



Bioeconomy development in EU regions

**Mapping of EU Member States' / regions' Research and
Innovation plans & Strategies for Smart Specialisation
(RIS3) on Bioeconomy**

Final Report – February 2017

Framework Contract: 2014.CE.16.BAT Lot 2

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Abbreviations

7FP	EU Framework Programme for Research and Innovation 2007-2013
AKIS	Agricultural Knowledge and Innovation Systems
BBI-JU	Bio-Based Industries Joint Undertaking
BERST	Project "Bioeconomy Regional Strategy Toolkit for benchmarking and developing strategies"
BMBF	Bundesministerium für Bildung und Forschung (Ministry for Education and Research, Germany)
CAP	Common Agricultural Policy
CEE	Central and Eastern Europe
CFP	Common Fisheries Policy
CP	Cohesion Policy
CPR	Common Provision Regulation
DG	Directorate General
EC	European Commission
EU	European Union
EAFRD	European Agricultural Fund for Rural Development
EIP	European Innovation Partnerships
EIT	European Institute of Technology
EMFF	European Maritime and Fisheries Fund
ERA-Net	European Research Area Network
ERDF	European Regional Development Fund
ERIAFF	European Regions for Innovation in Agriculture, Food and Forestry
ERRIN	European Network of Innovating Regions
ESF	European Social Fund
ESIF	European Structural and Investment Funds
EURADA	European Association of Development Agencies
EUSBSR	European Strategy for the Baltic Sea Region
EUR	Euro
H2020	HORIZON 2020 - EU Framework Programme for Research and Innovation 2014-2020
ICT	Information and Communication Technologies
IPTS	Institute for Prospective Technological Studies Sevilla
JPI	Joint Programming Initiative
JRC	Joint Research Centre
KIC	EIT's Knowledge and Innovation Communities (KICs)
LCA/LCD	Life Cycle-Approach/Life Cycle-Design
MS	Member State
NACE	<i>Nomenclature of economic activities</i> = European statistical classification of economic activities
NFF	Nutraceuticals and Functional Food
NUTS	<i>Nomenclature des unités territoriales statistiques</i> = European statistical classification of territorial units
OECD	Organization for Economic Development and Cooperation
OP	Operational Programme
R&D	Research and Development
R&I	Research and Innovation
RDP	Rural Development Programme
RIS	Regional Innovation Scoreboard
RIS3	Smart Specialisation Strategy, also called S3
S2E	Stairway to Excellence
SoE	Seal of Excellence
SCAR	Standing Committee on Agricultural Research
TO	Thematic Objective
TRL	Technology Readiness Level

ABSTRACT

The study "Mapping of EU Member States' / regions' Research and Innovation Plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy" maps the intended priorities and activities of EU Member States (MS) and regions with regard to research and innovation (R&I) on bioeconomy. This information helps to identify specialisation patterns of European regions and countries (e.g. agro-food, blue bioeconomy or bio-based chemicals). Moreover, European regions and countries have been classified according to a bioeconomy maturity index, developing six different types of regional bioeconomy profiles. The study shows that bioeconomy related R&I is a priority for most of European countries and regions in the time period 2014-2020. The majority of EU regions/countries (207; 98.6%) include bioeconomy related aspects in their 2014-2020 R&I priorities and plans. However, many regions in Europe (35.7%) still have a low level of maturity. They cannot fully exploit the potential of the bioeconomy on their own (i.e. jobs, growth, rural development). The study presents recommendations for better strategic planning, enhanced value-chain development and R&I on technologies, better knowledge transfer and skills, more efficient coordination of funding and synergies between instruments, as well as proposals to raise public awareness and acceptance.

1. EXECUTIVE SUMMARY

Introduction

The study "Mapping of EU Member States' / regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy" was commissioned by DG Research and Innovation (DG RTD) of the European Commission to a consortium of companies led by SWECO and Spatial Foresight GmbH.

The overall objective of the study is to map the intended priorities and activities of EU Member States (MS) and regions with regard to research and innovation (R&I) on bioeconomy according to the current national or regional Smart Specialisation Strategies (RIS3) and programmes supported by the European Structural and Investment Funds (ESIF) for 2014-2020. This information helped to define similarities, commonalities and specificities among the regions within the European Union and to identify and describe successful regional initiatives as well as bottlenecks and gaps.

The methodology of the study combines different approaches. In phase 1 and 2, a desk research was carried out to analyse RIS3 documents for 210 different countries and regions in EU-28 and to map research and innovation priorities related to bioeconomy in a database. In phase 3, 22 case studies were conducted and analysed through a review of documents as well as phone interviews. The quantitative and qualitative data was then integrated to a final report with conclusions and recommendations for future support policies as regards bioeconomy.

Results of the Analysis

The study shows that bioeconomy related research and innovation (R&I) is a priority for most of European countries and regions in the time period 2014-2020. Out of 210 analysed territorial units (EU regions and countries), **207 (98.6%) include bioeconomy related aspects in their 2014-2020 R&I priorities and plans.** However, denominations of bioeconomy aspects in the different territorial unit scan vary enormously (from low-carbon, green growth, sustainable agriculture, innovative food production, green chemistry, eco-innovation and circular economy to blue growth). The deployment of the bioeconomy at regional level in the EU requires, therefore, a more detailed analysis and in-depth understanding of the different regional conditions, needs and potentials.

There is a **huge thematic variety** with regard to bioeconomy related R&I, even within regions/countries. An "agro-food" focus is most common within bioeconomy related research and innovation. However, also "bio-based fuel and energy" and "other bio-based industries" are important themes within the bioeconomy. Most regions/countries combine several thematic focus areas. This is an indicator for the interconnection and diversity of thematic fields within the concept of bioeconomy.

Understanding bioeconomy from a **value chain perspective** (which means differentiating aspects of bioeconomy based on value chains, from biomass supply over biomass processing to the production of bio-energy and innovative bio-based products), "biomass processing and conversion" is the most prominent approach in Europe. The most frequent specific value chain approaches are "bio-energy and fuel from biomass" (74% of all indications) and/or "food and beverages" (60%).

According to the regions/countries, there is a **wide variety of knowledge and technological expertise** needed for different bioeconomy related activities. Bioeconomy requires expert knowledge and research in many different fields (e.g. 'applied biotechnology', 'nanotechnology', 'logistics', 'manufacturing', 'natural resources', 'agronomy'). There is no single typology, as there are multiple combinations of R&I fields prioritised among the regions and countries.

In general, there is no clear **territorial pattern** for bioeconomy R&I, although some trends in specialisation can be observed. Agro-food is the broad thematic focus area most frequently ranked at first. Regions with this profile are located in Portugal, Spain, North-West of France, North of Germany, Sweden, Latvia, Lithuania, Czech Republic, Slovakia, Hungary, Romania, Bulgaria, Greece, Croatia, Slovenia and Italy (the majority of Italian regions). Regions and countries with a thematic focus on "bio-based fuels and bioenergy" cover territories in Southern France, Southern Germany and Southern Poland, but also Southern and Central Finland, Scotland, Ireland and Galicia (Spain). A focus on "other bio-based industries", including biorefinery, biochemicals and biopharmaceuticals, is found in countries such as Estonia and by regions located mainly in France, Austria, England, Poland, Belgium and The Netherlands.

A **bioeconomy R&I maturity index** has been calculated for European regions and countries. It refers to a composite index taking into account the overall innovation capacity of a territory, the existence of specific bioeconomy features such as strategies or cluster and the perceived intensity of bioeconomy R&I activity. Among the countries and regions with high bioeconomy maturity are Sweden, Finland, England and Austria as well as the Flemish Region (BE), Central Jutland (DK), South Netherlands (NL), Baden-Württemberg and Hessen (both D) and several Swedish and Finnish regions. Overall, the picture of bioeconomy maturity is heterogeneous: There are 86 territorial units (41%) with a middle-high maturity (more than 5 maturity points), compared to 49 regions (23.3%) with a middle maturity (5 maturity points) and 75 regions (35.7%) with a low maturity (below 5 maturity points). There is no significant relationship between bioeconomy maturity and value chain approaches in bioeconomy related R&I in European regions and countries.

There is a wide array of **drivers of the bioeconomy** in European regions. The different drivers have an important influence on the way the bioeconomy is understood and promoted in the regions (e.g. resource driven, value-chain driven, business driven or knowledge driven). Drivers can be found in the regional resources and assets that could be part of the regional bioeconomy. In many cases, the focus on bioeconomy is supply-side driven; the supply of biological resources or industrial knowledge is actively used for the deployment of the bioeconomy. However, there are also external factors that stimulate the bioeconomy. An example of an external factors, is political decisions to increase competitiveness and to promote economic development. Also geopolitical trends or population dynamics can be important external drivers of change. Furthermore, a more intensive bioeconomical development can be stimulated by the need to reduce the dependence of a region or country on imported raw materials and fuels. Finally, it can be a response to environmental or territorial challenges (e.g. loss of population in rural areas, climate change).

Some countries and regions follow a **strategic approach** to support the bioeconomy. The analysis shows that 19 Member States already have a bioeconomy strategy (or a similar strategic document) in place or are in the process of developing a strategy. Moreover, 49 of the analysed regions have developed a regional bioeconomy strategy or a similar comprehensive document. In the regions and countries without an explicit bioeconomy strategy, the bioeconomy support is often embedded in one or several other strategic documents or funding programmes. These are mainly specific national or regional R&I strategies and plans, sectoral innovation strategies and plans (e.g. innovation in agriculture, fisheries, waste management) or strategic frameworks partially covering bioeconomy (e.g. circular economy, blue economy).

Regional bioeconomy ecosystems in Europe are, first and foremost, built around the usual stakeholders of regional innovation systems: Governments and public administration, businesses and representatives of sectoral associations and business intermediaries, as well as academic, scientific and technological institutions. Clusters are an important tool to gather stakeholders around specific bioeconomy sectors/products, especially in strongly industrialised regions, but also increasingly in rural regions. In comparison to traditional industrial clusters, bioeconomy related clusters often need to integrate also producers of biological resources, i.e. farmers and fishermen, as well as their associations, e.g. cooperatives. In particular, at the level of government, coordination among different policy areas (e.g. research and innovation, agriculture, environment) is needed to promote the bioeconomy.

Intermediary organisations or 'bridges' are particularly important in the field of bioeconomy, as many technologies are still rather immature and cooperation between different sectors is important. However, the bioeconomy does not always has its own players. Many regions report the lack of specific bioeconomy bodies or networks, in turn hampering the organised deployment of specific bioeconomy areas. In addition to the usual stakeholders stated above, some of the analysed bioeconomy related innovation systems present additional **emergent players** that seem to play a vital role in the promotion of the bioeconomy. Among these specific and emergent stakeholders are:

- Bioeconomy Strategy Councils
- Bridges and links between stakeholders (thematic platforms, networks, projects)
- Specialised Technology, Research and Innovation Centres
- Operational coordination bodies at local level
- Cross-border and interregional cooperation projects.

The analysis of the different features of the bioeconomy in European countries and regions shows a huge interest in developing the bioeconomy in the next years. However, the analysis also shows a wide variety of drivers towards bioeconomy, such as regional capacity and maturity and different

approaches and methods as regards bioeconomy. This diversity in thematic orientation and value-chain approach as regards bioeconomy hampers the understanding of regional aspects and makes the definition of support schemes more complex.

A **typology of regional bioeconomy profiles** has been elaborated:

Type 1: Regions with a natural resources and heritage driven bioeconomy profile

Type 2: Regions with a research driven bioeconomy profile

Type 3: Regions with a primary value chain bioeconomy profile (incipient)

Type 4: Regions with a primary value chain bioeconomy profile (advanced)

Type 5: Regions with an industrial biotech profile

Type 6: Regions with an integrated and advanced bioeconomy profile.

The vast majority of European RIS3 strategies foresees **support for bioeconomy R&I** in 2014-2020. Most of them within the field of agro-food or energy R&I. The analysis of case studies shows that the support can be either strategic with clear priorities in the bioeconomy field – in particular, in the regions with a general bioeconomy strategy – or embedded in one or several existing strategic frameworks.

The analysis of RIS3 strategies and related documents showed that a **wide range of instruments and modalities** to support the bioeconomy is envisaged by the regions for the 2014-2020 funding period. The different instruments range between support to R&I projects, promotion of networks and clusters, physical infrastructure to the promotion of technology transfer and technology services, training and capacity-building. Moreover, financial instruments and venture capital measures are foreseen to bundle resources and to raise more investments.

With regard to **targeted recipients** for bioeconomy support measures, most of the analysed regions/strategies focus on SMEs and companies. Many regions anticipate to focus on various target groups at the same time, instead of considering one specific group. Another relevant target group are projects that involve both business and research partners.

The information gathered in RIS3 documents for EU28 shows that 67% of the regions intend to use European Structural and Investment Funds (ESIF) as **funding source** to support their bioeconomy activities. Given that information on ESIF co-funding of R&I activities, apart from EAFRD, is usually not split per sector and that some bioeconomy relevant activities are included in different thematic objectives (low carbon, SME, environment), the real number of regions planning to use ESIF co-funding might be even higher. In particular, ERDF, EAFRD and EMFF are used by the regions and countries, but also to less extent ESF. Moreover, the data gathered show that 77% of the regions foresee H2020 co-funding for bioeconomy related activities. H2020 is mentioned as funding source in almost all RIS3 strategies. However, due to competitive character of the calls, it is difficult to state a definite figure for the period 2014-2020. Many regions highlight, in particular, different ERA-Net networks/projects and the JPIs (Joint Programming Initiatives) as relevant for their bioeconomy deployment. The analysis shows that European countries and regions also use a variety of other EU programmes for the purpose of bioeconomy promotion, e.g. Interreg, LIFE+, CIP/COSME, ERASMUS+, Intelligent Energy Europe.

In addition to pure H2020 and ERA-Net funding, the importance of **synergies between ESIF and H2020 funding** could be observed in several of the analysed cases. The 2014-2020 ESIF common strategic framework favours the complementary funding between the different ESIF, in particular ERDF and EAFRD, but also synergies with H2020. However, synergies between ESIF and H2020 or other programmes are not always easy to achieve, mainly due to the different funding objectives and frameworks of the calls. Especially since this funding period 2014-2020, many regions and countries promote actively the generation of synergies between ESIF and H2020 funding. Mechanisms to award ESIF grants for excellent projects have been or are being developed in many EU Member States and regions within the 'Seal of Excellence' scheme (e.g. Italy, Finland, Czech Republic, Scotland, Lombardy, Spain, France). Specific forms of synergies between different funding sources represent the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-Agri) and the Bio-Based Industries Joint Undertaking (BBI-JU) as a public (EU) and private partnership. Some regions estimated these initiatives as valuable for their bioeconomy deployment.

