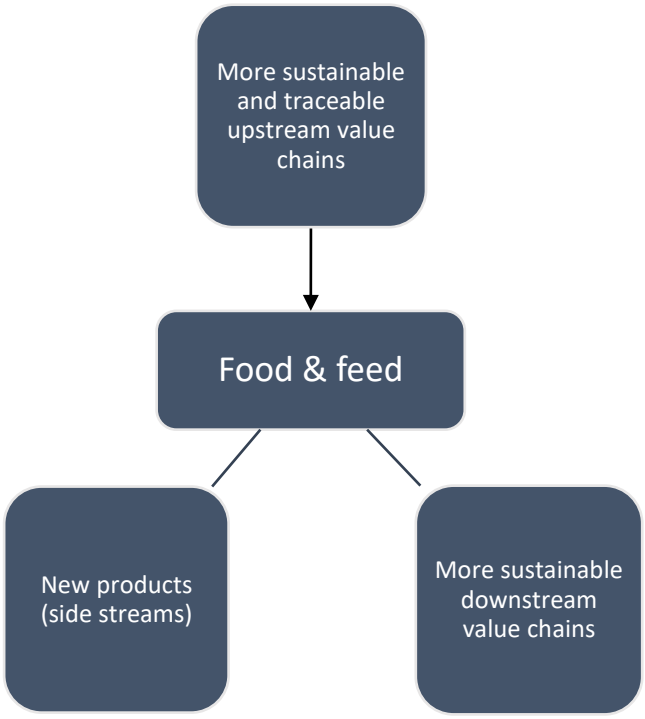
Note: IFC: institutions for collaboration; Employment$_{(2011)}$: ✻✻✻ = LQ > 1 in 70%+ of the related clusters, ✻✻ = LQ > 1 in the second tier (50%-69%) of related clusters, ✻ = LQ >1 in at least one related cluster, but in less than 49%, yellow square = no related cluster with LQ>1; Patent applications$_{(2016)}$: ✻✻✻ = RTA superior to 2 at national level, ✻✻ = RTA between 1.5 and 2 at national level, ✻ = RTA between 1 and 1.49 at national level , and yellow square = RTA below 1 (no specialization).

Source: authors' elaboration based on data from The European Cluster Observatory (2020) for "Employment", based on data from OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020 for "Patent applications" and based on personal researches and documentation provided by PP.

Table 23 shows a broad summary of quantitative and qualitative results provided along the previous chapters (cf. Capacities and opportunities in the topics identified for cross-regional cooperation). From a general point of view, food and feed is a crucial topic within the bioeconomy for all covered regions with a particular specialization in Austria, Slovenia and Switzerland, both in terms of employment and patent application data. With respect to regional policies and institutions, important clusters are distributed across the covered regions and more sustainable and environmental-friendly processes in food and feed production are a priority in all regions. Additionally, cross-sectoral links with other industries, e.g. pharmaceuticals (nutrition) and chemical products, are pointing towards important development opportunities, specifically addressed in the strategic orientations of regions like Salzburg, Baden-Württemberg, Bavaria and Lombardy. On the other

hand, food and feed industries also provide side-streams for the development of new bio-based value chains, such as the development of more sustainable and environmental-friendly materials (e.g. packaging), as reflected in strategies from Upper Austria, Espace Mittelland and Lombardy. Three major dynamics around the food & feed topic can be drawn from the documentation provided by PP (cf. Figure 9): first, regions focus on improving the sustainability of their upstream value chain with improvements in processes like the traceability and the quality of food from suppliers in the food industry. Second, downstream value chains, mainly within food and feed distribution and marketing, are also subject to sustainability improvements. Finally, some regions focus on the link between the food industry and the development of other bio-based products (broader nutrition applications, medical products, cosmetics, household products, etc.) or rely on side streams from the food and feed industry for the development of new bio-based value chains (e.g. green packaging).

Figure 9 - Potential cross-regional collaborations in food & feed



Source: authors' elaboration based on documentation provided by project partners.

4.2.2. Regional perspectives

In general, in Baden-Württemberg region food production takes priority of land use. As the managed surface area remained relatively constant for more than 30 years, the potential for enlarging agricultural production land seems non-existent. However, new technologies and changing crops allowed an increase in arable production (grain, maize, corn-cob mix, rape and beet, potato, sugar beets). These technologies are likely to increase (precision and smart farming). In Baden-Württemberg there are efforts to acquire microalgae for the food and feed sector.

Baden-Württemberg

Bavaria's agriculture and food industry (generated sales of € 46 billion in 2018, 250,000 employees) is characterized by small and often family owned farms (in total 105 297 in 2019) with an average used area of 35 ha (German average is 65 ha). In 2019 approx. 10 500 farms with a used area of over 360 000 ha were performing organic farming[8].

Focus areas for R&D and future opportunities are adaptation strategies to climate change and climate protection, conservation and strengthening of biodiversity, innovative approaches to the use of digital systems and methods or new approaches to diversification and regional value chains. The so called „Bavarian way" (with its strategies BioRegio 2020 and BioRegio 2030) opens up the opportunities in digitization and high-tech applications and solutions in the food and feed industry[9].

Bavaria

The Lombard agri-food production system represents the most important at the Italian level with approximately 70,000 production sites, involving 245,000 workers. The presence of the Lombardy Hi-Tech Agro-food Cluster is the recognition of excellence in the region. The main research priority themes are represented by sustainable and competitive agri-food supply chain, individual well-being (e.g. new solutions for healthy ageing through food, supplements and nutraceuticals), food safety and security. The Lombard food industry opens up huge opportunities for innovation and growth in the Bioeconomy sector, such as obtaining new foods and/or feed for zootechnical purposes, innovative ingredients and/or bioactive compounds for developing health-giving foods with a high nutritional value obtained from by-products generated by the agri-food processing industries.

[8] StMELF – Politik und Strategien (2020).

[9] StMELF (2020).

Lombardy

Alpine agriculture in Salzburg is internationally renowned for its finest milk, cheese, and meat products. The quality of Salzburg´s natural resources holds great potential for the creation of additional value chains in the food industry. For example, the TEH Akademie Salzburg offers knowledge and services of traditional European health medicine, which is defined by UNESCO as an immaterial cultural heritage. At its Centre for Gastrosophy, the University of Salzburg offers an interdisciplinary postgraduate master program, which includes a well-established research network with partners in Germany, Italy, France, and the International Commission for Research into European Food History ICREF.

Salzburg also has a long tradition in beer production, e.g. the companies Stiegl and more recently micronutrients are growing and research institutes such as the Nutrient Academy or the Transfer Center for extracellular vesicles focus on the value of food and micronutrients in order to use them in a medical and life science context.

Salzburg

Due to its specific natural characteristics, Slovenia has less favorable conditions for agricultural production. In Slovenia we have just over 70,000 agricultural holdings; each cultivates an average of 6.8 ha of utilized agricultural area, manages an average of 5.6 ha of forest and reaches an average of 6.0 heads of large livestock. Within crop production, which represents 57% of the value of total agricultural production, crop production predominates, following by the production of fruit, grapes, and wine (a total of about 20%). The volume and structure of crop production is largely related to animal production. In 2015, the structure of livestock farming was dominated by cattle breeding, mainly combined milk and meat production. Presently there are successful small to medium biorefineries, who use produced biofuel for local business activities or sell it to wholesale suppliers. Opportunities are reflected in the exploitation of by-products in food production and processing industry, management of raw materials, strategic supply chain management, optimization of processes in agri-food on the basis of automation, digitalization and robotization, use of advanced technologies in agricultural production, food production, storage and distribution.

Slovenia

Upper Austria is a region with food competence. The Food Cluster – established in Upper Austria - is a network, which covers the entire supply chain in the food industry regional and beyond. This network of companies in

the food industry, which works closely with suppliers, universities, research institutes, educational and public institutions, forms the basis for a competitive edge. Meantime, this food cluster is established as cross-sector interface, as contact point and contact hub of the food industry. There are approximately 240 cluster partners, who reflect the multi-facetted image of the industry.

Opportunities can be seen in technologies for the recovery of food waste, recycling and circular economy, positioning of strategies for the reduction of food waste and development of new value chains (e.g. use of new materials and by-products to gain added value). The main focus is on joint development of strategies and technologies for higher resource efficiency and food safety.

Upper Austria

4.4. Smart building

4.4.1. Results

Like biomass and food & feed, smart building is a strong industry for Alpine Space regions. Most of the regions are characterized by the presence of employment specialization in clusters related to smart building and by positive innovative capacities in the field (patent applications). From all topics studied in this report, smart building appears to be the most broadly covered in all regional strategies. Indeed, thanks to dense natural forests and a strong experience in the area of wood, most of the regions have access to wood value chains, offering great opportunities for collaborative projects around wood material in the building industry.

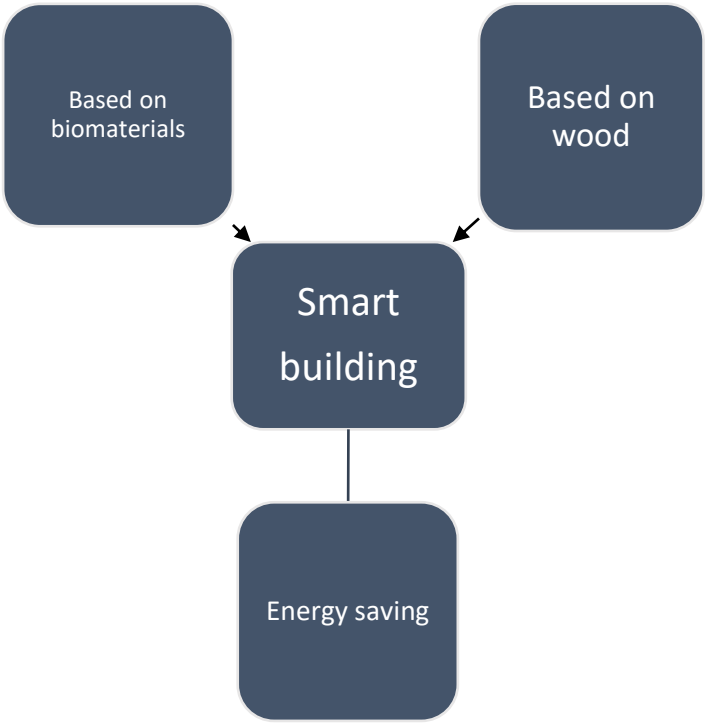
Table 24 - Regional strengths in the smart building

	Quantitative analysis		Qualitative analysis	
Regions	Employment	Patent applications	Strategy	IFC
Upper Austria	✻✻	✻	✓	✓
Salzburg	✻✻	✻	✓	✓
Baden-Württemberg	✻	✻	✓	✓
Bavaria		✻	✓	✓
Lombardy	✻✻	✻	✓	✓
Slovenia	✻✻✻	✻✻	✓	✓
Espace Mittelland	✻✻	✻	✓	✓

Note: IFC: institutions for collaboration; Employment$_{(2011)}$: ✻✻✻ = LQ > 1 in 70%+ of the related clusters, ✻✻ = LQ > 1 in the second tier (50%-69%) of related clusters, ✻ = LQ >1 in at least one related cluster, but in less than 49%, yellow square = no related cluster with LQ>1; Patent applications$_{(2016)}$: ✻✻✻ = RTA superior to 2 at national level, ✻✻ = RTA between 1.5 and 2 at national level, ✻ = RTA between 1 and 1.49 at national level , and yellow square = RTA below 1 (no specialization).