Although there are several European and national programmes and strategies to stimulate the bioeconomy, considerable bioeconomy deployment takes place in the regions at sub-national level through **bioeconomy projects and initiatives** promoted by regional and local public authorities, by clusters and private companies or by universities, research centres or technology and innovation service providers. Some of them use European and/or national co-funding, but also local and regional resources are put into value. The case studies identified numerous bioeconomy projects that could be grouped in seven different areas:

1. Knowledge generation
2. Knowledge transfer, engagement, stakeholder networks
3. New generation and re-definition of value chains and value cycles/demonstration/technological readiness
4. Public awareness, dissemination of information
5. Bioeconomy coordination, governance and platforms
6. Education
7. Learning from other regions, alliances.

Diverse **needs and bottlenecks** on their way to further deploy the bioeconomy have been identified by the regions and countries analysed in the case studies:

- Needs related to strategic planning and governance,
- Needs related to value chain/cycle development, in particular SME engagement,
- Needs related R&I on technologies, knowledge transfer, education and new bioeconomy skills,
- Needs related coordinated funding and synergies between instruments,
- Needs related to public awareness and acceptance,
- Bottlenecks related to external factors.

Conclusions

The analysis shows that many regions in Europe (35.7%) have a **low level of bioeconomy maturity**, i.e. they cannot fully exploit the potential (i.e. jobs, growth, resource efficiency, rural development) of the bioeconomy on their own. Further development of bioeconomy related R&I activities of EU regions and Member States would require, at least:

- a common definition/classification of bioeconomy, for bioeconomy related economic and research activities and for bioeconomy maturity in EU regions that allows for monitoring and benchmarking bioeconomy deployment and support knowledge transfer.
- a coordinated support from the EU level to cities and regions in strategic planning and communication within a streamlined and integrated EU strategy and policy framework for bioeconomy. Also the knowledge exchange between Member States and regions should be supported/encouraged.
- strategic planning and leadership to coordinate, align and combine efforts on R&I (engaging industrial/SME, research, agriculture/fishery and environmental stakeholders), according to the different bioeconomy profiles and maturity levels.
- a more specialised support on the development of value chains according to the different bioeconomy profiles and maturity levels. Cross-border and interregional cooperation (twinning, networks) with regions of a similar profiles are already a valued tool.
- support in engaging also traditional sectors (e.g. agriculture, trade, urban services, food, fisheries etc.) and, in particular, SMEs in conversion processes (technology, business) towards the bioeconomy.
- support on developing transdisciplinary and specific bioeconomy competences and skills, both for research and academia and in businesses.

- better access to finance for small scale demo activities and pilot plants until new value chains and new technologies reach a sufficient TRL level to be market ready.
- more synergies and better coordination in funding and investments, in particular between ESIF and H2020.
- activities to raise public awareness and acceptance in regional bioeconomy ecosystems and in overall society about the potential benefits and perceived threats of the bioeconomy for cities and regions. Participatory approaches should be used to develop solutions for potential conflicts at local and regional level regarding land use, management of natural resources and biotechnological research.

Recommendations

Regarding a better deployment of the bioeconomy at national and regional level in Europe, five main areas of **recommendations** can be derived from the results and conclusions of the study. These areas are:

- a. Bioeconomy strategic planning and governance,
- b. Value chain/cycle development, in particular SME engagement,
- c. R&I on technologies, knowledge transfer and new bioeconomy skills,
- d. Coordinated funding and synergies between instruments,
- e. Public awareness and acceptance.

Recommendations
<p>A) More and better bioeconomy strategic planning and governance at national and regional level</p>
<p>A.1) The regions with a middle and low level of maturity, in particular in Central and Eastern and in South Europe, need to develop their bioeconomy ecosystems, in particular bridging elements and platforms between traditional (agro-food, fisheries) sectors, industry, science and research, technology as well as public administration. This requires analysis of the existing potential and of the current and prospective value chain approach. Integrative bioeconomy ecosystems have to be developed. Specific 'bridging links' (e.g. thematic platforms, regional networks, flagship projects, specialised innovation centres, science parks) have to support the interaction between stakeholders and ensure knowledge transfer, knowledge management and communication. Rural Innovation Partnerships, linking existing local action groups, operational groups and regional innovation systems, can help to promote innovation in most prominent subsectors (agriculture, fisheries, forestry, food).</p>
<p>A.2) Strategic planning and governance is crucial to deploy the bioeconomy. The development of a common regional vision for bioeconomy, priority setting, and coordination among research, industrial and agricultural policies is key to develop regional bioeconomy support frameworks that can be co-funded by national and EU funds.</p>
<p>A.3) Twinning, partnerships and interregional cooperation between regions with the same bioeconomy profile/approach can facilitate learning and knowledge transfer. Cooperation projects and partnerships with bioeconomy focus shall be promoted within existing cooperation programmes and in macro-regional and sea-basin strategies.</p>
<p>B) Support to value chain/cycle development and engaging SMEs</p>
<p>B.1) New bioeconomy technologies and business processes require investments to lower operational costs and generate benefits. Technological readiness is still low. Support schemes are needed not only for high end solutions but also to increase the technology readiness level (TRL) of small-scale technologies that can be useful also in regions with a low bioeconomy maturity (e.g. for rural biorefineries, wastewater recycling, use of agricultural and fishery by-products, sustainable aquaculture, bio-packaging).</p>
<p>B.2) Pilot facilities/plants and development/demonstration plants to support upscaling activities are needed for new/niche value chains (e.g. biofuel from algae, green gas through bacteria etc.). Support for new infrastructure and equipment is needed, in particular in low-maturity regions. In addition, knowledge exchange and analysis of existing pilot and demonstration plants and infrastructure facilities is needed in order to better exploit existing ones and enable decision-making on building new ones. Moreover, a European platform (e.g. within the S3 platform) for small/scale and/or multi-input biorefineries to showcase</p>

different approaches to biorefining and different business opportunities, could show how to adapt to diverse regional perspectives, offer access to finance for demo scale activities, coordinate the use of existing research facilities and demonstration plants and avoid duplication of infrastructure.

B.3) In order to optimise, convert and integrate existing value chains to regional value cycles, local/regional stakeholders – SMEs, in particular – must be actively engaged and supported, e.g. through voucher programmes for the use of pilot facilities/plants and demo plants or open access demo infrastructure. Not only the primary producers have to be involved, but also stakeholders upstream and downstream of the core bioeconomy business (supplier of, machinery, equipment, energy, water, processing, logistics, local energy suppliers as clients for bioenergy, wastewater treatment, retail and distributors etc.).

C) Develop R&I on technologies, knowledge transfer and new bioeconomy skills

C.1) It is important to shorten the learning curve for new value chains through knowledge diffusion in thematic networks, platforms, cooperation projects, transfer of results etc. These platforms, e.g. S3 platforms, should involve all relevant stakeholders. In particular, low and middle maturity regions should be encouraged and supported in developing necessary capacities to join these platforms. Existing partnerships (e.g. EIP AGR1, BBI-JU) networks, initiatives and platforms (e.g. ERA-NETS, ERRIN, ERRIAFF, Vanguard, CPMR, S3 platforms, macro-regional initiatives) regarding bioeconomy should be better promoted in order to further stimulate learning and knowledge transfer to regions with a lower bioeconomy maturity.

C.2) There is a need for capacity-building and support schemes (administration) for participation in existing networks and platforms for smaller countries and regions with a low bioeconomy maturity.

C.3) Knowledge transfer and mutual learning between regions could be enhanced through more specific thematic platforms. Thematic networks and working groups for bioeconomy related R&I within the agro-food sector, as the most important bioeconomy sub-sector in EU regions, should be promoted to streamline common interests and prepare joint programming and R&I activities (e.g. on crops, horticulture, seeds, animal husbandry, dairy, bread and pastries, NFF, beverages, starch biomass, sugar biomass, water management, packaging). Networks and working groups could embrace a range of sub-sectors and value chain elements in order to optimise and modify into value cycles and create closed loops.

C.4) Bioeconomy support to R&I has to focus on multi- and transdisciplinary (not only biotech) projects to promote the generation of value cycles and closed loops. This requires integrated research but also transdisciplinary education (both university as well as vocational and continuous training) and skills for bioeconomy.

D) Coordinate funding and synergies between instruments

D.1) There is a need to generate synergies and improve coordination in funding and investments, in particular between ESIF and H2020 and the instruments of ERA-Nets and Era-Net Co-funds, JPI, EIP, KIC, S3 platforms, BBI-JU. These funding sources and activities that are already taking place, including the Seal of Excellence scheme, have to be disseminated and communicated to all relevant national and regional stakeholders in regional bioeconomy ecosystems, as they offer valuable funding opportunities and help to establish thematic platforms and networks within bioeconomy domains. Initiatives to coordinate and bring together funds and stakeholders, such as ERA-PLATFORM, have to be strengthened and further developed in order to enhance visibility and facilitate participation of regions and smaller countries.

D.2) Local and regional policymakers have to be aware of the potential benefits of and approaches to bioeconomy in their regions, and should increase their knowledge on how existing funds (ESIF, H2020, ERA-Nets, COSME, LIFE+ etc.) can be used and synergies generated to stimulate the bioeconomy at regional level. A better communication of good practices and project results might be necessary.

E) Raise public awareness and acceptance

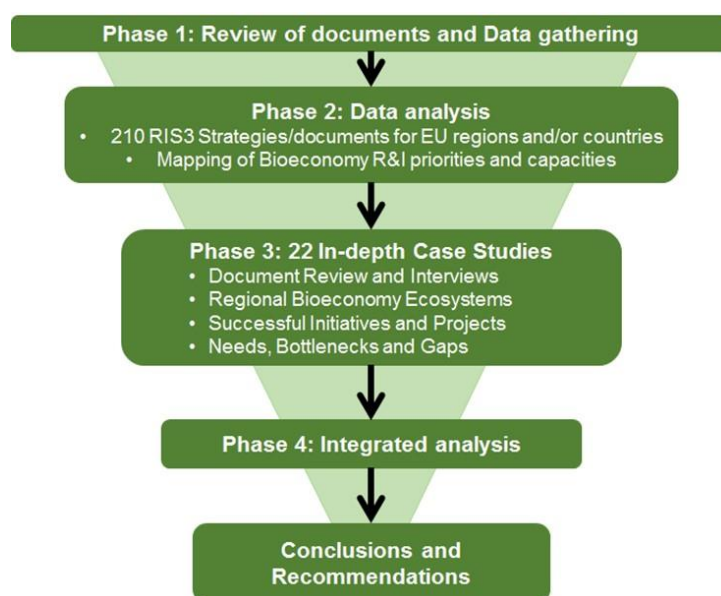
E.1) Regions need guidance and support in order to engage civil society/general public in the deployment of the bioeconomy. Activities are needed to raise awareness on potential benefits of new/modified value chains in industrial/ agricultural sectors, as well as on the benefits of a circular economy and on the cascading use of biological resources and residues/by-products. Negative perceptions and fears should be better analysed and addressed. Bioeconomy standards and labels should be developed to give an overview on positive and negative features of bio-based and recycled products. Protection of consumer rights has to be considered as an important aspect to enhance acceptance of bio-based and recycled products. Overall, advancing towards citizen-friendly value chains and cycles should be one objective of bioeconomy deployment.

2. INTRODUCTION

This report presents the results of the study “Mapping of EU Member States’ / regions’ Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy for 2014-2020”. The study project was commissioned by DG Research & Innovation, Directorate F – Bioeconomy (Unit F.1 – Strategy) and carried out by a consortium led by SWECO and Spatial Foresight with the support of ÖIR, t33, Nordregio, Berman Group and INFYDE.

The overall **objective** of the study is to map the intended priorities and activities of EU-28 Member States (MS) and regions with regard to research and innovation (R&I) on Bioeconomy, according to the current national or regional Smart Specialisation Strategies (RIS3) and programmes supported by the European Structural and Investment Funds (ESIF) for 2014-2020. This information helped to define similarities, commonalities and specificities among the regions in the European Union, to identify and describe successful regional initiatives with a potential to be transferred to other regions as well as bottlenecks and gaps. The study presents conclusions and policy recommendations that will serve the European Commission services and national/regional policymakers as an evidence base for future policies and initiatives strengthening bioeconomy.

The **methodology of the study** is presented in the following figure. Key methods are desktop research, thematic mapping and in-depth case study research.



Task 1 of the project organised an EU-wide (EU-28) desk research and data gathering based on official and informal documents which allowed filling a data base with regionalised (when regional data was available) information on current and planned bioeconomy related research and innovation activities across Europe. Task 2 analysed the collected regional data on current and planned bioeconomy related research and innovation activities across Europe, in order to learn more about the regional specific profiles with regard to bioeconomy research and innovation. On the whole, the analysis covers 210 territorial units (22 NUTS0 = countries, 25 NUTS1 regions, 125 NUTS2 regions, 38 NUTS3 regions). Task 3 analysed 21 regions/countries and 1 macro-regional network with regard to their specific bioeconomy profile/approach and to current and planned bioeconomy support programmes and plans (instruments, modalities, funding volumes), as well as pilot projects, demo cases and other close-to-market initiatives.

In Section 3, the study presents an introduction and overview on the potential of bioeconomy for European Member States and, in particular for the regions, pointing out the features and requirements for the deployment of bioeconomy and the role of the Smart Specialisation Strategies (RIS3) in planning R&I activities for the 2014-2020 period. Section 4 shows the results of the analysis of regional characteristics and approaches regarding bioeconomy and presents a typology of regions according to their bioeconomy profile. Section 5 gives examples of how the bioeconomy is being implemented in the EU Member States, in particular at regional level. Section 6 features the overall conclusions of the analysis and leads to a set of recommendations for future policies for bioeconomy presented in Section 7.

3. BIOECONOMY-RELATED RESEARCH AND INNOVATION IN EU REGIONS AND COUNTRIES

This section includes an introduction and overview on the potential of the bioeconomy for European Member States, in particular for the regions, pointing out the features and requirements for the deployment of the bioeconomy and the role of the Smart Specialisation Strategies (RIS3) in planning R&I activities for the 2014-2020 period.

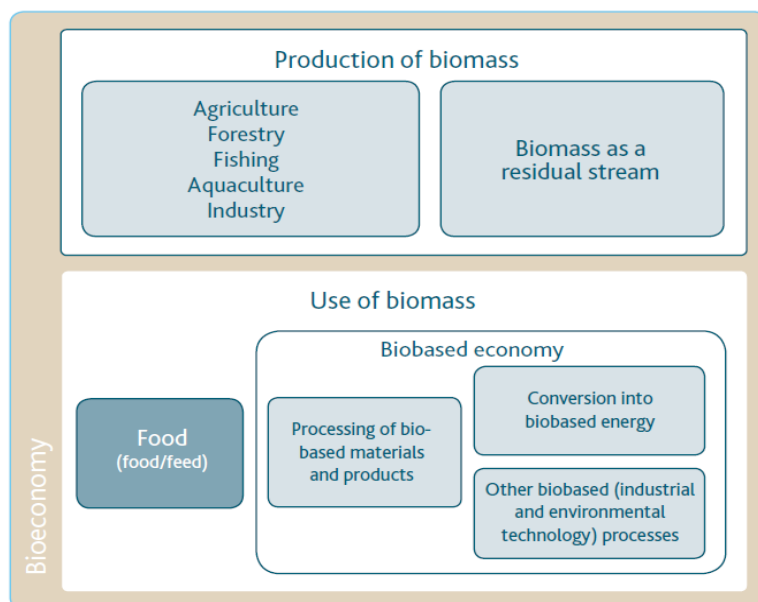
3.1. Understanding the bioeconomy – definitions and potential

Within the context of climate change, there is a growing pressure on non-renewable resources and a need to make our productions and consumption models more sustainable. The shift towards a more sustainable production of biomass and a more efficient use and management of bioresources can help to reduce waste, contamination and climate change as well as usage of fossil-based resources. This shift implies a whole set of changes in primary production as well as in industrial and economic processes that is generally labelled as bioeconomy.

Bioeconomy describes a concept that acknowledges the full potential of biotechnological research and innovation for the economy and society as a whole. It has been promoted since the last decade, in particular by biotechnology pioneer countries, such as for instance, the Netherlands, Germany and Finland. In 2009, the OECD presented an influential report on "The Bioeconomy to 2030: designing a policy agenda". In 2012, the European Commission presented the first European Bioeconomy Strategy (European Commission 2012a). Herein, bioeconomy was defined as follows:

"The bioeconomy encompasses the production of renewable biological resources and their conversion into food, feed, bio-based products and bioenergy. It includes agriculture, forestry, fisheries, food and pulp and paper production, as well as parts of chemical, biotechnological and energy industries. Its sectors have a strong innovation potential due to their use of a wide range of sciences (life sciences, agronomy, ecology, food science and social sciences), enabling and industrial technologies (biotechnology, nanotechnology, information and communication technologies (ICT), and engineering), and local and tacit knowledge".

Figure 3.1: The bioeconomy and the bio-based economy

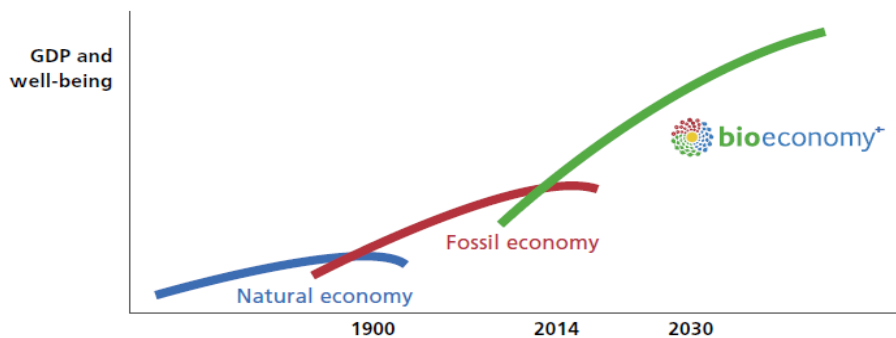


Source: Vlamse Overheid (2013:9), based on Minaraad and SALV recommendation 'Sustainable use of biomass in a bioeconomy' (2012)

Within the context of the challenges of our time, such as climate change through GHG emissions, biodiversity preservation, food safety and availability of materials and energy, the bioeconomy represents an important shift towards a new economic and industrial revolution. This is because bioeconomy is part of three major evolutions:

First, bioeconomy is key in the transition from fossil/petroleum- based resources towards bio-resources in industrial production. Bioeconomy refers to an economy that relies on renewable natural resources rather than on fossil resources and petroleum based materials to produce energy, products and services. In this sense, bioeconomy proposes a new industrial revolution/wave (as shown in Figure 3.2). The use of bioplastics in the automotive industry is one of many examples where conventional products are replaced by bio-based material, t (e.g. OECD 2014, BMBF 2014, Nova Institute 2015b).

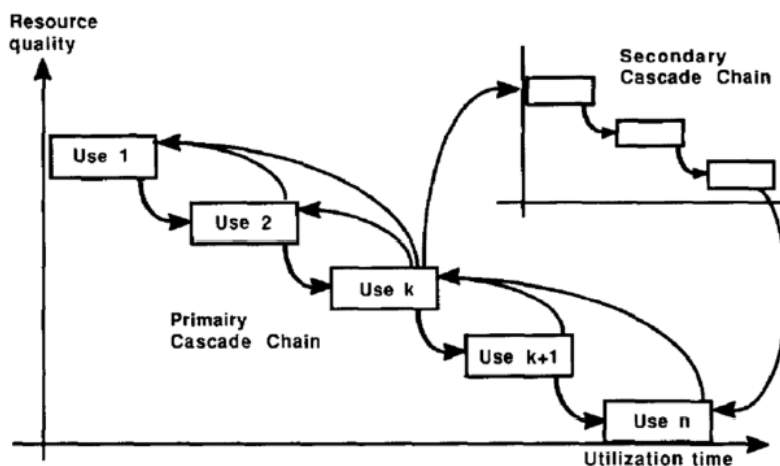
Figure 3.2: Bioeconomy as a new wave of economic development



Source: Finnish Ministry of Employment and the Economy (2014:5)

Second, bioeconomy is a crucial element of the circular economy based on the 'cascading use', re-use and recycling of resources (including waste) and the contemplation of complete lifecycles of resources and materials. A 'cascading use' describes the multiple utilisation of a resource (in different forms) during a specific time interval.

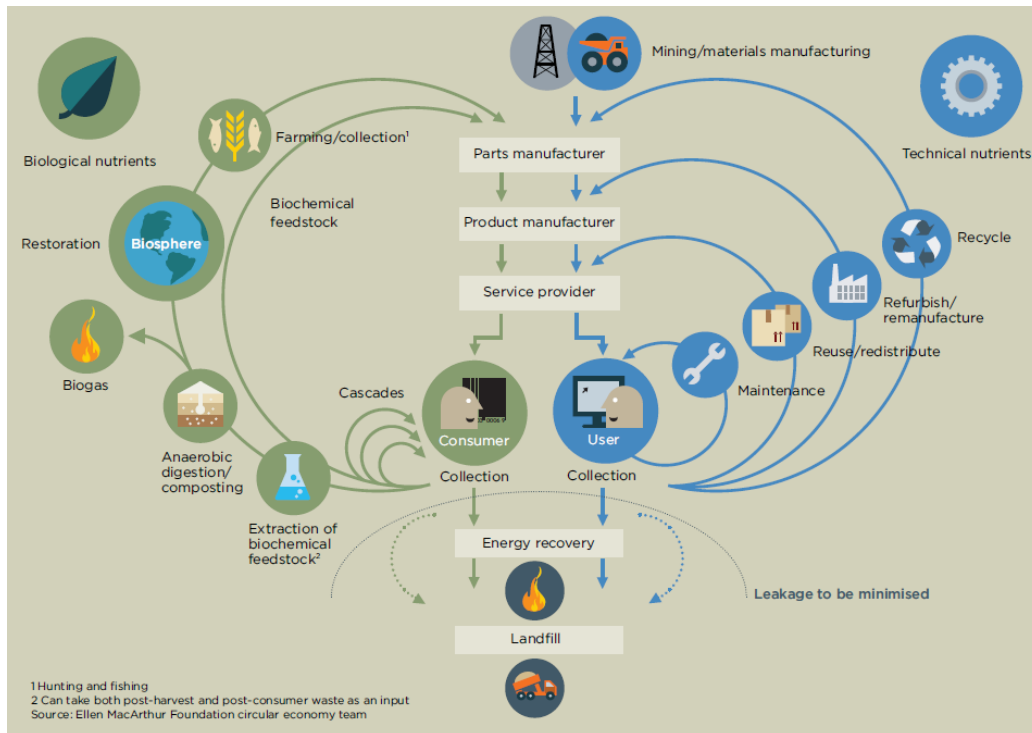
Figure 3.3: The utilisation of a resource within the cascading chain



Source: Vis et al. 2016:4 (based on Sirkin, T. & M. ten Houten (1994): The cascade chain - A theory and tool for achieving resource sustainability with applications for product design. In: Resources, Conservation and Recycling 10 (3): 213-276)

Bioeconomy is about adopting an integrated and systemic view on food, energy and industrial production. In a circular economy, materials that can be reused and recycled are injected back into consumption cycle as new (raw) materials. This converts what is waste for some economic actors into "secondary raw materials" for others.

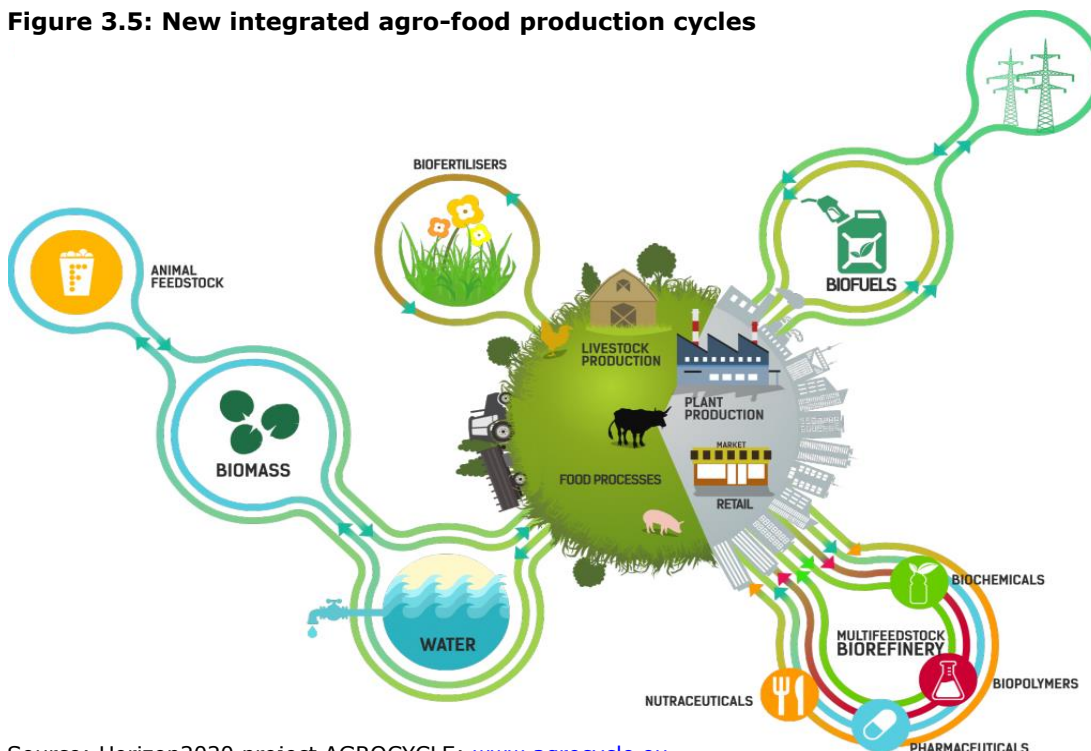
Figure 3.4: The Circular Economy



Source: Ellen MacArthur Foundation 2013:24

Understanding the systemic nature of problems such as scarcity of resources, pollution and reduction of waste, the European Commission adopted in December 2015 a circular economy package to foster sustainable economic growth, while using resources in a more sustainable way (European Commission 2015a). The circular economy initiative is closely linked to bioeconomy, industrial growth, energy and climate policies. A circular or life cycle approach to agriculture and manufacturing requires new and integrative perspectives of value chains and production processes, bringing together formerly separated sectors, e.g. agriculture, energy production, textiles and chemicals.

Figure 3.5: New integrated agro-food production cycles



Source: Horizon2020 project AGROCYCLE: www.agrocycle.eu

Third, bioeconomy offers a potential to modernise traditional economic sectors and to generate new sustainable economic growth through enabling new technologies such as biotechnology and nanotechnology.

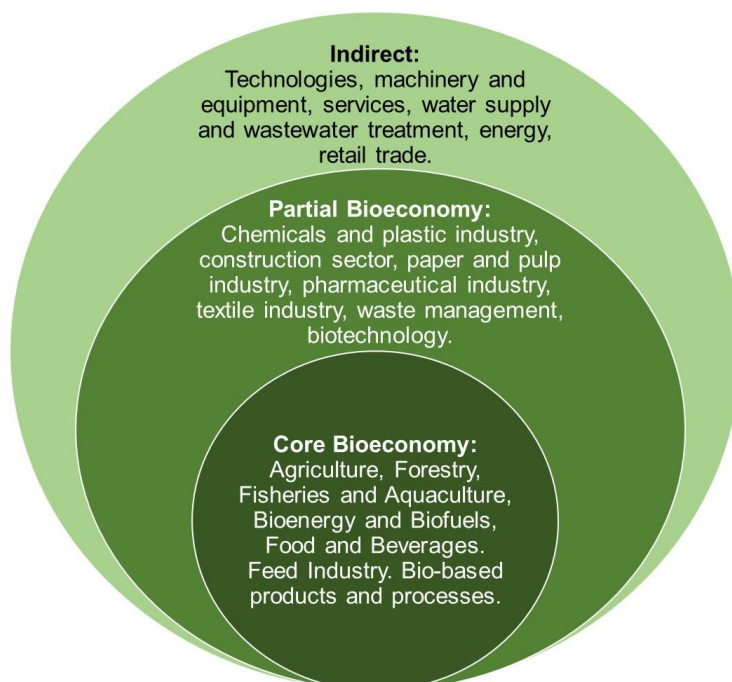
According to the Nova Institute (2016), in 2013 the European bioeconomy generated an estimated turnover of around EUR 2.1 trillion. “Almost half of the turnover came from the food and beverage sectors. The other half was generated by agriculture and forestry (also known as the primary sector) and the bio-based industries (chemicals and plastics, pharmaceuticals, paper and paper products, forest-based industries, textiles and textile products, biofuels and bioenergy)”. In the same year, the European bioeconomy employed 18.3 million people. Around 10.6 million people were employed in the primary sector, 4.5 million people in the food, beverages and tobacco sector and 3.2 million in the bio-based industries (e.g. forest-based industry, paper and paper products, textile industry).