With respect to the qualitative assessment (strategy, policy and IFC), Upper Austria, Salzburg, Baden-Württemberg, Lombardy, Slovenia and Espace Mittelland are stressing the development of new processes to optimize energy use in buildings in their strategic orientations. Thanks to their expertise in the plastics industry, regions like Salzburg, Bavaria, Slovenia and Espace Mittelland are dedicated to creating synergies in the production of new materials and notably in smart home technologies. Figure 10 exhibits the main dynamics for this topic, as encountered in the documentation provided by the PPs.

Figure 10 - Potential cross-regional collaborations in smart building



Source: authors' elaboration based on documentation provided by project partners.

4.4.2. Regional perspectives

Ranking second after Bavaria, Baden-Württemberg disposes of the richest reserves of wood in Germany. More than 75% of the harvested timber remains in the region[10]. Timber construction companies are a major driver of innovative developments. In line with the state´s regional bioeconomy strategy and the reduction of greenhouse gas emissions, the timber construction offensive and its hardwood technical centre (Technikum Laubholz GmbH) have been unveiled. With regard to timber construction, the state has been chosen as business location by numerous internationally operating companies, including market leaders in the field of prefabricated timber construction. Packaging industry (bio-polymers) and the energy sector (bioenergy), among others, are also taking change of the existing reserve of wood.

Baden-Württemberg

The Bavarian State Ministry for Housing, Building and Transport together with the Bavarian State Building Authorities are also focused on smart buildings. Close cooperation with stakeholders from the academia

[10] Clusterportal Baden-Württemberg - Forest and Wood-based Industry (2020).

(universities, universities of applied sciences, RTOs), the industry (companies, SMEs, StartUps) and cluster organsations (ICT, energy, forestry and timber, new materials, BIM) play an integral role[11].

Main opportunities are the implementation of new technologies on a local and regional level, via building automation, Internet of Things (IoT), app and sensor developments, data collection, operation management of buildings, mobile lighting and air-conditioning, energy savings and efficiency, utility supply and the user welfare[12].

Bavaria

Lombardy is the second region in Europe in the construction sector in terms of the total workforce, with 225.570 employees and a total added value of about 10 billion euro. In the S3 of the Lombardy Region, a strategic role for the development of the territory has been recognised within the Smart Cities and Communities, representing one of the possible drivers to stimulate the transformation of traditional and mature industries into Emerging Industries, to encourage the development of Eco-innovation and Social Innovation and also to promote the use and application of enabling industrial technologies such as ICT. Among the transversal themes identified with Smart Cities and Communities, the smart building sector has a high impact on the development of the Lombardy region, mainly focused on energy efficiency.

Lombardy

Since 2012 Salzburg is a smart city. Smart energy, smart buildings, smart mobility, and other improvements for all citizens are ongoing topics that need to be addressed by politicians, researchers and other public stakeholders.

In the energy sector the Center for Secure Energy Informatics at the University of Applied Sciences Salzburg is doing research on smart grid technologies and on privacy and security in intelligent energy systems. There is also a strong research and education focus on Smart Buildings, Smart Building Components and Smart Cities.

Over the last decade, the Centre for Alpine Construction was established in Salzburg, which acts as a platform or hub to network the diverse research in this field. All research institutes and companies in the Salzburg region and the border region of Bavaria are part of an innovative and international network.

[11] Bayerisches Staatsministerium für Wohnen, Bau und Verkehr (2020).

[12] Bayerisches Staatsministerium für Wohnen, Bau und Verkehr – "Smart Cities Smart Regions" (2020).

Research at the university's Human-Machine Interaction Center is conducted with a people centered approach. To enable the construction of integrative buildings is an emerging topic in the region and is also on the agenda of public construction companies in Salzburg.

In order to create a more sustainable and innovative construction field in Austria, the Competence Center for Construction Research, based in Salzburg, is creating national and international projects together with SMEs, research institutes and the many construction guilds.

Salzburg

Wood, which is considered as traditional building material, is thus increasingly becoming the raw material of the future. The current state of Slovenian providers of wood construction (also manufacturing of wooden joinery) shows that they are already at the top of Europe in terms of knowledge, ensuring favorable energy performance of buildings and construction with environmentally friendly materials. Opportunities are in development of new innovative wood composites using classic wood, the use of less commonly used wood species and non-native species already growing in Slovenia. A large part of the development will also be focused on the development of new business models, the development of BIM design, the development of modular systems. The concept of sustainable construction and the concept of smart home complement and intertwine.

Slovenia

Further fields of application regarding wooden building and biogenic insulating material have to be occupied, where originally inorganic construction materials like brick and steal are currently predominant. Thus wood could be increasingly used in growing urban areas, although intensive research will be necessary in the coming decades (e.g. towards multi-storey buildings, environmentally friendly impregnations and flame protection for renewable insulating materials).

Further opportunities lie in the combination of different materials such as the wood-plastic composites or combinations of wood, concrete and metal in furniture (e.g. concrete-wood-metal combination furniture in projects of the furniture and timber construction cluster).

The promotion of resource efficiency at all levels from production (Industry 4.0) to improved recyclability and optimisation of cascade use is necessary.

Upper Austria

4.5. Plastics

4.5.1. Results

The plastics industry is also a topic of crucial importance in the ARDIA-Net regions, even if its strengths are more unevenly distributed than for the previous topics. Bio-based polymers rely on biomass as an input. The industry is closely linked to chemistry value chains. As we will see in the following paragraphs, the applications of biopolymers can be varied (e.g. smart and/or lightweight materials for the construction and transport sectors or for medical devices, sustainable packaging, high-tech industries, medicine, etc.).

Table 25 - Regional strengths in plastics

	Quantitative analysis		Qualitative analysis	
Regions	Employment	Patent applications	Strategy	IFC
Upper Austria	✻		✓	✓
Salzburg	✻		✓	✓
Baden-Württemberg	✻		✓	✓
Bavaria	✻		×	✓
Lombardy	✻✻✻	✻	✓	✓
Slovenia	✻✻✻		✓	✓
Espace Mittelland	✻	✻	✓	✓

Note: IFC: institutions for collaboration; Employment$_{(2011)}$: ✻✻✻ = LQ > 1 in 70%+ of the related clusters, ✻✻ = LQ > 1 in the second tier (50%-69%) of related clusters, ✻ = LQ >1 in at least one related cluster, but in less than 49%, yellow square = no related cluster with LQ>1; Patent applications$_{(2016)}$: ✻✻✻ = RTA superior to 2 at national level, ✻✻ = RTA between 1.5 and 2 at national level, ✻ = RTA between 1 and 1.49 at national level , and yellow square = RTA below 1 (no specialization).

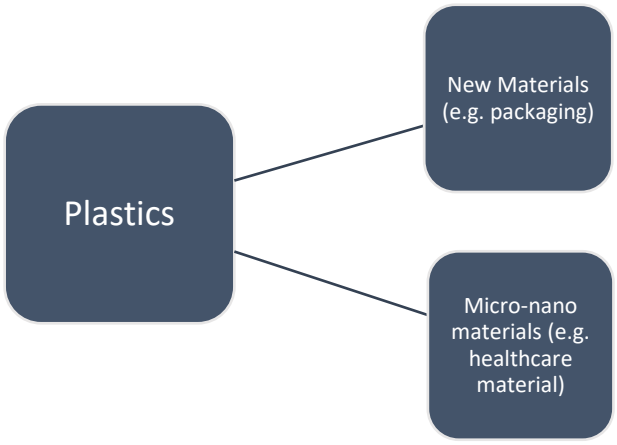
Source: authors' elaboration based on data from The European Cluster Observatory (2020) for "Employment", based on data from OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020 for "Patent applications" and based on documentation provided by project partners.

Table 25 shows the overall evaluation of the previous quantitative and qualitative analysis (cf. 3. Capacities and opportunities in the topics identified for cross-regional cooperation). Particularly strong specialization in employment related to the plastics industry can be found in Slovenia and Lombardy, while for patent applications only Italy and Switzerland are more specialized than the European average (RTA>1).

From a policy, strategy and IFC perspective, most regions are aiming at developing more sustainable plastic products. In this regard, regions are developing and promoting bio-based polymers for different purposes

like high-tech for vehicles (Baden-Württemberg), bio-packaging (Baden-Württemberg, Lombardy, Slovenia, Upper Austria, Espace Mittelland) or nanomaterials for the pharmaceutical industry (Baden-Württemberg, Bavaria, Lombardy, Salzburg, Upper Austria). Furthermore, regions like Upper Austria, Baden-Württemberg and Bavaria are known for their expertise in the automotive industry, with synergy potentials in the field of light-weight materials for vehicles. The regions of Lombardy, Slovenia and Espace Mittelland tend to be more focused on synergies between plastics and other regional strengths, such as smart building and/or food. Figure 11 exhibits the main dynamics for this topic.

Figure 11 - Potential cross-regional collaborations in plastics



Source: authors' elaboration based on documentation provided by project partners.

4.5.2. Regional perspectives

The bioplastic scene in Baden-Württemberg consists of bio-based polymers manufacturers situated at advanced stages of the value chain. Cross-sectoral synergies are already existing with high-tech automotive sectors such as the bio-based applications for distance-sensors, car interiors, engine covers and exhaust manifold. INNONET Kunststoff® represents more than 100 SMEs and companies specialized in manufacturing bio-based polymers. Applications for bio-packaging are supported by clusters like Packaging Valley. Since the local supply of biomass for these applications is falling short, the regional Bioeconomy strategy (2019) aims at the efficient (digital) mobilisation of regional biogenic raw materials based on the availability of residual materials, side streams and biowaste from primary production and processing. Recycling methods specifically for bioplastics will be also addressed through the implementation of this strategy.