An estimation for the Nordic countries (Finland, Sweden, Norway, Denmark and Iceland), shows that the total turnover of the key bioeconomy sectors is roughly EUR 184 billion including agriculture, fisheries and aquaculture, forestry, food industry, forest industry and bioenergy and biofuels. This corresponds to 10 % of the total economy in Nordic countries (Nordic Innovation 2014).

In the UK, the bioeconomy is estimated to have a direct impact on the economy of about £36.1 billion value added and 600 000 jobs (Capital Economics 2015). Italy has examined its bioeconomy sector and estimated a turnover of about EUR 250 billion per year and about 1,850,000 jobs (Italian Presidency of Council of Ministers 2016).

Given that the definition and inclusion of sectors vary from one study to the other, these studies are not fully comparable. In general, there are certain core bioeconomic activities that can be related to primary production and the direct use of primary resources: agriculture, fishing and forestry, food industry and bioenergy. Other sectors are increasingly forming part of the bio-based economy, as they use biological resources as input for their production processes. The need to adapt technologies and engineering to the bio-based production has an indirect impact also on sectors such as machine-tool manufacturing, services as well as water supply and retail trade (see Figure 3.6).

Figure 3.6: Economic sectors in the bioeconomy within the framework of this study



Source: Own elaboration

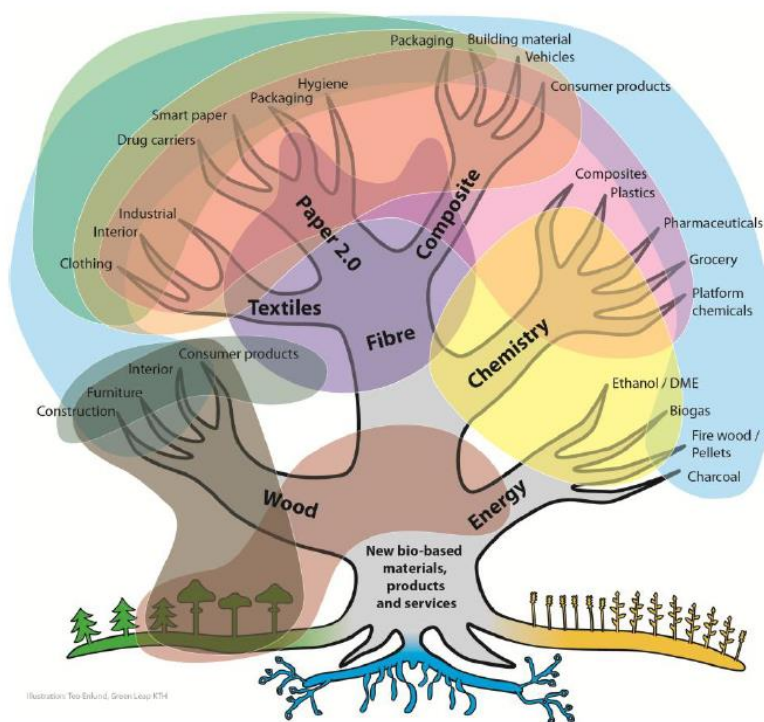
Bioeconomy is increasingly important in a number of economic sectors. An OECD report (2014:9) quotes figures for the chemical and plastics sector where current production is still rather low (e.g. only 0.4% of the worldwide polymer consumption in 2012 was represented by biopolymers), but growth rates are significant, while technology maturity levels rise and investment costs decline

steadily. The bio-based production is more advanced in countries that actively support the bioeconomy. In Germany, for example, it was estimated that 12.6% of the national chemical production in 2011 was based on biological and renewable raw material (BMBF 2014:26).

One of the particularities of the bioeconomy is that it is not sectoral in nature, nor does it have a focus on specific territories, technologies or science fields. Rather it brings together traditional sectors such as agriculture, forestry and fisheries with innovative research fields such as nanotechnology and synthetic biology as well as highly advanced manufacturing systems and technologies. For European countries and regions, this is an opportunity to promote growth and jobs, in particular, in rural or peripheral regions, in case the wealth in natural assets in these regions can be connected to the knowledge and technological capacities available in other regions of Europe.

Converging trends lead to market pull and technology push effects that encourage innovative approaches in many economic sectors, including agro-food, forestry and lumber, aquaculture, heat and electricity production, paper and pulp, construction, sustainable chemistry, industrial manufacturing, industrial and environmental biotechnology etc. The shift from fossil resources to biological resources affects also wider part of the manufacturing industry, such as the packaging industry, the chemical industry, the cosmetics industry as well as the production of energy and fuels (see Figure 3.7).

Figure 3.7: Sectors and products connected to forestry-based biomass



Source: Swedish Forest Industries Federation (2013:11)

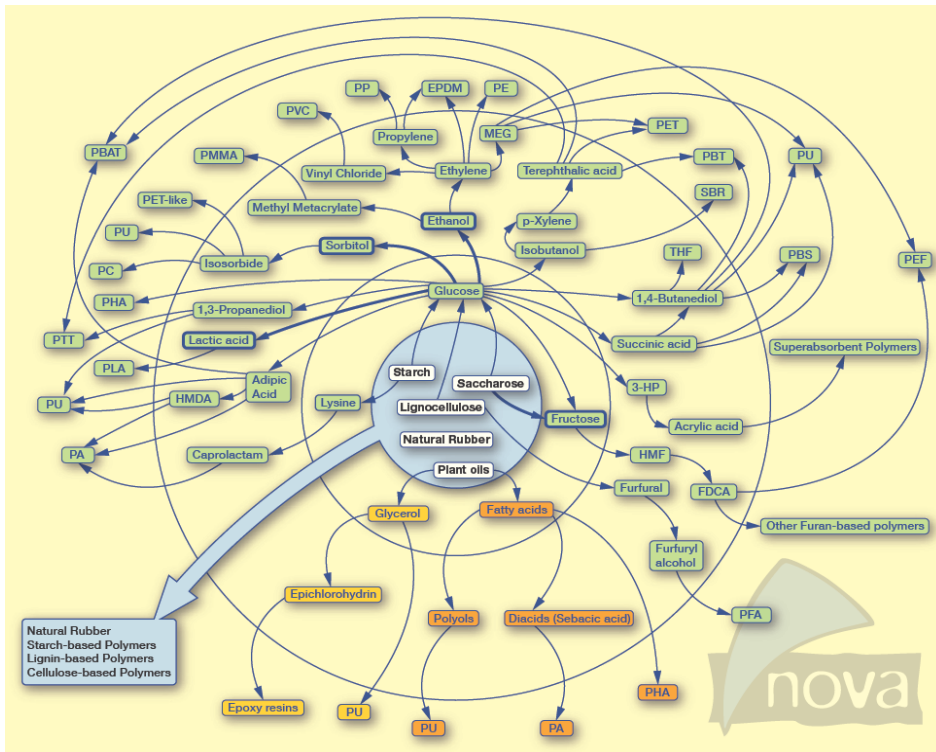
The systemic character of the bioeconomy and the interconnection between the different economic sectors makes it difficult to establish a single classification or statistical delimitation of the concept of bioeconomy. Experts agree that there *“is a need for a common understanding of the term ‘bioeconomy’ and a shared appreciation of how its boundaries within the global economy can be defined. Moreover, in order to understand the impact of different policies on the development of the bioeconomy, generally agreed indicators will need to be defined”*. (OECD 2015:17)

In the same line, a report on the situation of the bioresources in the Nordic Countries states that the *“development and growth of bioeconomy requires systemic change and innovations linking value creation across companies, sectors, and resource flows. Thus, innovation and business opportunities need to be identified across the boundaries of the traditional sectors and different sciences”* (Nordic Innovation 2014:84).

3.2. Bioeconomy value cycles

Because of its particular character, it is central to analyse the bioeconomy in the context of value chains or even in value cycles. This, however, implies two main difficulties. First, the integrated and circular character makes bioeconomic approaches differ from traditional approaches to use natural resources usually for one purpose only (e.g. crops for food/feed or wood for energy). Second, new and complex value cycles emerge due to new research findings and technological opportunities to work with the molecular building blocks of biological resources (as in Figure 3.8).

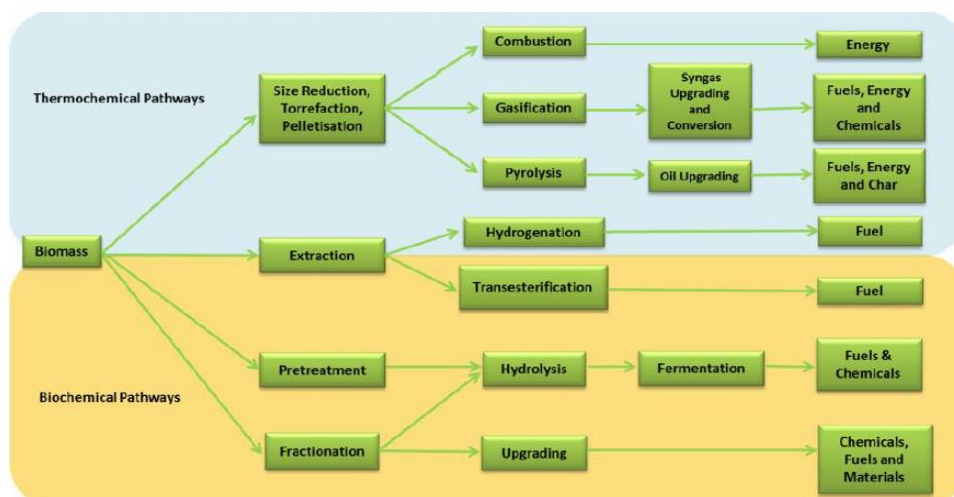
Figure 3.8: Biological building blocks



Source: Nova Institute 2015b:1

A central element of all bioeconomy value cycles is the process of **biorefinery**. Biorefinery describes different applications to turn basic natural resources like starch, sugar, lignocellulose or plant oils through different thermochemical and biochemical conversion processes into smaller elements or building blocks that serve for the elaboration of end products like fuels, chemicals or biomaterials.

Figure 3.9: Thermochemical and biochemical conversion pathways for biomass



Source: Kretschmer et al. 2013:43

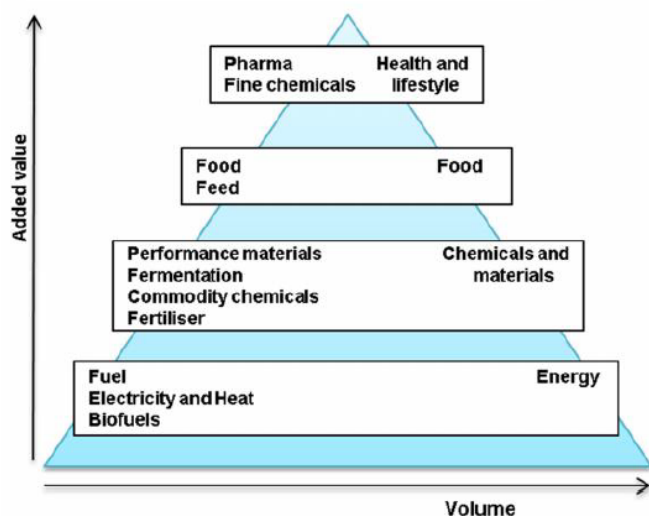
Biorefinery is defined as “the conversion of biomass into several product streams (materials, chemicals, energy, food and feed) and the integration of various technologies and processes” (Star-COLIBRI 2011:9). Biorefinery is similar to petrochemical refinery processes, with the difference that only biomass and bio-based waste is used as input. Moreover, “the biorefinery concept goes beyond the philosophy of oil refineries, by including sustainability management practices and closed loop processing cycles wherever possible. This aims to mimic the natural, global scale, carbon cycle. [...] More generally, the biorefinery concept includes the management of all sustainability issues, including environmental, economic and societal factors” (Star-COLIBRI 2011:10).

The production of biochemical building blocks through biorefinery is still not a mature technology. That means that investments are still needed to reach technological maturity and profitability in the production of bio-based products. However, foresight studies predict market solutions and technological maturity for high added value products within the next decades (e.g. NIC 2008, Star-COLIBRI 2011, Nova Institute 2015b).

Advanced and integrated biorefinery processes are crucial to reach higher returns through more added-value generation. The OECD highlights the potential of bio-based chemicals and materials compared to low-added value uses of biomass. “[...] in Flanders, bio-based products (such as paper, wood-fibre boards, bioplastics and biochemicals) create five times more added value (based on gross margin calculations) and ten times more employment than bioenergy (i.e. bio-based electricity or heat and biofuels).” (OECD 2013:30).

Therefore, for European regions and Member States that want to deploy the bioeconomy, there are two challenges with regard to value creation based on biomass (see Figure 3.10).

Figure 3.10: The biomass value triangle

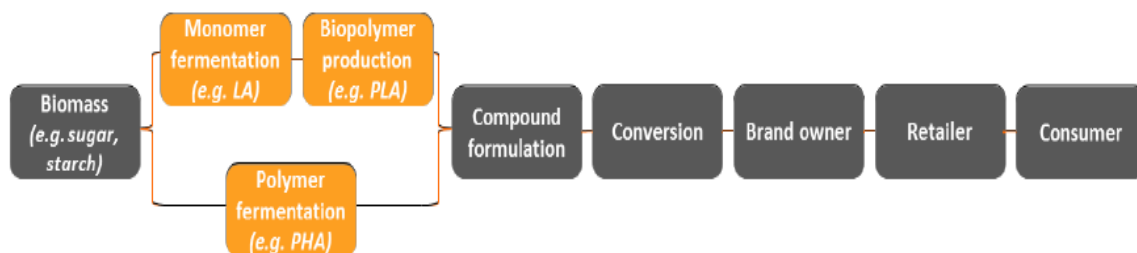


Source: Kretschmer et al. 2013:86, adapted after Eickhout (2012), based on http://www.biobasedeconomy.nl/themas/bioraffinage_v2/

First, the question of how to integrate existing value cycles in order to generate higher added value products and to receive more direct returns in terms of jobs and growth. This challenge is policy driven and intrinsically linked to relevant strategies for economic development and competitiveness. The second challenge refers to the question on how to reach technological maturity with regard to radical innovations in bioeconomy value chains. This challenge is basically research- and innovation driven.

To deploy the bioeconomy, the challenges cannot not be considered as isolated problems but need to be tackled together. With regard to the first challenge, there is still not much structured knowledge on how new bioeconomy value chains or cycles can be supported strategically at local and regional level. The development of new value cycles is difficult, as it has to involve not only actors that provide sufficient biomass input, but also players that can further develop biorefinery processes, as well as agents to develop products and markets around bio-based products. Only recently, projects like the European research project BIO-TIC proposed roadmaps for the development of actual value chains (see Figure 3.11).

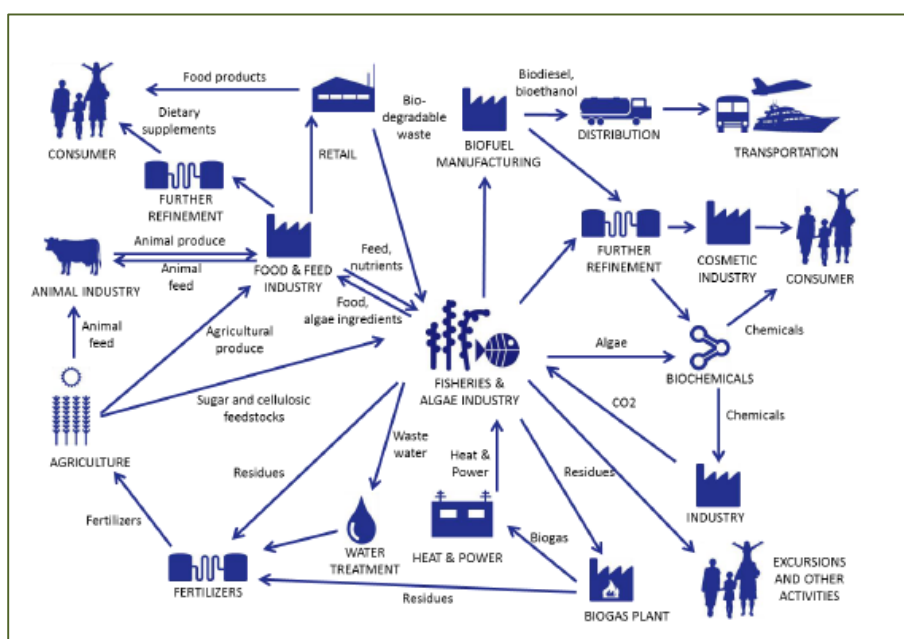
Figure 3.11: Example value chain for biopolymer production



Source: BIO-TIC (2015:20)

Another approach (Figure 3.12) covers the Nordic countries (Nordic Innovation 2014) and introduces actual steps on how to create more value out of bio-based value chains.

Figure 3.12: Nordic aquatic biorefinery business ecosystem



Source: Nordic Innovation (2014:33)

Regarding the second challenge, it would need to involve frontier research and development projects that align forces and resources from all over Europe.

There are several European research projects (e.g. EuroBioRef, Agrocycle, Bio-TIC, BERST), technology platforms and alliances (e.g. European bioplastics, European Technology Platform for Sustainable Chemistry, EIP-Agri), networks and platforms (e.g. ERA-Nets Waterworks, FACCE Surplus, BESTF3, ERA-HDHL, ERA4CS, CoBioTech, SUSFOOD2 and ERA-PLATFORM¹), and, in particular, the Bio-Based Industries Joint Undertaking (BBI) – a Public-Private Partnership between the EU and the Bio-based Industries Consortium – that work on the research, testing and demonstration of new value chains (see Strategic Innovation and Research Agenda – SIRA²).

¹ ERA-PLATFORM (www.era-platform.eu) is a platform of bioeconomy ERA-NET Actions in the field of food, agriculture, aquaculture, fisheries, forestry, climate, biodiversity and biotechnologies.

² Strategic Innovation and Research Agenda (SIRA) : http://bbi-europe.eu/sites/default/files/documents/BBI_SIRA_web_0.pdf

3.3. The regional perspective of the bioeconomy

Apart from knowledge and technology development taking place in R&D departments in large companies and/or flagship projects, such as the German bioeconomy cluster in and around Leuna (Sachsen-Anhalt), most of the conversion towards a bioeconomy occurs step-by-step at local and regional level. In order to produce the expected effects on jobs, growth, GHG emissions and the environment, the bioeconomy has to be implemented in the European regions, regardless their socio-economic structure, natural conditions and research profile.

Today, there are some European regions that strongly focus on the bioeconomy as one of their economic and innovation priorities and can be considered as bioeconomy leaders. Others are starting to develop bioeconomy strategies, updating and modernising either their agricultural profile or their industrial profile towards more integrated, sustainable, circular and resource efficient approaches. However, most European regions – even if convinced by the potential of the bioeconomy – still have a rather fragmented perspective and struggle with many diverse challenges to implement the bioeconomy on the ground.

The report on 'Regional Biotechnology - Establishing a methodology and performance indicators for assessing bio-cluster and bio-regions relevant to the KBBE area' (PwC 2011) was one of the first to highlight the territorial perspective of the bioeconomy. However, at that time, the focus was in particular on 'successful' bio-cluster and bio-regions. Some of the success factors of bio-regions were identified: a high level of awareness at regional level of the importance of the bioeconomy, the consequent allocation of resources, and the willingness of the regional policy makers and politicians to bring bioeconomy on national and EU agendas (PwC 2011:7).

After 2014, there have been more/many attempts to learn more about the regional perspective of the bioeconomy, in particular referring to differentiated challenges, potentials and strategies. Examples are the FP7-research project BERST³ that analysed the current and future bioeconomy potential of EU regions and the HORIZON 2020-research project BIO-STEP⁴ with the aim to promote a public dialogue on the goals of the bioeconomy and, among others, to disseminate good practices of regional bioeconomy approaches. The European Bioeconomy Observatory⁵ is promoted by the Joint Research Centre of the European Commission and presents country profiles and some regions with their bioeconomy profile and policies.

In addition to EU-wide and national research projects, there are also bottom-up initiatives to learn more about regional action within the bioeconomy. The northern-European countries analysed regional case studies in order to learn more about the different pathways to implement the bioeconomy (Nordregio 2014). The ERRIN network of innovative regions in Europe has established a Working Group on the Bioeconomy. A survey among 24 ERRIN regions and their bioeconomy activities, needs and potential produced insights to detailed regional approaches on bioeconomy and identified the importance of Smart Specialisation (RIS3) strategies for the growth of the regional bioeconomy sector (ERRIN 2015). Specific mappings of regional R&I priorities in the maritime and blue bioeconomy domain have been carried out for the North Sea areas (REID Consulting 2016) and for European coastal regions (CPMR 2016). The Vanguard initiative⁶ is another example of a bottom-up network of European regions to promote the implementation of bioeconomy research and innovation. At macro-regional level, the areas of the Baltic Sea Region⁷ and the Danube Region⁸ promote a collaborative approach to the bioeconomy, trying to establish pilot projects and inter- and transregional learning communities and networks.

Despite these initiatives to learn more about the regional configuration of the bioeconomy, the level of practical knowledge to stimulate bioeconomy at regional level is rather low, as confirmed already by a Regional Innovation Monitor Plus's Thematic paper. *"The regional perspective has been one of the least explored perspectives of the shift towards the new model. Taking into account different geographies is particularly relevant for understanding the dynamics of the transition, notably for changes of supply and value chains. The wider diffusion of new solutions or business models will depend on the absorption capacity and innovation potential of European regions and cities"* (Technopolis 2014:2). The same report concluded that *"there is a need for a more comprehensive research on regional and local aspects of the transition towards a circular*

³ www.berst.eu

⁴ www.bio-step.eu/

⁵ biobs.jrc.ec.europa.eu/

⁶ <http://www.s3vanguardinitiative.eu/>

⁷ <http://bsrbioeconomy.net/>, see also Norden/Innogate 2014.

⁸ <https://danube-inco.net>

economy [...]. Regions and cities have a potential to become leaders and catalysers of this shift, [...]" (Technopolis 2014:23). This call for more analysis and understanding of the regional diversity in tackling the bioeconomy is repeated and specified with more detail in recent strategic documents.

For instance, the European Commission mentioned already in the Staff Working Document that accompanied the Communication on the Bioeconomy (EC 2012b) the need for regional approaches to stimulate the bioeconomy, as it "*can significantly contribute to the future development of rural and coastal areas*". Also, the funding opportunities for region within the EU Cohesion Policy, CAP and CFP, together with the support from Horizon 2020 were highlighted.

Preparing for the review of the EU Bioeconomy Strategy in 2017, stakeholders confirmed the need to strengthen the role of cities and regions in implementing the bioeconomy. In this context, the EUROPEAN BIOECONOMY STAKEHOLDERS MANIFESTO was launched in **Utrecht** in April 2016 at the **Fourth Bioeconomy Stakeholders' Conference** under the auspices of the Dutch EU Presidency by stakeholders from large and small companies, NGOs, governments and associations from all over Europe. The Manifesto highlights that "*regions are key actors in developing a European bioeconomy and bioeconomy can make regions more attractive. Regions are important to keep vital rural economies and realising regional cycles. Mutual learning within and between regions and more resources for peer-to-peer exchanges at the EU level are essential*", and mentions guiding principles to effectively implement the bioeconomy on the ground, i.e. in existing agriculture, forestry, marine and industrial contexts (BEU 2016).

In particular, Central and Eastern European regions demand more and tailor-made support to deploy the bioeconomy. The 'Lodz Declaration', concluded by Central and Eastern European regions and stakeholders from companies, academia, NGOs and farmers at the **European Bioeconomy Congress Lodz 2016**⁹, states that "*regions should play a crucial role in successful development of bioeconomy potential, increasing the R&D and technology capacities, deployment of local Biocommunities organized on the base of local sustainable circular bioeconomy value chains.*"

The **Bratislava** Bioeconomy Conference on the '*The role of regions in European Bioeconomy*' was organised in October 2016 under the auspices of the Slovak Presidency of the Council of the EU with support of the European Commission. The conclusions highlight that the "*Bioeconomy should be based on the development of sustainable and circular Bioeconomy at regional and local level (Bio-regions and Bio-communities). [...] EU Member States and regions are encouraged to develop their national/regional Bioeconomy strategies, in synergy with their smart specialisation strategies. [...] Supportive 'region-friendly' tools and framework conditions shall be further promoted, for the uptake of Bioeconomy, initiating new cross-sectoral, cross-regional and macroregional cooperation schemes*". (BBEC 2016)

Thus, it becomes more and more clear/evident that the deployment of the bioeconomy have to involve not only different stakeholder groups, in particular at the local and regional level, but also existing production, distribution and policy-support systems have to evolve in line with the changing demands of a circular and decentralised model of production. One cannot speak of 'one' regional model to implement the bioeconomy. Strategies, business models, showcases and support policies will have to take into account the existing bioeconomic features of a given region and its regional bioeconomy ecosystem.

In fact, one cannot even talk of only one strategy or model for one region, but have to differentiate the needs to implement the bioeconomy at - at least - three different levels. The EUROPEAN BIOECONOMY STAKEHOLDERS MANIFESTO indicates that different 'regional spheres' have to be taken on board to implement the bioeconomy:

1. Policy and decision-makers (involving various administrative levels and different competences on economic development/industry, agriculture/fisheries, and research and education),
2. Primary production communities, assuring the availability of biofeedstock and
3. 'Local/ regional value cycles' within a logistically defined area that connect consumers, producers, resource/waste managers, logistics and retailers (BEU 2016).

⁹ http://bioeconomy.lodzkie.pl/wp-content/uploads/dekl_en.pdf

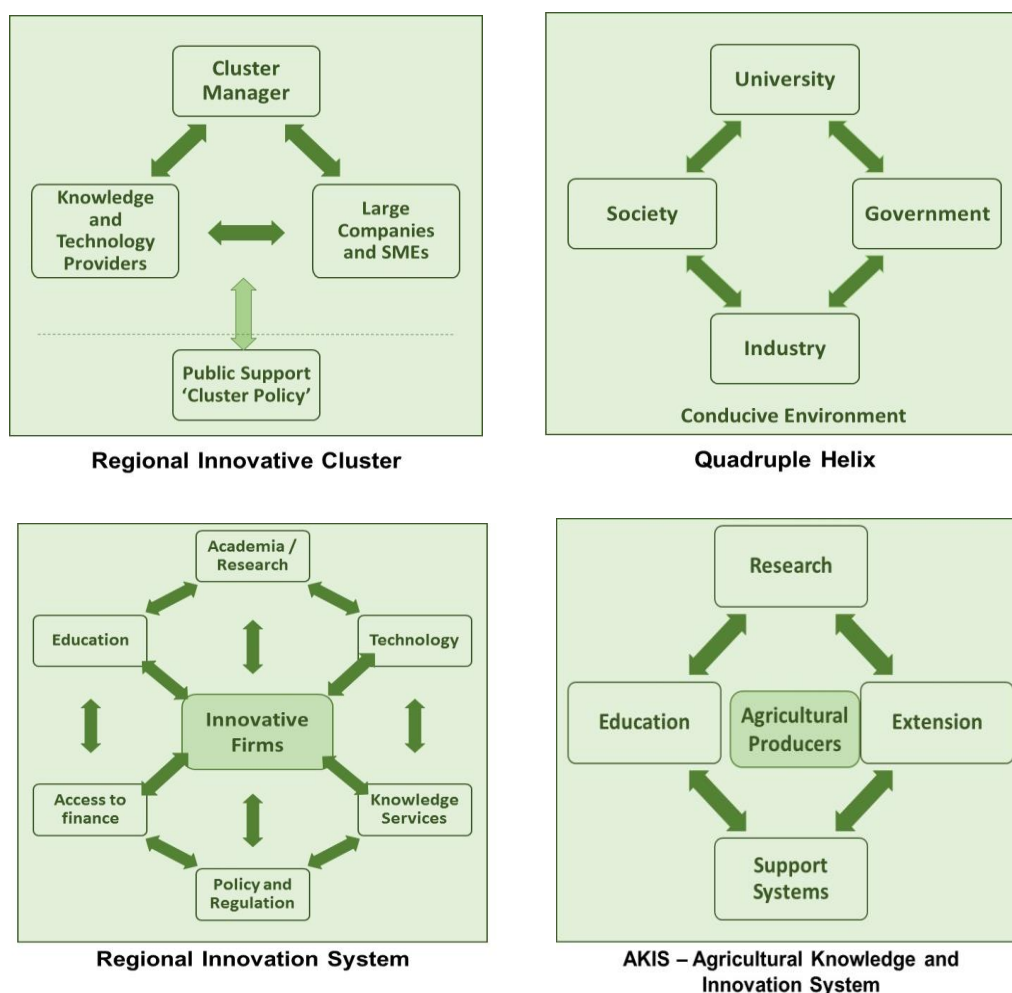
In short, regional bioeconomy ecosystems have to be developed and put into action. The next section describes the specific features and elements of regional bioeconomy ecosystems.