Baden-Württemberg

The plastics processing industry in Bavaria is characterized by a high level of innovation and a diverse range of products (plastics into films, packaging, building supplies, technical parts, consumer goods and many other products) and generated sales of EUR 15.2 billion in 2018 with 82,000 employees. Beside this, also Plastic Industry Networks and Clusters in Bavaria (e.g. on chemistry, environment, new materials, MAI Carbon etc.) together with universities and RTOs are focused on respective fields (sorting, separating, recycling etc.)[13][14].

Within the actual bioeconomy strategy-process in Bavaria, also the development of sustainable resource-efficient bio-based products, incl. alternatives to plastic offer new opportunities.

Bavaria

Manufacturing is the most important regional sector, with 62 billion € of value-added generated and a total workforce of 904.762 million people. Considering subsectors, rubber and plastic sector contributes to the value-added for the 6,9%. The plastics sector in Lombardy is characterised by a high rate of investment in R&D, and research on new applications is concentrated in several industrial sectors. The main R&D priorities included in the regional Smart Specialisation Strategy in Lombardy regarding the plastic sector are represented by the eco-design of plastic products, the increase of production of sustainable and biodegradable plastics from residual biomass, the enhancement of the development of innovative technologies for the mechanical recycling of plastic products.

Lombardy

Salzburg university's department of chemistry and physics of materials and the Competence Center of Smart Materials: The ability to engineer matter at different length scales has become a necessity for further advances in the production and development of functional materials. The function and stability of nanomaterials is size-dependent, and very often depend on interfacial processes. The various working groups of the Materials Science and Mineralogy division investigate how these processes can influence the growth and function of synthetic, geo- and biogenic materials. This includes the influence of materials interfaces on their functional properties as well as their impact on the environment. Understanding such complex processes is crucial for the development and sustainable use of materials.

[13] StMWi – Bioökonomiestragie Bayern (2020).

[14] KVI Bayern (2020).

Salzburg

Production of biopolymers in Slovenia is rather scarce and is still a specialty area with a few distinct producers. Specific biomass (e.g. algae, biodegradable textile fibers, paper dust, waste feathers, etc.) is used to produce bio-based plastics, e.g. plastics for which we use as filler biomaterial and a synthetic polymer (polyethylene or polypropylene) or a polymer as a binder from biomass degradation products (e.g. protein waste), but in very small scale. Bio-based plastics is usable for technical packaging purposes as well as for consumer products (e.g. pots in horticulture, tubes). Opportunities are in excellent research and development capabilities in areas such as materials (polymers, textiles, paper, construction materials), advanced surface functionalization technologies and process technologies, analytical methods reflected in their international recognition, top scientific publications, intensive involvement in domestic and foreign research projects.

Slovenia

In Upper Austria, we have the unique circumstance to represent the whole plastics value chain which is networked and supported by the plastics cluster. This leads to extraordinary opportunities to build up a circular plastics economy together with stakeholders from the biomass-industry. Cross-regional collaboration is needed to further develop the bio-economy in the plastics value chain. There are strong partnerships between Upper Austrian companies and companies of regions like Bavaria, Baden-Württemberg, Lombardy or Czech Republic with complementing specializations in the plastics bio-economy. Upper Austria stands for plastics recycling machinery, e.g. the world market leader of mechanical recycling machines - EREMA Group - comes from Upper Austria. Even start-ups emerge in this field. WoodKplus, the competence center for bio based polymers, sets a strong focus on research and development to support the bio-economy in Upper Austria.

Agrana stands for sugar and starch production as well for producing biopolymers. They developed a 100% biodegradable bag made from corn-starch. Opportunities for biopolymer applications can be seen in the agricultural and horticultural sector, for example silage films or biodegradable labels, etc.

Upper Austria

4.6. Pharmaceuticals

4.6.1. Results

With demographic changes and rising life expectancy, human health has become a primary focal point of interest for governments, policy makers, research institutions and firms. Pharmaceuticals in a broad sense play a crucial role in these developments and can form an intersection between trends in the health economy and the bioeconomy. Concerned areas range from phytopharma products and services (based on medicinal and aromatic plants and herbs) to cosmetics or medical packaging materials. The topic is also strongly related to the development of personalized healthcare and a more sustainable and healthier nutrition (food topic).

Table 26 - Regional strengths in pharmaceuticals

	Quantitative analysis		Qualitative analysis	
Regions	Employment	Patent applications	Strategy	IFC
Upper Austria	✻		✓	✓
Salzburg	✻		✓	✓
Baden-Württemberg	✻		✓	✓
Bavaria	✻		✓	✓
Lombardy	✻✻✻		✓	✓
Slovenia	✻✻✻	✻	✓	✓
Espace Mittelland	✻	✻	✓	✓

Note: IFC: institutions for collaboration; Employment$_{(2011)}$: ✻✻✻ = LQ > 1 in 70%+ of the related clusters, ✻✻ = LQ > 1 in the second tier (50%-69%) of related clusters, ✻ = LQ >1 in at least one related cluster, but in less than 49%, yellow square = no related cluster with LQ>1; Patent applications$_{(2016)}$: ✻✻✻ = RTA superior to 2 at national level, ✻✻ = RTA between 1.5 and 2 at national level, ✻ = RTA between 1 and 1.49 at national level , and yellow square = RTA below 1 (no specialization).

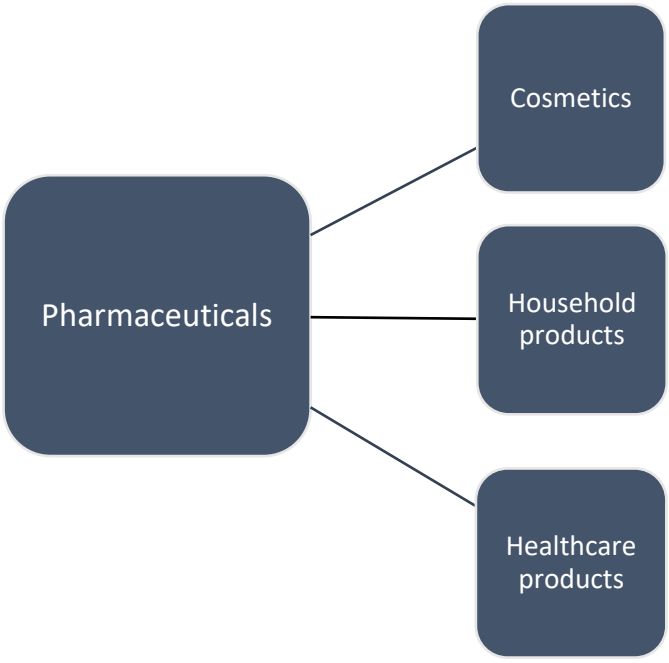
Source: authors' elaboration based on data from The European Cluster Observatory (2020) for "Employment", based on data from OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020 for "Patent applications" and based on documentation provided by project partners.

As Table 26 exhibits, all regions (with a strong emphasis for the regions of Lombardy and Slovenia) have specialized clusters related to the pharmaceutical industry. With respect to patent applications in pharma-related fields, only Slovenia and Switzerland appear to be more specialized than the European average. It needs to be considered (as stated earlier), that patent data is only publicly available for the national levels

and that regional patent specialization patterns could diverge from the results based on national data. In the case of Switzerland for example, it is known that patenting activity in pharma-related fields is strongly concentrated in the Basel area (North-Western Switzerland) and less in the Espace Mittelland region.

With respect to the qualitative analysis, the pharmaceutical industry is well represented in the policies of all covered regions. Institutions for collaboration are available in all regions, with Upper Austria, Salzburg and Bavaria specializing in personalized medicine applications and together with Baden-Württemberg, Lombardy and Slovenia also in the field of new medical materials at the intersection with the plastics industry and nano- and micro-components. Finally, regions like Baden-Württemberg, Espace Mittelland, Lombardy and Slovenia have a long experience in growing and using medical herbs and plants and offer great potential for the development of phytopharmaceutical and plant-based cosmetic value chains.

Figure 12 - Potential cross-regional collaborations in pharmaceuticals



Source: authors' elaboration based on documentation provided by project partners.

4.6.2. Regional perspectives

Over 90 pharmaceutical companies research, develop and/or produce in Baden-Württemberg. Based on the number of employees, it is the number one pharmaceutical location in Germany[15]. The state is very well known for its long history in the field of phytopharmaceuticals as well as homeopathy[16]. The region between the city of Ulm and Lake Constance is known for its vast biotechnological production capacities.

Most of the pharma-relevant start-ups are biotech companies, service providers and contract manufacturers. Strong synergies between biopharma and biotech companies have been set up in the region in recent years.

Baden-Württemberg

Bavaria's pharma industry (generated sales of € 4,5 billion in 2015, 25 000 employees) is focused on production and trade with an ever-growing R&D sector. The industry is focused in a few hotspots in Bavaria, esp. in the metropole regions of Nuremberg and Munich[17].

New trends in the biotech and pharma sector related to bioeconomy are biopharmaceutical production, antibody-based drugs (esp. Roche in Upper Bavaria) but also research on medicinal plants and herbs[18].

Bavaria

Lombardy's chemical and pharmaceutical industry is a vital part of a thriving regional economy as it significantly contributes to the generation and distribution of wealth. It produces an annual turnover of €40.7 billion, more than half of the national total. In terms of value-added, 42% of the national value-added is produced in Lombardy. Bio-based pharmaceuticals, bio-based cosmetics and bio-based chemicals are highly specialised sectors for the development of bioeconomy in Lombardy. In fact, the cosmetic sector in Lombardy is represented by a highly innovative character, committed to valorise biomass for 25% of its raw materials. Furthermore, the biotech sector, together with the pharmaceutical and biomedical ones, represents one of the key sectors for the development of regional bioeconomy. In fact, more than 4.000 companies are present in the regional territory.

Lombardy

[15] Bundesverband der Arzneimittel-Hersteller (2019).

[16] BIOPRO Baden-Württemberg - Gesundheitsindustrie – Zahlen und Fakten für Baden-Württemberg (2020).

[17] Pharmainitiative Bayer – Faktenblatt Die Pharmazeutische Industrie in Bayern (2015).

[18] StMWi (2019).

Salzburg's main asset in pharma for the bioeconomy is the establishment of the SCI-TRECS (SpinalCord Injury and Tissue Regeneration Center Salzburg) - a GMP (Good Manufacturing Practice) laboratory, which has been located at the Salzburg University Hospital since 2011. The laboratory is accredited for the production of MSC therapeutics for clinical trials and holds a GMP license according to §63 AMG. The focus is on the production of cell-based therapeutics and aseptic filling and packaging.

Potentials and opportunities regarding pharma for the bioeconomy lie in other areas like healthy and functional food.

Salzburg also has a focus on medical technology, which deals with the human/machine interface and mechanical engineering. Digital health is becoming a focal point at the PMU and at the Salzburg University Hospital. An up-and-coming start-up scene also offers many potentials and opportunities to work in this field.