3.4. Regional bioeconomy ecosystems

The cross-cutting, intersectoral and circular character of the bioeconomy demands a systemic perspective of the regional deployment of the bioeconomy. The approach is in line with other systemic approaches to stimulate innovation at regional level or within certain economic sectors, but even more ambitious as it has to clearly establish links between different science disciplines, technologies and sectors and re-defining value chains into regional value cycles.

Regional bioeconomy ecosystems are based on the conceptual approaches which have been developed over the last decades to better understand and stimulate innovation in multi-actor settings. Thus, bioeconomy deployment can be linked to the theory of innovative clusters (Porter 1990), the triple and quadruple helix approach (Etzkowitz and Leydesdorff 1995), the approach of regional innovation systems (Braczyk et al. 1998) and to AKIS (agricultural knowledge and innovation systems) (EU SCAR 2012) (see Figure 3.13).

Figure 3.13: Different models of regional innovation ecosystems



Source: Own elaboration

The integrative and participatory character of the Smart Specialisation Strategy (RIS3) planning process is also built on this systemic view of regional R&I activities (Foray et al. 2012). Also, most envisaged bioeconomy-related programmes or policies in place for the 2014-2020 period at national and regional level adopt this systemic view (see chapter 3.5).

The organisation of all relevant bioeconomy stakeholders at regional level follows and widens the approach of clusters and regional innovation systems. Already in 2008, the European Commission¹⁰ (DG Enterprise and Industry) recognised the important role of bio-cluster in stimulating innovation and improving competitiveness, and undertook efforts to improve their coordination and sustainability 'through improved science-industry linkages, world-class innovation clusters and the development of regional clusters and networks' (PWC 2011:2).

In 2010, the sentinel KBBE study confirmed the need for collaborative structures to promote the bioeconomy: *"Because of the high R&D investments needed to develop an innovative bio-based product, we see a growing number of public-private partnerships developing. There is a clear need for a coordinated technology development covering different technologies and parts of the value chain (feedstock development, product development, production optimization, innovative application development). Cooperation in cluster structures rather than in single-company partnerships is significantly accelerating the development of processes and their penetration into the industry."* (KBBE 2010:40)

The 2011 examination of regional biotechnology clusters defined bio-cluster as *"heterogeneous entities, varying widely in structure, evolution and goals that represent a local complex system where different types of organisations interact for research, innovation and economic growth. Existing literature suggests that the clusters offer key competitive advantages with respect to three key variables: employment, innovation, and productivity. Productivity is enhanced by lowering transaction costs with untraded interdependencies. Innovation is dependent on the interactive knowledge exchange between varieties of knowledge actors, especially because of the proximity necessary for tacit knowledge exchange. Employment comes as a result of new business formations and is massively assisted by mentoring, role-model provision, learning, communication, and commercialisation gains that arise from operating in a cluster setting."* (PwC 2011:2)

The BERST project identified the following key elements of regional bio-cluster (BERST 2015:4):

- the presence of an entrepreneurial culture with active, innovative, flexible and risk taking entrepreneurs plays a pivotal role in driving clusters towards successful development;
- political leaders who are willing to support the development of the bioeconomy by providing governance, institutional structures and financial support;
- organizations that provide the technical knowhow and innovation for the development of bioeconomy products;
- a continuous supply of biomass resources of constant quality is critical for the development of bioeconomy products;
- competitive production of bioeconomy products: commercially viable products, such as chemicals, medicines, food, bioplastics, transport fuels, electricity and heat.

However, these general recommendations do not reflect the diverse realities of regional bio-cluster in Europe. In fact, also agricultural, wood, sustainable construction and agro-food cluster, fishery and maritime cluster, as well as chemistry and industrial biotechnology cluster can be bio-cluster. In 2014, a bio-cluster expert highlighted that *"the only European cluster directly inspired by bioeconomy is Central Germany's Bioeconomy Cluster based in Halle (Saxony-Anhalt), where a variety of partners in the industrial and research fields work towards the use of non-food biomasses for energy and new materials production"* (Bonaccorso 2014). Today, several other bioeconomy cluster have emerged in Europe. But still, also other 'thematic' clusters are relevant for the deployment of the bioeconomy at regional level. Examples of these are:

- Cluster organised around biological resources, e.g. Cork Cluster in Extremadura (ES), Paper Province Värmland (SE), Croatian Wood Cluster (HR), Cluster Inno'vin Bordeaux-Aquitaine (FR).
- Agrofood cluster, e.g. Pôle Industries & Agro-Ressources (IAR) (FR), Food+i (North of Spain), Agri-Tech East (UK), Food Nordwest (DE), Food Cluster of Lower Austria (AT).

¹⁰ COMMUNICATION FROM THE COMMISSION: Towards world-class clusters in the European Union: Implementing the broad-based innovation strategy. Brussels, 17.10.2008. COM(2008) 652

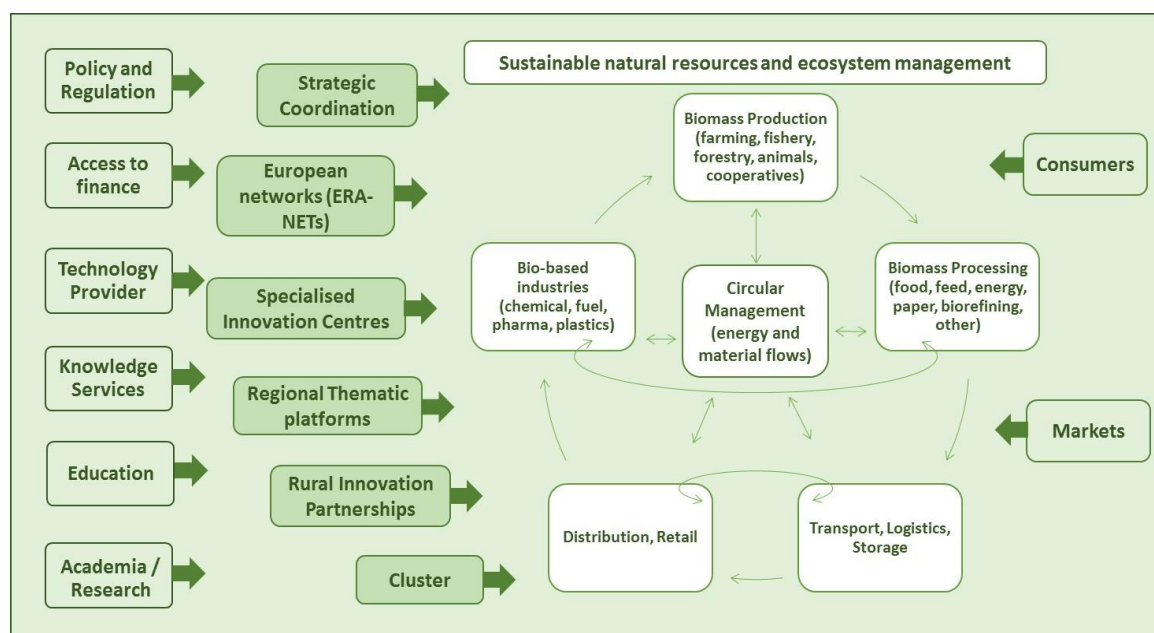
- Bioenergy cluster, e.g. Canterbury Bioenergy Cluster (UK), Cluster of Bioenergy and Environment of Western Macedonia (Greece), Dynamic Bioenergy Cluster Central Finland (FI).
- Industrial biotechnology/new materials/biorefinery cluster e.g. CLIB2021 North Rhine-Westphalia (DE), Dutch Biorefinery Cluster (NL), GreenWin (Wallonie, BE).
- Sustainable chemistry cluster, e.g. Lombardy Green Chemistry Cluster (IT), Bioeconomy Central Germany (Sachsen-Anhalt, DE), Grangemouth Cluster (Scotland, UK).
- Bio-marine cluster, e.g. Pôle Mer Bretagne Atlantique (FR), Welsh Seafood Cluster (UK).

Research and innovation in a variety of fields is necessary to implement the value cycles of the bioeconomy. However, in general, it is not enough to collaborate in one cluster or in one specific field in a given region. Collaboration between clusters, sectors, technologies and knowledge fields would be needed to promote bioeconomic principles in regional economies and societies.

Bioeconomy development, as other emerging technologies “often represent challenges to existing governance structures, and it is important to ensure that existing structures do not constitute a barrier to innovation” (OECD 2015:19). Therefore, within regional systems, emphasis has not only to be put on public administration and government, research and innovation centres, and on businesses and clusters but also on other relevant stakeholders that can integrate different biomass and production loops and, ideally, start to close the loops as in the circular economy approach. Integration and circular connection between different regional actors and clusters would assure availability of feedstock, feasible separation and conversion processes, as well as supply of the whole range of bio-based products, as well as its collection and return to the production cycle after use. These extended innovation systems might be understood as **regional bioeconomy ecosystems**. They would allow working along new value cycles and value networks.

Moreover, new players – compared to the usual cluster, quadruple-helix or innovation system approaches – might need to be integrated in order to link production cycles based on by-products, to fill in gaps in consumption-production patterns and to create new value cycles around secondary raw materials. Thematic platforms and other bridging entities can be relevant stakeholders to organise research and innovation activities for new and modified value chains. Logistics, circular management of material and energy flows, biorefining as well as resource/ecosystem management will play key roles in future regional bioeconomy ecosystems (Golembiewski et al. 2015). Figure 3.14 outlines a model for such an ecosystem that takes into account a wider understanding and integration of relevant players.

Figure 3.14: Model of a regional bioeconomy ecosystem



Source: Own elaboration

For achieving such development, strategic policy approaches are necessary. Given the close relation to R&I and the need to consider bioeconomy ecosystems at regional level, regional innovation strategies such as the existing RIS3 strategies may provide the most prominent access point to support the bioeconomy.

3.5. Smart Specialisation Strategies (RIS3) 2014-2020 supporting the bioeconomy

According to the Article 2 (3) of the Common Provision Regulation (EU) 1301/2013, “*smart specialisation strategy*’ means the national or regional innovation strategies which set priorities in order to build competitive advantage by developing and matching research and innovation own strengths to business needs in order to address emerging opportunities and market developments in a coherent manner, [...]”

Conceptually, the notion of ‘Smart Specialisation Strategy’ builds on the vast experience in Europe with elaborating and implementing ‘regional innovation strategies’ (RIS). Since the 1990s, many EU regions defined strategies for a coordinated and joint development of their regional innovation systems. Considering the waves of these innovation support schemes (1. RTP/RIS/RITTS in the 1990s, 2. RIS-NAC and PRIA in the mid-2000s), the current smart specialisation strategies can be described as the third generation of regional innovation strategies. Their formal name is ‘Research and Innovation Strategies for Smart Specialisation’ (S3 or RIS3). The RIS3 strategies create clear and stable investment conditions to mobilise public and private R&I investments, for instance for industrial modernisation or agro-food innovation via the use of Key Enabling Technologies (KETs). The content of each RIS3 emerges from the analysis of the regional endogenous resources and the specific competitive advantages of the region compared to others. In RIS3 strategies the competitive profile of a region is analysed based on its economic profile and on its capacities in research and innovation, as well as on its level of integration in international or global markets. The RIS3 methodology proposes the consideration of the concept of ‘related variety’ among the different important economic sectors in a region, meaning that they are already linked or have the potential to be connected and strengthened through key enabling technologies, such as biotechnology. It also assumes that there are more potential areas for innovations than the typical players (Universities, business in-house R&D) and it proposes to stimulate the ‘entrepreneurial discovery process’ in unusual settings (incubators, SMEs in traditional sectors, entrepreneurs, social economy etc.) (Foray et al. 2012).

The existence of a national or regional Smart Specialisation Strategy is one of the ex-ante conditionalities of the funding period 2014-2020 for the approval of a Regional / National Operational Programme, which is co-funded by the ERDF. In particular, ex-ante conditionality 1.1 is linked to the “*existence of a national or regional smart specialisation strategy in line with the National Reform Program, to leverage private research and innovation expenditure, which complies with the features of well-performing national or regional R&I systems*”. (CPR (EU) 1301/2013, Annex XI). To fulfil this ex-ante conditionality, the national or regional Smart Specialisation Strategy is supposed to:

- be based on a SWOT or similar analysis to concentrate resources on a limited set of research and innovation priorities;
- outline measures to stimulate private RTD investment;
- contain a monitoring mechanism;
- contain a framework outlining available budgetary resources for research and innovation that has been adopted. (CPR (EU) 1301/2013, Annex XI).

Hence, all regions in the European Union have a strategic RIS3 document (or are covered by a national RIS3), regarding their research and innovation priorities and plans for the next years. Regional or national ERDF Programmes usually refer to a RIS3. RIS3 documents are the basis for the programming of measures and actions within the ESIF programming documents 2014-2020 under Thematic Objective 1 related to R&I.

These EU-wide research and innovation priorities for the 2014-2020 funding period have been part of the knowledge base for this study, aiming at the search and analysis of bioeconomy related priorities in all regional and national RIS3 documents. The RIS3 strategies are also an important tool to promote future-oriented collaborations between regions and key stakeholders in research

and innovation in the EU regions. The analysis of RIS3 documents allows finding commonalities and synergies between regions, for instance on similar interests within the bioeconomy deployment. However, priorities on bioeconomy are very diverse and can be covered in different research or business areas mentioned in the RIS3 documents, e.g. agri-food, aquaculture and fisheries, renewable or sustainable energy, biotechnology, sustainable chemistry, new materials, resource efficiency/circular economy.

The knowledge base built on the RIS3 documents has been used by experts, either to analyse the data and get an overview on European research and innovation priorities or to identify regions with a similar research and innovation profile in order to plan and organise collaborations for research and development, knowledge transfer or policy innovation.

According to recent figures of the European S3 Platform at the IPTS/JRC¹¹, the most frequently cited research and innovation fields with a connection to bioeconomy are: agro-food, energy, advanced materials, eco-innovation and tourism. But within these overarching fields, a wide variety of specific RIS3 priorities, as well as sectoral and technology sub-areas exist.