Salzburg

In the area of Slovenia, there is a lot of knowledge and infrastructure in the field of natural medicines (phytopharmaceuticals), but they are not meaningfully connected in vertical or horizontal chains, which reduces our competitiveness on a global scale. Slovenia has excellent natural resources, developed research and development capacities and qualified companies to become the leading country in Europe in the field of production of herbal medicines. Slovenia has expertise and the largest producers of plant extracts in Europe. Phytopharmaceutical represents a great challenge and potential for both rural development and the cosmetics industry, as well as the wellness and tourism segment.

Slovenia

Upper Austria has a very strong focus on medical technology. One of S3 (#upperVision2030) focus areas is "systems and technologies for people" that tackles the human/machine interface, medical materials and digital health. Based on the regional strengths the Medical Technology Cluster mainly targets medical engineering, digital health, medical materials.

Potentials and opportunities regarding pharma for the bio-economy can be found in areas healthy and functional food which are focused by the Food Cluster, new materials and hygiene products (absorbent / degradable?) which are dealt with in close cooperation with the Medical Technology and the Plastics Cluster as well as residues of medicines in sewage treatment plants which is an issue tackled by the Cleantech Cluster.

Upper Austria

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Appendices

Appendix A: IPC Table

Section (IPC-0)	Subsection (IPC-1)	Class (IPC-2)	Name (description)
A			**HUMAN NECESSITIES**
	A0		AGRICULTURE
		A01	Agriculture, forestry, animal husbandry, hunting, trapping, fishing
	A2		FOODSTUFFS, TOBACCO
		A21	Baking, equipment for making or processing doughs, doughs for baking
		A22	Butchering, meat treatment, processing poultry or fish
		A23	Foods or foodstuffs, their treatment
		A24	Tobacco, cigars, cigarettes, smokers' requisites
	A4		PERSONAL OR DOMESTIC ARTICLES
		A41	Wearing apparel
		A42	Headwear
		A43	Footwear
		A44	Haberdashery, jewelry
		A45	Hand or travelling articles
		A46	Brushware
		A47	Furniture, domestic articles or appliances, coffee mills, spice mills, suction cleaners in general
	A6		HEALTH, LIFE-SAVING, AMUSEMENT
		A61	Medical or veterinary science, hygiene
		A62	Life-saving, fire-fighting
		A63	Sports, games, amusements
B			**PERFORMING OPERATIONS, TRANSPORTING**
	B0		SEPARATING, MIXING
		B01	Physical or chemical processes or apparatus in general
		B02	Crushing, pulverizing, or disintegrating, preparatory treatment of grain for milling
		B03	Separation of solid materials using liquids or using pneumatic tables or jigs, magnetic or electrostatic

		separation of solid materials from solid materials or fluids, separation by high-voltage electric fields
	B04	Centrifugal apparatus or machines for carrying-out physical or chemical processes
	B05	Spraying or atomizing in general, applying liquids or other fluent materials to surfaces
	B06	Generating or transmitting mechanical vibrations
	B07	Separating solids from solids, sorting
	B08	Cleaning
	B09	Disposal of solid waste, reclamation of contaminated soil
B2-3		SHAPING
	B21	Mechanical metal-working without essentially removing material, punching metal
	B22	Casting, powder metallurgy
	B23	Machine tools, metal-working not otherwise provided for
	B24	Grinding, polishing
	B25	Hand tools, portable power-driven tools, handles for hand implements, workshop equipment, manipulators
	B26	Hand cutting tools, cutting, severing
	B27	Working or preserving wood or similar material, nailing or stapling machines
	B28	Working cement, clay, or stone
	B29	Working of plastics, working of substances in a plastic state
	B30	Presses
	B31	Working paper, making articles or paper, cardboard or material worked in a manner analogous to paper,
	B32	Layered products
	B33	Additive manufacturing technology
B4		PRINTING
	B41	Printing, lining machines, typewriters, stamps
	B42	Bookbinding, albums, files, special printed matter
	B43	Writing or drawing implements, bureau accessories
	B44	Decorative arts
B6		TRANSPORTING
	B60	Vehicles in general

		B61	Railways
		B62	Land vehicles for travelling otherwise than on rails
		B63	Ships or other waterborne vessels, related equipment
		B64	Aircraft, aviation, cosmonautics
		B65	Conveying, packing, storing, handling thin or filamentary material
		B66	Hoisting, lifting, hauling
		B67	Opening or closing bottles, jars or similar containers, liquid handling
		B68	Saddlery, upholstery
	B8		MICROSTRUCTURAL TECHNOLOGY, NANOTECHNOLOGY
		B81	Microstructural technology
		B82	Nanotechnology
C			**CHEMISTRY, METALLURGY**
	C0-1		CHEMISTRY
		C01	Inorganic chemistry
		C02	Treatment of water, waste water, sewage, or sludge
		C03	Glass, mineral or slag wool
		C04	Cements, concrete, artificial stone, ceramics, refractories
		C05	Fertilizers, manufacture thereof
		C06	Explosives, matches
		C07	Organic chemistry
		C08	Organic macromolecular compounds, their preparation or chemical working-up, compositions based thereon
		C09	Dyes, paints, polishes, natural resins, adhesives, compositions not otherwise provided for, applications of materials not otherwise provided for
		C10	Petroleum, gas or coke industries, technical gases containing carbon monoxide, fuels, lubricants, peat
		C11	Animal or vegetable oils, fats, fatty substances or waxes, fatty acids therefrom, detergents, candles
		C12	Biochemistry, beer, spirits, wine, vinegar, microbiology, enzymology, mutation or genetic engineering
		C13	Sugar industry
		C14	Skins, hides, pelts, leather

	C2-3		METALLURGY
		C21	Metallurgy of iron
		C22	Metallurgy, ferrous or non-ferrous alloys, treatment of alloys or non-ferrous metals
		C23	Coating metallic material, coating material with metallic material, chemical surface treatment, diffusion treatment of metallic material, coating by vacuum evaporation, by sputtering, by ion implantation or by chemical vapor deposition, inhibiting corrosion of metallic material or incrustation
		C25	Electrolytic or electrophoretic processes, apparatus therefor
		C30	Crystal growth
	C4		COMBINATORIAL TECHNOLOGY
		C40	Combinatorial technology
D			**TEXTILES, PAPER**
	D0		TEXTILES OR FLEXIBLE MATERIALS
		D01	Natural or man-made threads or fibers, spinning
		D02	Yarns, mechanical finishing of yarns or ropes, warping or beaming
		D03	Weaving
		D04	Braiding, lace-making, knitting, trimmings, non-woven fabrics
		D05	Sewing, embroidering, tufting
		D06	Treatment of textiles or the like, laundering, flexible materials not otherwise provided for
		D07	Ropes, cables other than electric
	D2		PAPER
		D21	Paper-making, production of cellulose
E			**FIXED CONSTRUCTIONS**
	E0		BUILDING
		E01	Construction of roads, railways or bridges
		E02	Hydraulic engineering foundations, soil-shifting
		E03	Water supply, sewerage
		E04	Building

		E05	Locks, keys, window or door fittings, safes
		E06	Doors, windows, shutters, or roller blinds, ladders
	E2		EARTH OR ROCK DRILLING, MINING
		E21	Earth or rock drilling, mining
F			**MECHANICAL ENGINEERING, LIGHTING, HEATING, WEAPONS, BLASTING**
	F0		ENGINES OR PUMPS
		F01	Machines or engines, engine plants, steam engines
		F02	Combustion engines, hot-gas or combustion-product engine plants
		F03	Machines or engines for liquids, wind, spring or weight motors, producing mechanical power or a reactive propulsive thrust, not otherwise provided for
		F04	Positive-displacement machines for liquids, pumps for liquids or elastic fluids
	F1		ENGINEERING IN GENERAL
		F15	Fluid-pressure actuators, hydraulics or pneumatics
		F16	Engineering elements or units, general measures for producing and maintaining effective functioning of machines or installations, thermal insulation
		F17	Storing or distributing gases or liquids
	F2		LIGHTING, HEATING
		F21	Lighting
		F22	Steam generator
		F23	Combustion apparatus, combustion processes
		F24	Heating, ranges, ventilating
		F25	Refrigeration or cooling, combined heating and refrigeration systems, heat pump systems, manufacture or storage of ice, liquefaction or solidification of gases
		F26	Drying
		F27	Furnaces, kilns, ovens, retorts
		F28	Heat exchange
	F4		WEAPONS, BLASTING
		F41	Weapons
		F42	Ammunition, blasting

G			**PHYSICS**
	G0-1		INSTRUMENTS
		G01	Measuring
		G02	Optics
		G03	Photography, cinematography, analogous techniques using waves other than optical waves, electrography, holography
		G04	Horology
		G05	Controlling, regulating
		G06	Computing
		G07	Checking-devices
		G08	Signaling
		G09	Educating, cryptography, display, advertising, seals
		G10	Musical instruments, acoustics
		G11	Information storage
		G12	Instrument details
		G16	Information and communication technology
	G2		NUCLEONICS
		G21	Nuclear physics, nuclear engineering
H			**ELECTRICITY**
	H0		ELECTRICITY
		H01	Basic electric elements
		H02	Generation, conversion or distribution of electric power
		H03	Basic electronic circuitry
		H04	Electric communication technique
		H05	Electric techniques not otherwise provided for

Source: personal elaboration based on WIPO, International Patent Classification Database, version 01.2019.

Appendix B: Complete IPC classes related to the topics identified (based on the EU Taxonomy and personal research)

Biomass		Food & Feed		Smart Building		Plastic		Pharma	
A01	Agriculture, forestry, animal husbandry, hunting, trapping, fishing	A01	Agriculture, forestry, animal husbandry, hunting, trapping, fishing	A01	Agriculture, forestry, animal husbandry, hunting, trapping, fishing	A61	Medical or veterinary science, hygiene	A01	Agriculture, forestry, animal husbandry, hunting, trapping, fishing
A23	Foods or foodstuffs, their treatment	A22	Butchering, meat treatment, processing poultry or fish	A47	Furniture, domestic articles or appliances	B29	Working of plastics, working of substances in a plastic state	A23	Foods or foodstuffs, their treatment
B09	Disposal of solid waste, reclamation of contaminated soil	A23	Foods or foodstuffs, their treatment	B27	Working or preserving wood or similar material, nailing or stapling machines in general	B60	Vehicles in general	A61[Q]	Medical or veterinary science, hygiene [Medical or veterinary science, hygiene (Specific use of cosmetics or similar toilet preparations)]
C02	Treatment of water, wastewater, sewage, or sludge	B09	Disposal of solid waste, reclamation of contaminated soil	B28	Working cement, clay, or stone	B61	Railways	B82	Nanotechnology
C07*	Organic chemistry	C05	Fertilizers, manufacture thereof	B29	Working of plastics, working of substances in a plastic state	B62	Land vehicles for travelling otherwise than on rails	C01	Inorganic chemistry

E03	Water supply, sewerage	C07	Organic chemistry	C01*	Inorganic chemistry	B63	Ships or other waterborne vessels, related equipment	C05	Fertilizers, manufacture thereof
F23	Combustion apparatus, combustion processes	C08	Organic macromolecular chemistry	C02	Treatment of water, wastewater, sewage, or sludge	B65	Conveying, packing, storing, handling thin or filamentary material	C07	Organic chemistry
F24	Heating, ranges, ventilating	C12	Biochemistry, beer, spirits, wine, vinegar, microbiology, enzymology, mutation or genetic engineering	C04	Cements, concrete, artificial stone, ceramics, refractories	C01	Inorganic chemistry	C08	Organic macromolecular chemistry
G06*	Computing	C13	Sugar industry	C21*	Metallurgy of iron	C07	Organic chemistry	C11	Animal or vegetable oils, fats, fatty substances or waxes, fatty acids therefrom, detergents, candles
H02	Electricity	G06*	Computing	E03	Water supply, sewerage	C08	Organic macromolecular chemistry	C12	Biochemistry, beer, spirits, wine, vinegar, microbiology, enzymology, mutation or genetic engineering
				E04	Building	E03	Water supply, sewerage	G06*	Computing

				E05	Locks, keys, window or door fittings, safes	G06*	Computing		
				F24	Heating, ranges, ventilating				
				G06*	Computing				
				H02	Electricity				

Note: * represent a class, which is only partly related to a topic.

Source: authors' elaboration based on Technical Expert Group (2020), *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance*, pp. 56-63

Appendix C: Detailed patent applications for all IPC related to the bioeconomy

Appendix C.1. – Patent applications for IPC related to the section A (Human Necessities), 2016

Countries	A01 Agriculture, forestry, animal husbandry, hunting, trapping, fishing	A22 Butchering, meat treatment, processing poultry or fish	A23 Foods or foodstuffs, their treatment	A47 Furniture, domestic articles or appliances	A61 Medical or veterinary science, hygiene
Austria	29,7	0,0	6,3	30,3	108,1
Germany	442,9	26,8	76,2	413,6	1388,4
Italy	87,1	5,0	53,9	176,0	375,4
Slovenia	4,7	0,0	1,0	2,7	7,6
Switzerland	81,2	2,2	110,2	120,9	730,2
European Union (28 countries)	**1057,4**	**67,3**	**359,9**	**1012,2**	**4686,1**
Mean (EU28)	37,8	2,4	12,9	36,2	167,4

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Appendix C.2. – Patent applications for IPC related to the section B (Performing Operations, Transporting), 2016

Countries	B09 Disposal of solid waste, reclamation of contaminated soil	B27 Working or preserving wood or similar material, nailing or stapling machines in general	B28 Working cement, clay, or stone	B29 Working of plastics, working of substances in a plastic state	B60 Vehicles in general
Austria	0,0	6,5	4,6	43,6	57,4
Germany	1,4	48,2	26,6	457,5	1037,0
Italy	2,8	8,0	14,2	91,1	151,2
Slovenia	0,0	0,0	0,0	0,0	4,2
Switzerland	0,4	15,4	0,8	63,6	44,1
European Union (28 countries)	**14,0**	**91,5**	**68,5**	**910,9**	**2204,7**
Mean (EU28)	0,5	3,3	2,4	32,5	78,7

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Appendix C.3. – Patent applications for IPC related to the section B (Performing Operations, Transporting), 2016

Countries	B61 Railways	B62 Land vehicles for travelling otherwise than on rails	B63 Ships or other waterborne vessels, related equipment	B65 Conveying, packing, storing, handling thin or filamentary material	B82 Nanotechnology
Austria	40,2	14,4	0,0	54,3	0,6
Germany	178,6	258,2	4,3	542,0	4,4
Italy	14,7	91,9	48,7	281,6	1,3
Slovenia	1,0	0,7	29,1	0,3	0,0
Switzerland	22,8	21,7	1,0	226,7	1,4
European Union (28 countries)	**356,4**	**563,9**	**9,9**	**1376,0**	**30,0**
Mean (EU28)	12,7	20,1	0,4	49,1	1,1

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Appendix C.4. – Patent applications for IPC related to the section C (Chemistry, Metallurgy), 2016

Countries	C01 Inorganic chemistry	C02 Treatment of water, wastewater, sewage, or sludge	C04 Cements, concrete, artificial stone, ceramics, refractories	C05 Fertilizers, manufacture thereof	C07 Organic chemistry
Austria	1,7	2,4	12,1	1,8	16,4
Germany	68,9	37,4	89,9	13,9	402,7
Italy	6,9	16,3	9,8	2,7	51,0
Slovenia	1,0	1,5	0,0	0,0	2,9
Switzerland	14,9	20,0	20,6	1,7	193,3
European Union (28 countries)	**188,6**	**158,2**	**205,0**	**43,4**	**1111,7**
Mean (EU28)	6,7	5,6	7,3	1,6	39,7

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Appendix C.5. – Patent applications for IPC related to the section C (Chemistry, Metallurgy), 2016

Countries	C08 Organic macromolecular chemistry	C11 Animal or vegetable oils, fats, fatty substances or waxes, fatty acids thereform, detergents, candles	C12 Biochemistry, beer, spirits, wine, vinegar, microbiology, enzymology, mutation or genetic engineering	C13 Sugar industry	C21 Metallurgy of iron
Austria	73,9	0,6	35,5	0,0	10,7
Germany	455,4	98,7	252,9	1,2	30,1
Italy	76,3	7,2	44,8	0,3	3,9
Slovenia	1,7	0,0	1,7	0,0	0,0
Switzerland	103,3	18,4	106,7	0,7	3,6
European Union (28 countries)	**1050,8**	**199,1**	**883,7**	**2,9**	**68,2**
Mean (EU28)	37,5	7,1	31,6	0,1	2,4

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Appendix C.6. – Patent applications for IPC related to the section E (Fixed Constructions) and F (Mechanical Engineering, Lighting, Heating, Weapons), 2016

Countries	E03 Water supply, sewerage	E04 Building	E05 Locks, keys, window or door fittings, safes	F23 Combustion apparatus, combustion processes	F24 Heating, ranges, ventilating
Austria	3,2	34,0	34,1	5,8	9,8
Germany	77,7	229,7	314,0	107,4	192,2
Italy	12,4	65,0	88,5	19,5	60,1
Slovenia	0,0	1,0	4,0	0,8	4,6
Switzerland	31,1	46,9	29,3	21,9	27,6
European Union (28 countries)	**170,8**	**654,1**	**580,6**	**211,5**	**466,4**
Mean (EU28)	6,1	23,4	20,7	7,6	16,7

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Appendix C.7. – Patent applications for IPC related to the section G (Physics) and H (Electricity), 2016

Countries	G06 Water supply, sewerage	H02 Building
Austria	44,7	36,0
Germany	740,6	685,8
Italy	75,7	72,5
Slovenia	3,6	1,3
Switzerland	190,0	207,5
European Union (28 countries)	**2539,6**	**1336,5**
Mean (EU28)	90,7	47,7

Source: authors' elaboration based on OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, January 2020.

Appendix D: List of clusters from the European Cluster Observatory

New Cluster Definitions

Cluster	NACE	Industry Name
Aerospace Vehicles and Defence	30.30	Manufacture of air and spacecraft and related machinery
Agricultural Inputs and Services	01.61	Support activities for crop production
	01.62	Support activities for animal production
	01.63	Post-harvest crop activities
	01.64	Seed processing for propagation
	20.15	Manufacture of fertilisers and nitrogen compounds
Apparel	14.11	Manufacture of leather clothes
	14.12	Manufacture of workwear
	14.13	Manufacture of other outerwear
	14.14	Manufacture of underwear
	14.19	Manufacture of other wearing apparel and accessories
	14.20	Manufacture of articles of fur
Appliances	27.51	Manufacture of electric domestic appliances
	27.52	Manufacture of non-electric domestic appliances
Automotive	24.53	Casting of light metals
	24.54	Casting of other non-ferrous metals
	28.13	Manufacture of other pumps and compressors
	29.10	Manufacture of motor vehicles
	29.20	Manufacture of bodies (coachwork) for motor vehicles manufacture of trailers and semi-trailers
	29.31	Manufacture of electrical and electronic equipment for motor vehicles
	29.32	Manufacture of other parts and accessories for motor vehicles
	30.40	Manufacture of military fighting vehicles
Biopharmaceuticals	21.10	Manufacture of basic pharmaceutical products
	21.20	Manufacture of pharmaceutical preparations
Business Services	49.32	Taxi operation
	62.01	Computer programming activities
	62.02	Computer consultancy activities
	62.03	Computer facilities management activities
	62.09	Other information technology and computer service activities
	63.11	Data processing, hosting and related activities
	64.20	Activities of holding companies
	70.10	Activities of head offices
	70.22	Business and other management consultancy activities
	71.11	Architectural activities
	71.12	Engineering activities and related technical consultancy
	71.20	Technical testing and analysis
	74.30	Translation and interpretation activities

Cluster	NACE	Industry Name
	74.90	Other professional, scientific and technical activities n.e.c.
	77.12	Renting and leasing of trucks
	77.40	Leasing of intellectual property and similar products, except copyrighted works
	78.10	Activities of employment placement agencies
	78.30	Other human resources provision
	81.10	Combined facilities support activities
	82.20	Activities of call centres
	82.30	Organisation of conventions and trade shows
Coal Mining	05.10	Mining of hard coal
	05.20	Mining of lignite
	09.90	Support activities for other mining and quarrying
Communications Equipment and Services	26.30	Manufacture of communication equipment
	61.20	Wireless telecommunications activities
	61.30	Satellite telecommunications activities
	61.90	Other telecommunications activities
Construction Products and Services	23.14	Manufacture of glass fibres
	23.51	Manufacture of cement
	23.52	Manufacture of lime and plaster
	23.61	Manufacture of concrete products for construction purposes
	23.62	Manufacture of plaster products for construction purposes
	23.64	Manufacture of mortars
	23.65	Manufacture of fibre cement
	23.70	Cutting, shaping and finishing of stone
	23.99	Manufacture of other non-metallic mineral products n.e.c.
	24.20	Manufacture of tubes, pipes, hollow profiles and related fittings, of steel
	25.30	Manufacture of steam generators, except central heating hot water boilers
	35.30	Steam and air conditioning supply
	42.12	Construction of railways and underground railways
	42.22	Construction of utility projects for electricity and telecommunications
	42.91	Construction of water projects
Distribution and Electronic Commerce	46.11	Agents involved in the sale of agricultural raw materials, live animals, textile raw materials and semi-finished goods
	46.12	Agents involved in the sale of fuels, ores, metals and industrial chemicals
	46.13	Agents involved in the sale of timber and building materials
	46.14	Agents involved in the sale of machinery, industrial equipment, ships and aircraft
	46.15	Agents involved in the sale of furniture, household goods, hardware and ironmongery
	46.16	Agents involved in the sale of textiles, clothing, fur, footwear and leather goods
	46.17	Agents involved in the sale of food, beverages and tobac-