As part of the S3 Platform, the "**Stairway to Excellence**" (S2E) project is centred on providing assistance to the 13 Member States (EU13) who joined the European Union since 2004 with the aim of closing the innovation gap and promoting excellence in Europe. The "Stairway to Excellence" country reports help to understand the national/regional maturity with regard to innovation, including among others bioeconomy-related R&I, in the described EU13 countries.

Within the S3 platform, different **thematic platforms** are forming between regions of similar interest and priorities. To date, three thematic platforms are formed: Agri-Food, Energy and Industrial Modernisation. The first has a strong connection with the bioeconomy, the other two include, among others, sub-areas related to bio-energy or new production cycles and biorefinery processes. The main objective of the platforms is to stimulate knowledge transfer and learning as well as joining forces for building up a critical mass of researchers and innovators in highly specific areas, and bringing together resources for strategic investments in close-to-market initiatives (demo projects, living laboratories, pilot plants etc.). The platforms stimulate a partnership approach and offer funding for launching interregional initiatives and thematic partnerships¹².

In addition, there are other network initiatives in Europe that build on the cooperation between regions based on similar research and innovation priorities. Many of them have also a specific relationship to the bioeconomy. One example is **ERRIN** (European Regions Research and Innovation Network), a network of more than 90 European regions interested in research and innovation issues. The network facilitates knowledge exchange as well as joint actions and project partnerships between members with the aim to strengthen their regions' research and innovation capacities. Since 2015, ERRIN has a bioeconomy working group. One of their activities is a mapping exercise of European regions on the current situation and priorities regarding the bioeconomy (ERRIN 2015).

Another example is **ERIAFF** (European Regions for Innovation in Agriculture, Food and Forestry). ERIAFF represents the interests of regions which have set their priorities on agriculture, forestry and food industries. The ERIAFF regions collaborate with the European Innovation Partnership (EIP) '*Agricultural Productivity and Sustainability*' and define common views on EU policies and funding in agriculture, forestry and food sectors.

The **Vanguard Initiative** is a network of 30 regions in Europe. Vanguard promotes interregional cooperation on innovation in order to speed up the market uptake of new technologies. The network has a collaborative approach and seeks to explore public-private investment and co-funding possibilities. The Vanguard Initiative involves key stakeholders from regional governments, industry, universities/research and technology providers. Vanguard seeks to promote, in particular, integrated pilot plant solutions needed by industry to validate high-risk investments in the circular economy before full scale industrial implementation. One of the thematic pilot actions is dedicated to the bioeconomy. Within this pilot action, new industrial value chains are tested with industry-led

¹¹ In 2011, the so-called 'S3 Platform' (<http://s3platform.jrc.ec.europa.eu/home>) was established. It is hosted by the Institute for Prospective Technological Studies (IPTS) in Seville (Joint Research Centre). One important tool developed by the S3 Platform is the Eye@RIS3 database (<http://s3platform.jrc.ec.europa.eu/map>). This is a database on priorities in RIS3s, as these have been indicated by regions and Member States.

¹² For example: Call for Expressions of interest for setting-up and co-leading new partnerships in specific thematic areas related to Agri-Food (S3 Platform, IPTS-JRC Seville).

cross-regional demonstration projects. The seven bioeconomy demo cases are presented in the table below.

Table 3.1: Vanguard bioeconomy related demo cases

Demo Cases	Objective	Leading Region
Biobased Aromatics	Interregional value chains and joint demonstration on biomass valorisation to aromatics	Flanders – VITO (Belgium)
Lignocellulose Refinery	Production of bulk and fine chemicals and fuels from lignocellulose biomass. Set-up of a European value chain from lignocellulose to end products using biotechnology (refinery)	Randstad – Biobased Delta (Netherlands)
Biogas Beyond Energy	Advancing the state of the art of biogas production towards more and higher value added outputs	Lombardy – Green Chemistry Association (Italy)
(Waste) gas into value	Turning C1 gas streams (from biogas production, biomass gasification or industrial emissions) into chemicals or fuels	Flanders - Ghent Bio-energy Valley (Belgium)
Bio Aviation Fuel	Promoting larger scale aviation biofuel production	Värmland – Paper Province (Sweden)
Food & Feed from Agrofood Waste	Extracting functional foods and feed from different waste streams, such as fish, domesticated animals, cereals, fruit, and vegetables.	Scotland – Scottish Enterprise (UK)
Food and Feed ingredients from Algae	Extraction of high value products from microalgae for the food & feed sector.	Asturias (Spain)

Source: Vogelaar, S. and Martinelli, F., 2016.

In addition to the above mentioned networks, there are several **macro-regional working groups** dedicated to the bioeconomy. One example is the Policy Area Bioeconomy¹³ in the Action Plan for the European Union Strategy for the Baltic Sea Region (EUSBSR). Another case is the Danube network on Research and Innovation in its “Energy and Bioeconomy” pillar¹⁴. The RIS3 processes are a useful information source for these macro-regional networks. *“The bioeconomy in the Baltic Sea region can greatly benefit from Smart Specialisation Strategies (S3) tailored as frameworks for place-based investments, innovation and business development. This can be realized by taking advantage of local and regional comparative advantages in bio-resources; specialized competencies, companies and entrepreneurs; knowledge infrastructures; and supporting institutions and policies”*¹⁵.

Finally, the RIS3 strategies help regions to define their R&I priorities and to focus their interests and projects for the bioeconomy. Funding to implement the RIS3 action plans in 2014-2020 can come from several private and public sources, regional and national funding and European Structural and Investment Funds (ESIF), H2020 and other funds such as ERA-NET co-funds and programmes such as LIFE+, ERASMUS+, COSME etc. Cross-border and transnational projects within the Interreg programmes 2014-2020 are usually not focused on the bioeconomy alone. However, they might provide resources to design and launch new interregional partnerships in bioeconomy related areas.

¹³ <http://bsrbioeconomy.net/index.html>

¹⁴ https://danube-inco.net/ourpillars/energy_and_bio_economy

¹⁵ Introduction to a Bioeconomy workshop at the 7th EUSBSR Strategic Forum 2016: <http://www.strategyforum2016.eu/programme/seminars/fostering-innovation-and-growth-in-the-bioeconomy-through-smart-specialisation-33547563>

4. REGIONAL SPECIALISATION OF BIOECONOMY-RELATED R&I IN THE 2014-2020 FUNDING PERIOD

In order to gather more detailed information on regional specialisation of the bioeconomy in European regions, a EU-wide (EU-28) data gathering on bioeconomy related activities across Europe was conducted. Primary data source for this study were the RIS3 strategies available for EU-28 countries and regions for the funding period 2014-2020. Since the territorial level of RIS3 strategies varies widely, the study covers sometimes only the national level, other times only the regional level, or both, according to a country's level of RIS3 elaboration. The study employs the generic term "region" as denominator for all territorial units from NUTS 0 (national level) to NUTS 3. On the whole, the analysis covers 210 territorial units (22 NUTS0 = countries, 25 NUTS1 regions, 125 NUTS2 regions, 38 NUTS3 regions).

As already discussed, there is no common definition of the concept of bioeconomy in neither regional nor national RIS3 documents. "Bioeconomy" as such appears rarely in RIS3 documents but several other related themes appear more often in the examined documents: agro-food innovation, blue growth/economy, circular/green economy, sustainable/green chemistry/agriculture/construction/ manufacturing, paper 2.0 etc.

The purpose of this study is not to find a new definition of the bioeconomy concept nor to examine existing definitions. However, in order to be able to aggregate and compare information on the bioeconomy in this study, covering 28 Member States and many different languages, a common classification was necessary. Therefore, a specific bioeconomy classification model has been developed and used for data gathering and data analysis. This classification is based on a broad definition of bioeconomy, including agro-food activities and advanced manufacturing related to biorefinery processes and all relevant topics that can be linked to a more efficient and sustainable use of biological resources. The classification model is presented in Annex 2 'Task 2 Data Analysis Report'.

Among the 210 territorial units analysed, 207 (98.6%) include bioeconomy related aspects in the 2014-2020 R&I priorities and plans. Only for Franche-Comté (FR), Martinique (FR) and Syddanmark (DK) no specific relevance of bioeconomy related R&I could be found according to the available data.

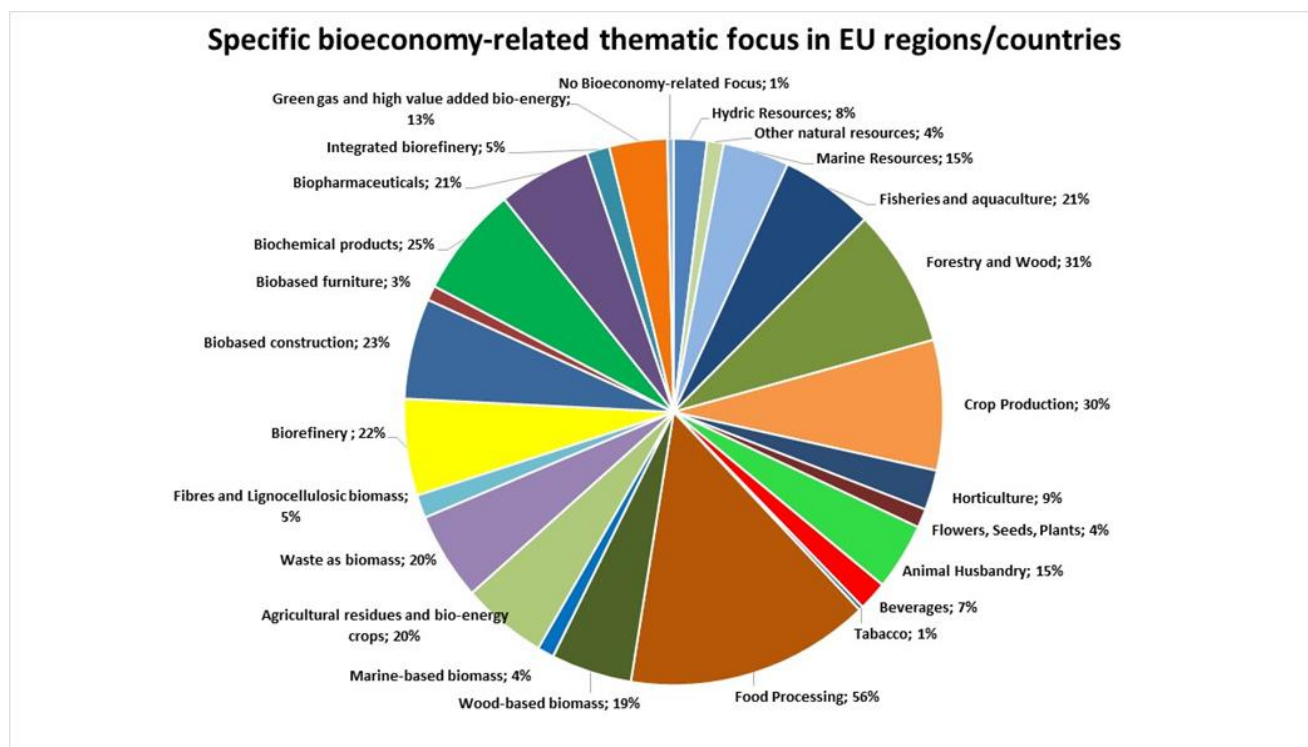
The data analysis examined the following specific characteristics of the regional and national bioeconomy:

- Thematic focus
- Value chain approaches
- Bioeconomy-related R&I fields
- Bioeconomy maturity
- Drivers of the bioeconomy
- Stakeholders and regional ecosystems.

The analysis of these features allowed developing a typology of European regions according to their bioeconomy profile and approach.

4.1. Thematic focus of regional bioeconomy priorities

There is a huge variety in bioeconomy related thematic areas that are tackled by EU regions and countries. Most strategies combine several thematic focus areas. The interconnection and diversity of thematic fields within the bioeconomy become visible as thematic concentrations on one single area are seldom. Figure 4.1 depicts the distribution of thematic fields related to bioeconomy R&I from the RIS3 strategies.

Figure 4.1: Frequency of specific bioeconomy thematic focus areas in regions/countries


Source: Own elaboration

Overall, the thematic field of agro-food is the most prominent field. Looking at the specific thematic areas, "food processing" is most frequently (56%) followed by "forestry and wood" (31%), "crop production" (30%), "fisheries and aquaculture" (21%), "marine resources" (15%) and "animal husbandry" (15%). Bio-based fuel and energy themes cover land-based bio-based energy resources ("wood-based", "agricultural residues and bio-crops", "waste as biomass") while "marine biomass" is less frequent (4%). Within bio-based industries, frequently named specific areas are "biochemical products" (25%), "bio-based construction" (23%), "biorefinery" (22%) and "biopharmaceuticals" (21%). More sophisticated areas are less mentioned "integrated biorefinery", "fibres and lignocellulosic biomass" (both 5%).

4.1.1. Agro-food – the most prominent approach to bioeconomy

Agricultural activities provide the basis for food and non-food production. Despite of a relatively low importance for jobs and economic growth, compared to industry and services, primary activities play a vital role in rural and mountainous regions in Europe. They retain population and drive development in rural areas, provide ecological services and deliver wider public goods. These multiple functions are performed in the context of major demographic, economic and environmental challenges. Primary production is also the base for food and nutrition security and for public health (European Commission 2016b).