Cluster	NACE	Industry Name
		co
	46.18	Agents specialised in the sale of other particular products
	46.19	Agents involved in the sale of a variety of goods
	46.21	Wholesale of grain, unmanufactured tobacco, seeds and animal feeds
	46.22	Wholesale of flowers and plants
	46.23	Wholesale of live animals
	46.24	Wholesale of hides, skins and leather
	46.31	Wholesale of fruit and vegetables
	46.32	Wholesale of meat and meat products
	46.34	Wholesale of beverages
	46.35	Wholesale of tobacco products
	46.38	Wholesale of other food, including fish, crustaceans and molluscs
	46.41	Wholesale of textiles
	46.42	Wholesale of clothing and footwear
	46.43	Wholesale of electrical household appliances
	46.44	Wholesale of china and glassware and cleaning materials
	46.45	Wholesale of perfume and cosmetics
	46.46	Wholesale of pharmaceutical goods
	46.47	Wholesale of furniture, carpets and lighting equipment
	46.48	Wholesale of watches and jewellery
	46.49	Wholesale of other household goods
	46.51	Wholesale of computers, computer peripheral equipment and software
	46.52	Wholesale of electronic and telecommunications equipment and parts
	46.61	Wholesale of agricultural machinery, equipment and supplies
	46.62	Wholesale of machine tools
	46.63	Wholesale of mining, construction and civil engineering machinery
	46.64	Wholesale of machinery for the textile industry and of sewing and knitting machines
	46.65	Wholesale of office furniture
	46.66	Wholesale of other office machinery and equipment
	46.69	Wholesale of other machinery and equipment
	46.71	Wholesale of solid, liquid and gaseous fuels and related products
	46.72	Wholesale of metals and metal ores
	46.76	Wholesale of other intermediate products
	47.91	Retail sale via mail order houses or via Internet
	52.10	Warehousing and storage
	77.31	Renting and leasing of agricultural machinery and equipment
	77.32	Renting and leasing of construction and civil engineering machinery and equipment
	77.33	Renting and leasing of office machinery and equipment (including computers)

Cluster	NACE	Industry Name
	77.34	Renting and leasing of water transport equipment
	77.35	Renting and leasing of air transport equipment
	77.39	Renting and leasing of other machinery, equipment and tangible goods n.e.c.
	82.92	Packaging activities
Downstream Chemical Products	20.12	Manufacture of dyes and pigments
	20.30	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
	20.41	Manufacture of soap and detergents, cleaning and polishing preparations
	20.42	Manufacture of perfumes and toilet preparations
	20.51	Manufacture of explosives
	20.52	Manufacture of glues
	20.53	Manufacture of essential oils
	20.59	Manufacture of other chemical products n.e.c.
Downstream Metal Products	25.29	Manufacture of other tanks, reservoirs and containers of metal
	25.40	Manufacture of weapons and ammunition
	25.71	Manufacture of cutlery
	25.72	Manufacture of locks and hinges
	25.91	Manufacture of steel drums and similar containers
	25.92	Manufacture of light metal packaging
	25.99	Manufacture of other fabricated metal products n.e.c.
Education and Knowledge Creation	72.11	Research and experimental development on biotechnology
	72.19	Other research and experimental development on natural sciences and engineering
	72.20	Research and experimental development on social sciences and humanities
	85.41	Post-secondary non-tertiary education
	85.42	Tertiary education
	85.52	Cultural education
	85.59	Other education n.e.c.
	85.60	Educational support activities
	94.12	Activities of professional membership organisations
Electric Power Generation and Transmission	35.11	Production of electricity
	35.12	Transmission of electricity
Environmental Services	36.00	Water collection, treatment and supply
	38.12	Collection of hazardous waste
	38.22	Treatment and disposal of hazardous waste
	38.32	Recovery of sorted materials
Financial Services	64.11	Central banking
	64.30	Trusts, funds and similar financial entities
	64.91	Financial leasing
	64.92	Other credit granting
	64.99	Other financial service activities, except insurance and pension funding n.e.c.
	66.11	Administration of financial markets
	66.12	Security and commodity contracts brokerage

Cluster	NACE	Industry Name
	66.19	Other activities auxiliary to financial services, except insurance and pension funding
	66.30	Fund management activities
Fishing and Fishing Products	03.11	Marine fishing
	03.12	Freshwater fishing
	10.20	Processing and preserving of fish, crustaceans and molluscs
Food Processing and Manufacturing	10.31	Processing and preserving of potatoes
	10.32	Manufacture of fruit and vegetable juice
	10.39	Other processing and preserving of fruit and vegetables
	10.41	Manufacture of oils and fats
	10.42	Manufacture of margarine and similar edible fats
	10.51	Operation of dairies and cheese making
	10.52	Manufacture of ice cream
	10.61	Manufacture of grain mill products
	10.62	Manufacture of starches and starch products
	10.72	Manufacture of rusks and biscuits manufacture of preserved pastry goods and cakes
	10.73	Manufacture of macaroni, noodles, couscous and similar farinaceous products
	10.81	Manufacture of sugar
	10.82	Manufacture of cocoa, chocolate and sugar confectionery
	10.83	Processing of tea and coffee
	10.84	Manufacture of condiments and seasonings
	10.85	Manufacture of prepared meals and dishes
	10.86	Manufacture of homogenised food preparations and dietetic food
	10.89	Manufacture of other food products n.e.c.
	10.91	Manufacture of prepared feeds for farm animals
	10.92	Manufacture of prepared pet foods
	11.01	Distilling, rectifying and blending of spirits
	11.02	Manufacture of wine from grape
	11.03	Manufacture of cider and other fruit wines
	11.04	Manufacture of other non-distilled fermented beverages
	11.05	Manufacture of beer
	11.06	Manufacture of malt
	11.07	Manufacture of soft drinks production of mineral waters and other bottled waters
Footwear	15.11	Tanning and dressing of leather dressing and dyeing of fur
	15.20	Manufacture of footwear
Forestry	02.10	Silviculture and other forestry activities
	02.20	Logging
	02.30	Gathering of wild growing non-wood products
	02.40	Support services to forestry
Furniture	31.01	Manufacture of office and shop furniture

Cluster	NACE	Industry Name
	31.02	Manufacture of kitchen furniture
	31.03	Manufacture of mattresses
	31.09	Manufacture of other furniture
Hospitality and Tourism	01.70	Hunting, trapping and related service activities
	55.10	Hotels and similar accommodation
	55.20	Holiday and other short-stay accommodation
	55.30	Camping grounds, recreational vehicle parks and trailer parks
	55.90	Other accommodation
	77.21	Renting and leasing of recreational and sports goods
	79.11	Travel agency activities
	79.12	Tour operator activities
	79.90	Other reservation service and related activities
	91.02	Museums activities
	91.03	Operation of historical sites and buildings and similar visitor attractions
	91.04	Botanical and zoological gardens and nature reserves activities
	92.00	Gambling and betting activities
	93.11	Operation of sports facilities
	93.12	Activities of sport clubs
	93.19	Other sports activities
	93.21	Activities of amusement parks and theme parks
	93.29	Other amusement and recreation activities
Information Technology and Analytical Instruments	26.11	Manufacture of electronic components
	26.12	Manufacture of loaded electronic boards
	26.20	Manufacture of computers and peripheral equipment
	26.40	Manufacture of consumer electronics
	26.51	Manufacture of instruments and appliances for measuring, testing and navigation
	26.52	Manufacture of watches and clocks
	26.70	Manufacture of optical instruments and photographic equipment
	26.80	Manufacture of magnetic and optical media
	58.21	Publishing of computer games
	58.29	Other software publishing
Insurance Services	65.11	Life insurance
	65.12	Non-life insurance
	65.20	Reinsurance
	66.21	Risk and damage evaluation
	66.29	Other activities auxiliary to insurance and pension funding
Jewellery and Precious Metals	32.11	Striking of coins
	32.12	Manufacture of jewellery and related articles
	32.13	Manufacture of imitation jewellery and related articles
Leather and Related Products	15.12	Manufacture of luggage, handbags and the like, saddlery

Cluster	NACE	Industry Name
		and harness
Lighting and Electrical Equipment	27.11	Manufacture of electric motors, generators and transformers
	27.12	Manufacture of electricity distribution and control apparatus
	27.20	Manufacture of batteries and accumulators
	27.31	Manufacture of fibre optic cables
	27.32	Manufacture of other electronic and electric wires and cables
	27.33	Manufacture of wiring devices
	27.40	Manufacture of electric lighting equipment
	27.90	Manufacture of other electrical equipment
Livestock Processing	10.11	Processing and preserving of meat
	10.12	Processing and preserving of poultry meat
	10.13	Production of meat and poultry meat products
Marketing, Design, and Publishing	58.11	Book publishing
	58.12	Publishing of directories and mailing lists
	58.14	Publishing of journals and periodicals
	58.19	Other publishing activities
	63.12	Web portals
	63.91	News agency activities
	63.99	Other information service activities n.e.c.
	70.21	Public relations and communication activities
	73.11	Advertising agencies
	73.12	Media representation
	73.20	Market research and public opinion polling
	74.10	Specialised design activities
	91.01	Library and archives activities
Medical Devices	26.60	Manufacture of irradiation, electromedical and electrotherapeutic equipment
	32.50	Manufacture of medical and dental instruments and supplies
Metal Mining	07.10	Mining of iron ores
	07.21	Mining of uranium and thorium ores
	07.29	Mining of other non-ferrous metal ores
Metalworking Technology	23.91	Production of abrasive products
	25.11	Manufacture of metal structures and parts of structures
	25.12	Manufacture of doors and windows of metal
	25.61	Treatment and coating of metals
	25.62	Machining
	25.73	Manufacture of tools
	25.94	Manufacture of fasteners and screw machine products
	28.41	Manufacture of metal forming machinery
	28.91	Manufacture of machinery for metallurgy
Music and Sound Recording	59.20	Sound recording and music publishing activities
Non-metal Mining	08.11	Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate

Cluster	NACE	Industry Name
	08.12	Operation of gravel and sand pits mining of clays and kaolin
	08.91	Mining of chemical and fertiliser minerals
	08.92	Extraction of peat
	08.93	Extraction of salt
	08.99	Other mining and quarrying n.e.c.
Oil and Gas Production and Transportation	06.10	Extraction of crude petroleum
	06.20	Extraction of natural gas
	09.10	Support activities for petroleum and natural gas extraction
	19.10	Manufacture of coke oven products
	19.20	Manufacture of refined petroleum products
	49.50	Transport via pipeline
Paper and Packaging	17.11	Manufacture of pulp
	17.12	Manufacture of paper and paperboard
	17.21	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard
	17.22	Manufacture of household and sanitary goods and of toilet requisites
	17.23	Manufacture of paper stationery
	17.24	Manufacture of wallpaper
	17.29	Manufacture of other articles of paper and paperboard
Performing Arts	90.01	Performing arts
	90.02	Support activities to performing arts
	90.03	Artistic creation
	90.04	Operation of arts facilities
Plastics	20.16	Manufacture of plastics in primary forms
	22.21	Manufacture of plastic plates, sheets, tubes and profiles
	22.22	Manufacture of plastic packing goods
	22.23	Manufacture of builders' ware of plastic
	22.29	Manufacture of other plastic products
	28.96	Manufacture of plastics and rubber machinery
Printing Services	18.11	Printing of newspapers
	18.12	Other printing
	18.13	Pre-press and pre-media services
	18.14	Binding and related services
Production Technology and Heavy Machinery	25.21	Manufacture of central heating radiators and boilers
	28.11	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
	28.12	Manufacture of fluid power equipment
	28.14	Manufacture of other taps and valves
	28.15	Manufacture of bearings, gears, gearing and driving elements
	28.21	Manufacture of ovens, furnaces and furnace burners
	28.22	Manufacture of lifting and handling equipment
	28.24	Manufacture of power-driven hand tools
	28.25	Manufacture of non-domestic cooling and ventilation equipment

Cluster	NACE	Industry Name
	28.29	Manufacture of other general-purpose machinery n.e.c.
	28.30	Manufacture of agricultural and forestry machinery
	28.49	Manufacture of other machine tools
	28.92	Manufacture of machinery for mining, quarrying and construction
	28.93	Manufacture of machinery for food, beverage and tobacco processing
	28.94	Manufacture of machinery for textile, apparel and leather production
	28.95	Manufacture of machinery for paper and paperboard production
	28.99	Manufacture of other special-purpose machinery n.e.c.
	30.20	Manufacture of railway locomotives and rolling stock
	30.99	Manufacture of other transport equipment n.e.c.
Recreational and Small Electric Goods	28.23	Manufacture of office machinery and equipment (except computers and peripheral equipment)
	30.91	Manufacture of motorcycles
	30.92	Manufacture of bicycles and invalid carriages
	32.20	Manufacture of musical instruments
	32.30	Manufacture of sports goods
	32.40	Manufacture of games and toys
	32.91	Manufacture of brooms and brushes
	32.99	Other manufacturing n.e.c.
Textile Manufacturing	13.10	Preparation and spinning of textile fibres
	13.20	Weaving of textiles
	13.30	Finishing of textiles
	13.91	Manufacture of knitted and crocheted fabrics
	13.92	Manufacture of made-up textile articles, except apparel
	13.93	Manufacture of carpets and rugs
	13.94	Manufacture of cordage, rope, twine and netting
	13.95	Manufacture of non-wovens and articles made from non-wovens, except apparel
	13.96	Manufacture of other technical and industrial textiles
	13.99	Manufacture of other textiles n.e.c.
	14.31	Manufacture of knitted and crocheted hosiery
	14.39	Manufacture of other knitted and crocheted apparel
	20.60	Manufacture of man-made fibres
Tobacco	12.00	Manufacture of tobacco products
Transportation and Logistics	33.16	Repair and maintenance of aircraft and spacecraft
	49.39	Other passenger land transport n.e.c.
	49.41	Freight transport by road
	51.10	Passenger air transport
	51.21	Freight air transport
	51.22	Space transport
	52.21	Service activities incidental to land transportation
	52.23	Service activities incidental to air transportation
	52.24	Cargo handling

Cluster	NACE	Industry Name
	52.29	Other transportation support activities
Upstream Chemical Products	20.11	Manufacture of industrial gases
	20.13	Manufacture of other inorganic basic chemicals
	20.14	Manufacture of other organic basic chemicals
	20.17	Manufacture of synthetic rubber in primary forms
	20.20	Manufacture of pesticides and other agrochemical products
Upstream Metal Manufacturing	24.10	Manufacture of basic iron and steel and of ferro-alloys
	24.31	Cold drawing of bars
	24.32	Cold rolling of narrow strip
	24.33	Cold forming or folding
	24.34	Cold drawing of wire
	24.41	Precious metals production
	24.42	Aluminium production
	24.43	Lead, zinc and tin production
	24.44	Copper production
	24.45	Other non-ferrous metal production
	24.46	Processing of nuclear fuel
	24.51	Casting of iron
	24.52	Casting of steel
	25.50	Forging, pressing, stamping and roll-forming of metal powder metallurgy
	25.93	Manufacture of wire products, chain and springs
Video Production and Distribution	18.20	Reproduction of recorded media
	59.11	Motion picture, video and television programme production activities
	59.12	Motion picture, video and television programme post-production activities
	59.13	Motion picture, video and television programme distribution activities
Vulcanized and Fired Materials	22.11	Manufacture of rubber tyres and tubes retreading and rebuilding of rubber tyres
	22.19	Manufacture of other rubber products
	23.11	Manufacture of flat glass
	23.12	Shaping and processing of flat glass
	23.13	Manufacture of hollow glass
	23.19	Manufacture and processing of other glass, including technical glassware
	23.20	Manufacture of refractory products
	23.31	Manufacture of ceramic tiles and flags
	23.32	Manufacture of bricks, tiles and construction products, in baked clay
	23.41	Manufacture of ceramic household and ornamental articles
	23.43	Manufacture of ceramic insulators and insulating fittings
	23.44	Manufacture of other technical ceramic products
	23.49	Manufacture of other ceramic products
Water Transportation	30.11	Building of ships and floating structures
	30.12	Building of pleasure and sporting boats

Cluster	NACE	Industry Name
	33.15	Repair and maintenance of ships and boats
	38.31	Dismantling of wrecks
	50.10	Sea and coastal passenger water transport
	50.20	Sea and coastal freight water transport
	50.30	Inland passenger water transport
	50.40	Inland freight water transport
	52.22	Service activities incidental to water transportation
Wood Products	16.10	Sawmilling and planing of wood
	16.21	Manufacture of veneer sheets and wood-based panels
	16.22	Manufacture of assembled parquet floors
	16.23	Manufacture of other builders' carpentry and joinery
	16.24	Manufacture of wooden containers
	16.29	Manufacture of other products of wood manufacture of articles of cork, straw and plaiting materials

Source: EC, 2014, pp. 18-28.

Emergings Industries' Definitions

Emerging Industry	NACE	NACE Name
Advanced	17.11	Manufacture of pulp
Packaging	17.12	Manufacture of paper and paperboard
	17.21	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard
	17.22	Manufacture of household and sanitary goods and of toilet requisites
	17.23	Manufacture of paper stationery
	17.24	Manufacture of wallpaper
	17.29	Manufacture of other articles of paper and paperboard
	22.21	Manufacture of plastic plates, sheets, tubes and profiles
	22.22	Manufacture of plastic packing goods
	22.29	Manufacture of other plastic products
	24.20	Manufacture of tubes, pipes, hollow profiles and related fittings, of steel
	25.61	Treatment and coating of metals
	25.73	Manufacture of tools
	25.99	Manufacture of other fabricated metal products n.e.c.
	28.99	Manufacture of other special-purpose machinery n.e.c.
	29.32	Manufacture of other parts and accessories for motor vehicles
	31.01	Manufacture of office and shop furniture
	46.76	Wholesale of other intermediate products
Biopharmaceuticals	11.01	Distilling, rectifying and blending of spirits
	17.22	Manufacture of household and sanitary goods and of toilet requisites
	20.13	Manufacture of other inorganic basic chemicals
	20.14	Manufacture of other organic basic chemicals
	20.30	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
	20.41	Manufacture of soap and detergents, cleaning and polishing preparations
	20.59	Manufacture of other chemical products n.e.c.
	21.10	Manufacture of basic pharmaceutical products
	21.20	Manufacture of pharmaceutical preparations
	46.46	Wholesale of pharmaceutical goods
	72.11	Research and experimental development on biotechnology
	72.19	Other research and experimental development on natural sciences and engineering
Blue Growth	03.11	Marine fishing
Industries	03.12	Freshwater fishing
	09.10	Support activities for petroleum and natural gas extraction
	10.20	Processing and preserving of fish, crustaceans and molluscs
	22.19	Manufacture of other rubber products
	25.99	Manufacture of other fabricated metal products n.e.c.
	28.11	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
	28.22	Manufacture of lifting and handling equipment

Emerging Industry	NACE	NACE Name
	30.11	Building of ships and floating structures
	30.12	Building of pleasure and sporting boats
	33.15	Repair and maintenance of ships and boats
	35.11	Production of electricity
	35.12	Transmission of electricity
	36.00	Water collection, treatment and supply
	42.91	Construction of water projects
	46.14	Agents involved in the sale of machinery, industrial equipment, ships and aircraft
	49.41	Freight transport by road
	50.10	Sea and coastal passenger water transport
	50.20	Sea and coastal freight water transport
	50.30	Inland passenger water transport
	50.40	Inland freight water transport
	52.10	Warehousing and storage
	52.22	Service activities incidental to water transportation
	52.23	Service activities incidental to air transportation
	52.24	Cargo handling
	52.29	Other transportation support activities
	71.12	Engineering activities and related technical consultancy
	71.20	Technical testing and analysis
	72.19	Other research and experimental development on natural sciences and engineering
	73.11	Advertising agencies
	77.32	Renting and leasing of construction and civil engineering machinery and equipment
	77.34	Renting and leasing of water transport equipment
	79.11	Travel agency activities
Creative Industries	18.20	Reproduction of recorded media
	49.32	Taxi operation
	58.11	Book publishing
	58.12	Publishing of directories and mailing lists
	58.14	Publishing of journals and periodicals
	58.19	Other publishing activities
	59.11	Motion picture, video and television programme production activities
	59.12	Motion picture, video and television programme post-production activities
	59.13	Motion picture, video and television programme distribution activities
	59.20	Sound recording and music publishing activities
	62.01	Computer programming activities
	62.02	Computer consultancy activities
	62.03	Computer facilities management activities
	62.09	Other information technology and computer service activities
	63.11	Data processing, hosting and related activities
	63.12	Web portals

Emerging Industry	NACE	NACE Name
	63.91	News agency activities
	63.99	Other information service activities n.e.c.
	64.20	Activities of holding companies
	70.10	Activities of head offices
	70.21	Public relations and communication activities
	70.22	Business and other management consultancy activities
	71.11	Architectural activities
	71.12	Engineering activities and related technical consultancy
	71.20	Technical testing and analysis
	73.11	Advertising agencies
	73.12	Media representation
	73.20	Market research and public opinion polling
	74.10	Specialised design activities
	74.30	Translation and interpretation activities
	74.90	Other professional, scientific and technical activities n.e.c.
	77.12	Renting and leasing of trucks
	77.40	Leasing of intellectual property and similar products, except copy-righted works
	78.10	Activities of employment placement agencies
	78.30	Other human resources provision
	81.10	Combined facilities support activities
	82.20	Activities of call centres
	82.30	Organisation of conventions and trade shows
	91.01	Library and archives activities
Digital Industries	22.29	Manufacture of other plastic products
	25.61	Treatment and coating of metals
	25.73	Manufacture of tools
	26.11	Manufacture of electronic components
	26.12	Manufacture of loaded electronic boards
	26.20	Manufacture of computers and peripheral equipment
	26.30	Manufacture of communication equipment
	26.40	Manufacture of consumer electronics
	26.51	Manufacture of instruments and appliances for measuring, testing and navigation
	26.52	Manufacture of watches and clocks
	26.70	Manufacture of optical instruments and photographic equipment
	26.80	Manufacture of magnetic and optical media
	27.12	Manufacture of electricity distribution and control apparatus
	27.90	Manufacture of other electrical equipment
	28.24	Manufacture of power-driven hand tools
	28.29	Manufacture of other general-purpose machinery n.e.c.
	28.99	Manufacture of other special-purpose machinery n.e.c.
	32.50	Manufacture of medical and dental instruments and supplies
	46.43	Wholesale of electrical household appliances
	46.51	Wholesale of computers, computer peripheral equipment and software
	46.52	Wholesale of electronic and telecommunications equipment and

Emerging Industry	NACE	NACE Name
		parts
	46.66	Wholesale of other office machinery and equipment
	46.69	Wholesale of other machinery and equipment
	58.11	Book publishing
	58.21	Publishing of computer games
	58.29	Other software publishing
	61.20	Wireless telecommunications activities
	61.30	Satellite telecommunications activities
	61.90	Other telecommunications activities
	62.01	Computer programming activities
	62.02	Computer consultancy activities
	62.09	Other information technology and computer service activities
	70.21	Public relations and communication activities
	73.20	Market research and public opinion polling
Environmental	06.20	Extraction of natural gas
Industries	09.10	Support activities for petroleum and natural gas extraction
	16.21	Manufacture of veneer sheets and wood-based panels
	16.29	Manufacture of other products of wood manufacture of articles of cork, straw and plaiting materials
	17.22	Manufacture of household and sanitary goods and of toilet requisites
	20.14	Manufacture of other organic basic chemicals
	20.15	Manufacture of fertilisers and nitrogen compounds
	20.16	Manufacture of plastics in primary forms
	20.59	Manufacture of other chemical products n.e.c.
	22.29	Manufacture of other plastic products
	23.49	Manufacture of other ceramic products
	23.51	Manufacture of cement
	24.10	Manufacture of basic iron and steel and of ferro-alloys
	25.21	Manufacture of central heating radiators and boilers
	25.30	Manufacture of steam generators, except central heating hot water boilers
	25.99	Manufacture of other fabricated metal products n.e.c.
	26.51	Manufacture of instruments and appliances for measuring, testing and navigation
	28.11	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
	28.29	Manufacture of other general-purpose machinery n.e.c.
	28.99	Manufacture of other special-purpose machinery n.e.c.
	35.11	Production of electricity
	35.12	Transmission of electricity
	36.00	Water collection, treatment and supply
	38.12	Collection of hazardous waste
	38.22	Treatment and disposal of hazardous waste
	38.31	Dismantling of wrecks
	38.32	Recovery of sorted materials

Emerging Industry	NACE	NACE Name
	46.21	Wholesale of grain, unmanufactured tobacco, seeds and animal feeds
	46.22	Wholesale of flowers and plants
	49.50	Transport via pipeline
	52.22	Service activities incidental to water transportation
	52.29	Other transportation support activities
	71.12	Engineering activities and related technical consultancy
	72.11	Research and experimental development on biotechnology
	72.19	Other research and experimental development on natural sciences and engineering
Experience	01.70	Hunting, trapping and related service activities
Industries	46.18	Agents specialised in the sale of other particular products
	46.42	Wholesale of clothing and footwear
	46.49	Wholesale of other household goods
	47.91	Retail sale via mail order houses or via Internet
	49.39	Other passenger land transport n.e.c.
	50.30	Inland passenger water transport
	50.40	Inland freight water transport
	52.22	Service activities incidental to water transportation
	52.23	Service activities incidental to air transportation
	55.10	Hotels and similar accommodation
	55.20	Holiday and other short-stay accommodation
	55.30	Camping grounds, recreational vehicle parks and trailer parks
	55.90	Other accommodation
	58.29	Other software publishing
	62.01	Computer programming activities
	62.09	Other information technology and computer service activities
	63.12	Web portals
	70.21	Public relations and communication activities
	70.22	Business and other management consultancy activities
	77.21	Renting and leasing of recreational and sports goods
	79.11	Travel agency activities
	79.12	Tour operator activities
	79.90	Other reservation service and related activities
	82.30	Organisation of conventions and trade shows
	90.01	Performing arts
	90.02	Support activities to performing arts
	90.03	Artistic creation
	90.04	Operation of arts facilities
	91.02	Museums activities
	91.03	Operation of historical sites and buildings and similar visitor attractions
	91.04	Botanical and zoological gardens and nature reserves activities
	92.00	Gambling and betting activities
	93.11	Operation of sports facilities
	93.12	Activities of sport clubs
	93.19	Other sports activities

Emerging Industry	NACE	NACE Name
	93.21	Activities of amusement parks and theme parks
	93.29	Other amusement and recreation activities
Logistical Services	33.16	Repair and maintenance of aircraft and spacecraft
	49.32	Taxi operation
	49.39	Other passenger land transport n.e.c.
	49.41	Freight transport by road
	51.10	Passenger air transport
	51.21	Freight air transport
	51.22	Space transport
	52.21	Service activities incidental to land transportation
	52.23	Service activities incidental to air transportation
	52.24	Cargo handling
	52.29	Other transportation support activities
	61.30	Satellite telecommunications activities
Medical Devices	23.32	Manufacture of bricks, tiles and construction products, in baked clay
	25.40	Manufacture of weapons and ammunition
	25.73	Manufacture of tools
	26.11	Manufacture of electronic components
	26.12	Manufacture of loaded electronic boards
	26.40	Manufacture of consumer electronics
	26.51	Manufacture of instruments and appliances for measuring, testing and navigation
	26.52	Manufacture of watches and clocks
	26.60	Manufacture of irradiation, electromedical and electrotherapeutic equipment
	26.70	Manufacture of optical instruments and photographic equipment
	27.12	Manufacture of electricity distribution and control apparatus
	27.31	Manufacture of fibre optic cables
	27.32	Manufacture of other electronic and electric wires and cables
	27.33	Manufacture of wiring devices
	27.51	Manufacture of electric domestic appliances
	27.90	Manufacture of other electrical equipment
	28.12	Manufacture of fluid power equipment
	28.13	Manufacture of other pumps and compressors
	28.25	Manufacture of non-domestic cooling and ventilation equipment
	28.29	Manufacture of other general-purpose machinery n.e.c.
	28.95	Manufacture of machinery for paper and paperboard production
	28.99	Manufacture of other special-purpose machinery n.e.c.
	32.50	Manufacture of medical and dental instruments and supplies
	46.46	Wholesale of pharmaceutical goods
	62.03	Computer facilities management activities
Mobility	22.21	Manufacture of plastic plates, sheets, tubes and profiles
Technologies	22.29	Manufacture of other plastic products
	24.10	Manufacture of basic iron and steel and of ferro-alloys

Emerging Industry	NACE	NACE Name
	24.53	Casting of light metals
	24.54	Casting of other non-ferrous metals
	25.30	Manufacture of steam generators, except central heating hot water boilers
	25.50	Forging, pressing, stamping and roll-forming of metal powder metallurgy
	25.61	Treatment and coating of metals
	25.62	Machining
	25.73	Manufacture of tools
	25.94	Manufacture of fasteners and screw machine products
	25.99	Manufacture of other fabricated metal products n.e.c.
	26.11	Manufacture of electronic components
	27.11	Manufacture of electric motors, generators and transformers
	27.12	Manufacture of electricity distribution and control apparatus
	27.32	Manufacture of other electronic and electric wires and cables
	27.33	Manufacture of wiring devices
	27.51	Manufacture of electric domestic appliances
	27.90	Manufacture of other electrical equipment
	28.11	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
	28.12	Manufacture of fluid power equipment
	28.13	Manufacture of other pumps and compressors
	28.15	Manufacture of bearings, gears, gearing and driving elements
	28.22	Manufacture of lifting and handling equipment
	28.24	Manufacture of power-driven hand tools
	28.25	Manufacture of non-domestic cooling and ventilation equipment
	28.29	Manufacture of other general-purpose machinery n.e.c.
	28.30	Manufacture of agricultural and forestry machinery
	28.41	Manufacture of metal forming machinery
	28.49	Manufacture of other machine tools
	28.92	Manufacture of machinery for mining, quarrying and construction
	28.94	Manufacture of machinery for textile, apparel and leather production
	28.95	Manufacture of machinery for paper and paperboard production
	28.96	Manufacture of plastics and rubber machinery
	28.99	Manufacture of other special-purpose machinery n.e.c.
	29.10	Manufacture of motor vehicles
	29.20	Manufacture of bodies (coachwork) for motor vehicles manufacture of trailers and semi-trailers
	29.31	Manufacture of electrical and electronic equipment for motor vehicles
	29.32	Manufacture of other parts and accessories for motor vehicles
	30.20	Manufacture of railway locomotives and rolling stock
	30.30	Manufacture of air and spacecraft and related machinery
	30.40	Manufacture of military fighting vehicles
	30.92	Manufacture of bicycles and invalid carriages
	46.69	Wholesale of other machinery and equipment

Source: EC, 2014, pp. 31-37.