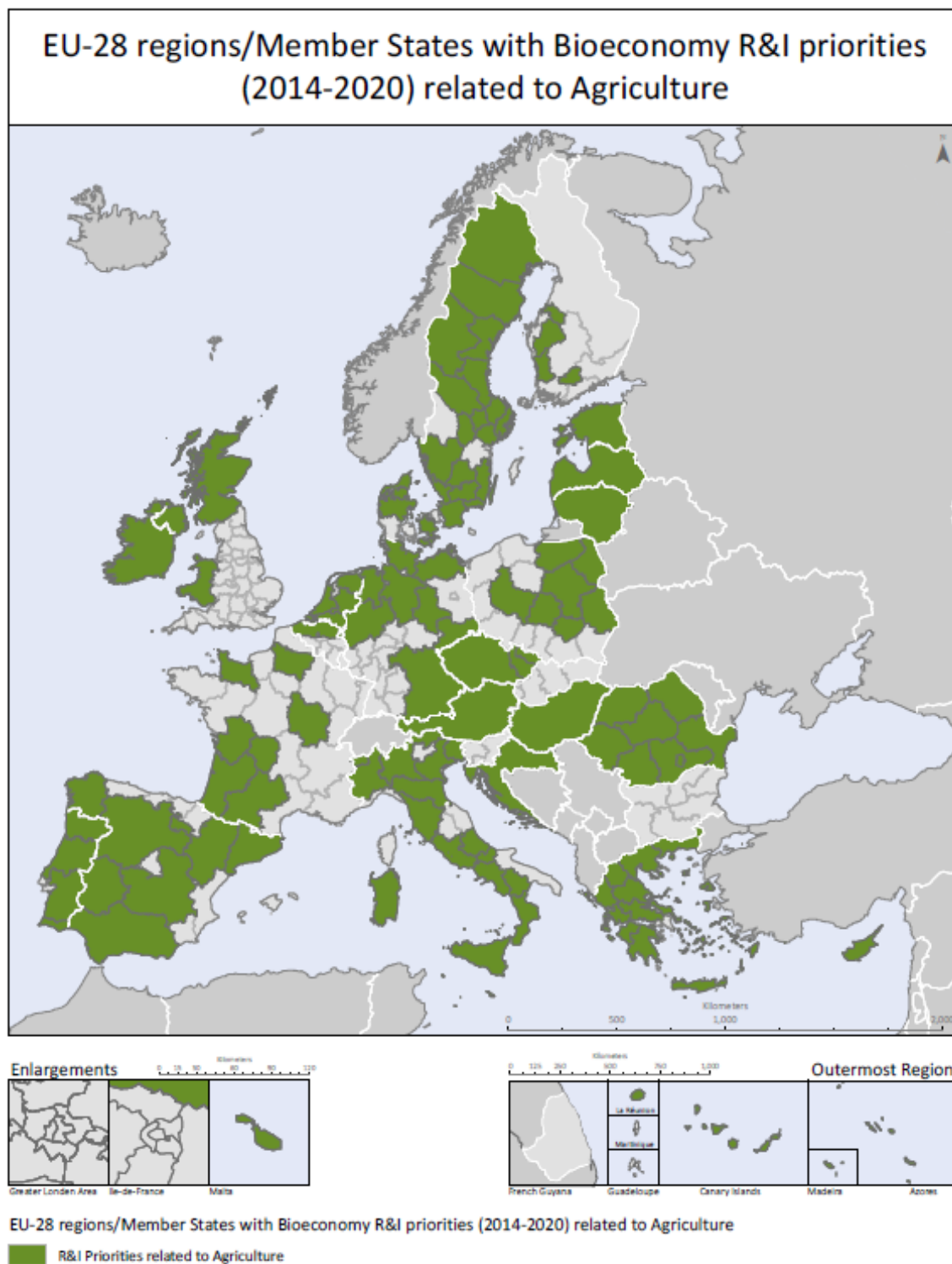
The strategic approach of the European Union to agricultural research focuses on land-based primary production from agriculture and forestry and extends to food and non-food chains and the rural economy. Five priority areas for research and innovation have been identified in two action lines:

a) Creating value from land - sustainable primary production: Priority 1: Resource management (notably soil, water and biodiversity), Priority 2: Healthier plants and animals, Priority 3: Integrated ecological approaches from farm to landscape level.

b) Enhancing rural innovation - modernising rural areas and policies: Priority 4: New openings for rural growth, Priority 5: Enhancing the human and social capital in rural areas (European Commission 2016b).

Agro-food activities offer numerous value creation options by fostering innovations that might translate into the introduction of new products on the market and the adoption of new and more efficient production methods (Giner 2009).

The following EU Member States and regions have R&I priorities in the field of Agriculture (2014-2020) (please see Annex Document 8 for a list of relevant regions and countries):



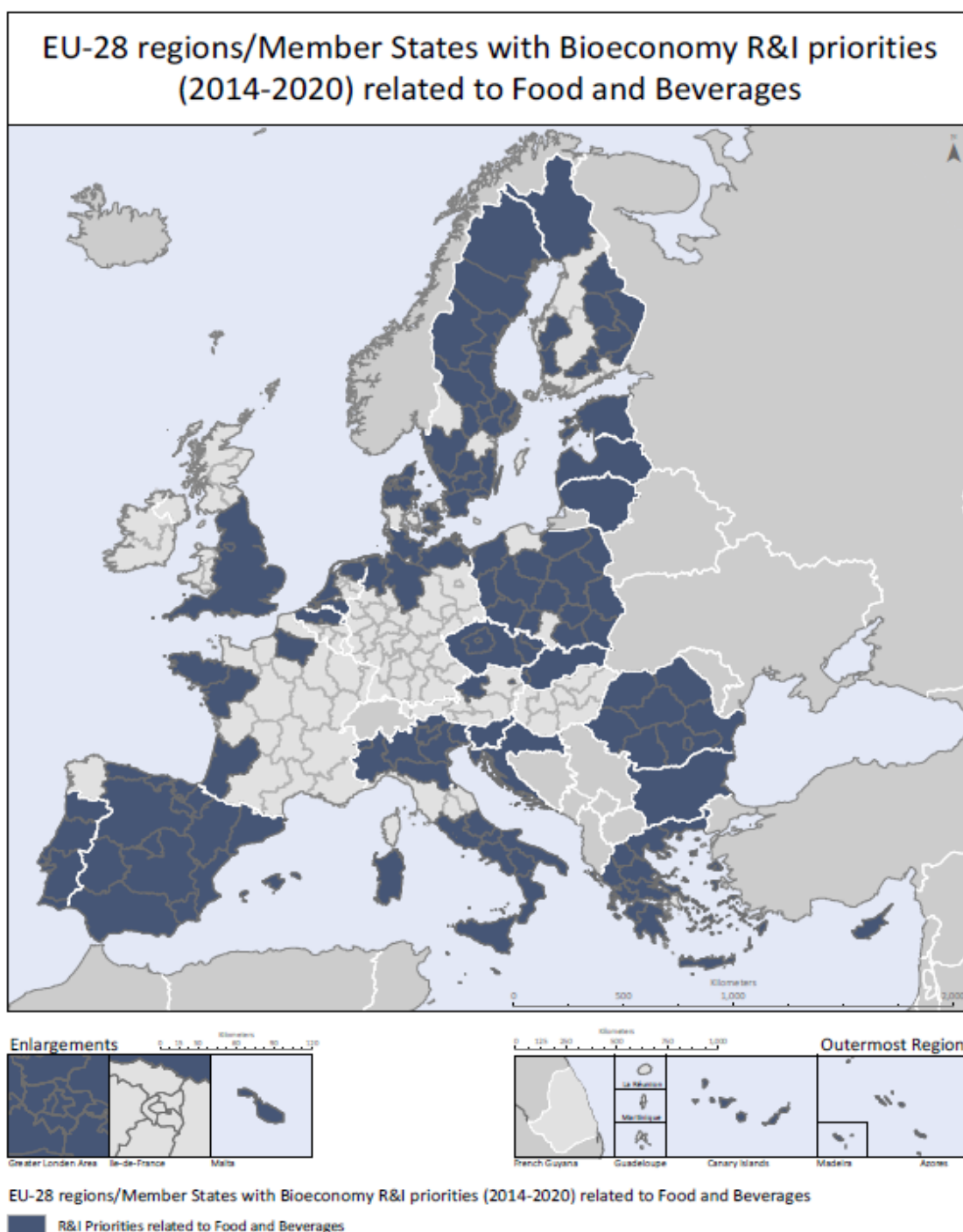
January, 2017

Data: NUTS 2010

Source: 'Mapping of EU Member States'/regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy for 2014-2020' elaborated by Spatial Foresight, SWECO, ÓIR, Berman Group, Nordregio, Infyde for DG RTD, European Commission

The use of innovative technologies, approaches and business models for food systems is considered an important factor “for boosting the competitiveness of the European industry” (ibid.). Covicchi and Ciampi Stancova (2016) highlight the diverse benefits of food value chains for regional economies and the potential benefits through increased research and innovation activities in food systems. According to data of the European Food and Drink Industry (2013-2014), EU-28 R&I investment by the food and drink sector is 0.27 % of the sector's turnover (European Commission 2016a:13). There is hence potential for improvement as regards research initiatives.

The following EU Member States and regions have R&I priorities in the field of Food and Beverages (2014-2020) (please see Annex Document 8 for a list of relevant regions and countries):

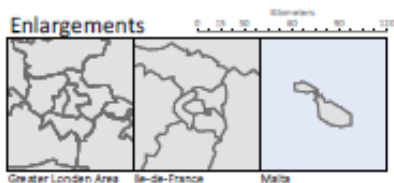
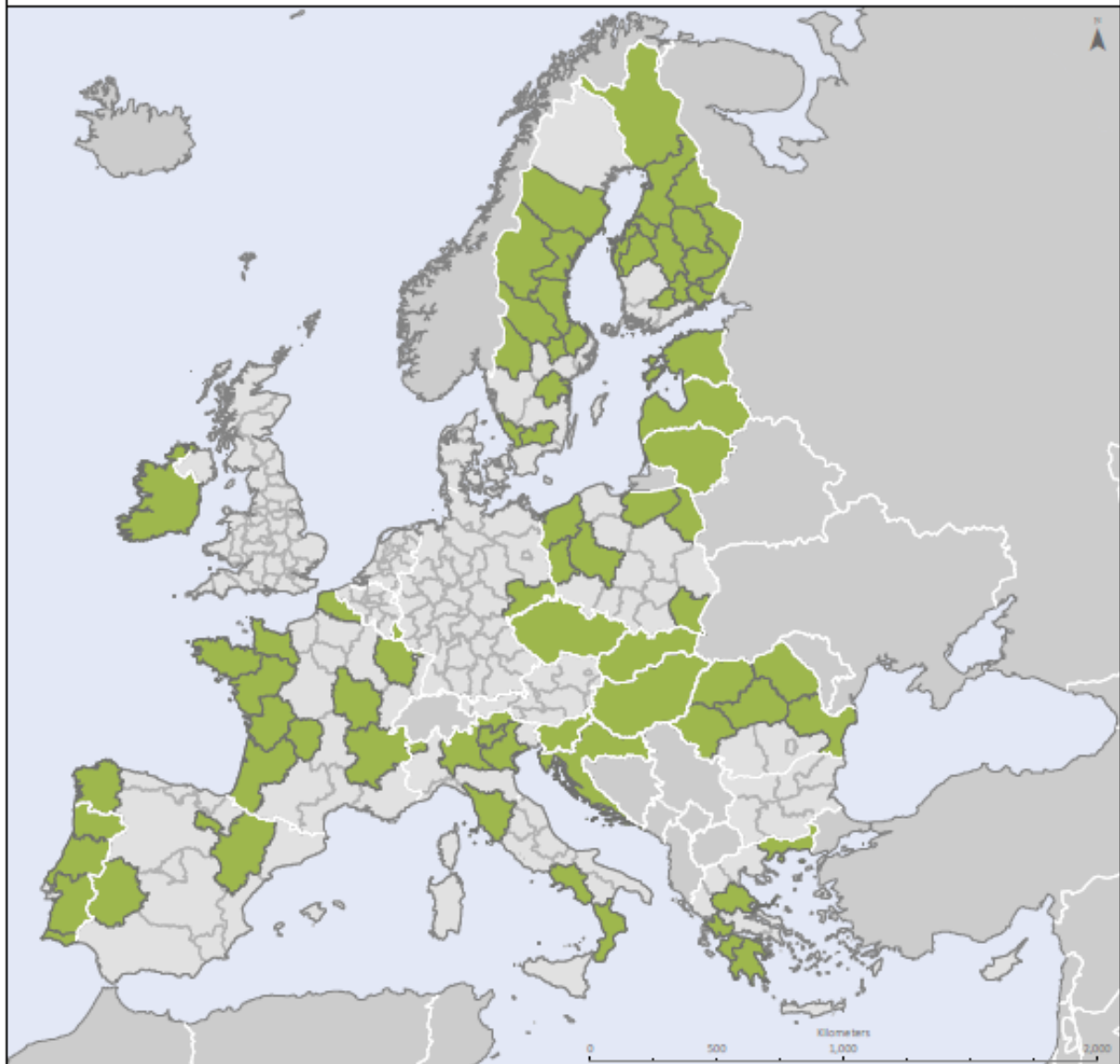


January, 2017


Data: NUTS 2010

Source: 'Mapping of EU Member States'/regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy for 2014-2020' elaborated by Spatial Foresight, SWECO, OIR, Berman Group, Nordregio, Infyde for DG RTD, European Commission

EU-28 regions/Member States with Bioeconomy R&I priorities (2014-2020) related to Forest-based Bioeconomy



EU-28 regions/Member States with Bioeconomy R&I priorities (2014-2020) related to Forest-based Bioeconomy

 R&I Priorities related to Forest-based Bioeconomy

January, 2017

Data: NUTS 2010

Source: 'Mapping of EU Member States/regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy for 2014-2020' elaborated by Spatial Foresight, SWECO, ÖIR, Berman Group, Nordregio, Infyde for DG RTD, European Commission



4.1.2. Forest-based bioeconomy

The forest-based sector includes all stakeholders with a major interest in forestry, forest-based materials and products. Wood is the key component of the pulp and paper industry, it can be used for energy production, it is an important construction material and for the furniture industry. Forest-based biomass is also used for many different bio-based products, such as insulation material, barrier materials for damp protection, biopolymers, bio-based plastics and composites, carbon fibre, chemicals and cellulose-based textiles, smart packaging materials (Swedish Forest Industries Federation 2013).

In addition to raw materials, forests also provide a wide range of vital ecosystem services. The forest plays an essential role in climate change mitigation, safeguarding biodiversity, providing fresh-water, non-wood forest products and recreational environments. The forest-based sector depends on a broad range of scientific disciplines and technologies. Recent advances in for example physics, cell biology and genomics have enabled new tree-breeding technologies for enhancing wood qualities and pest resilience as well as enzymes for use in papermaking (Forest-based Sector Technology Platform 2013).

As can be observed in the map on the previous page, some EU Member States and regions have R&I priorities in the field of Forest-based Bioeconomy in the 2014-2020 period. (please see Annex Document 8 for a list of relevant regions and countries).

4.1.3. Blue bioeconomy

In 2012, the EC Communication on Blue Growth (EC 2012c) highlighted the role of the seas and the coasts as drivers for the economy and suggested that the EU's blue economy represents 5.4 million jobs and a gross added value of just under EUR 500 billion per year. The strategy focused on five high potential areas including aquaculture and blue biotechnology.

In 2014, the EC Communication on Blue Innovation (EC 2014b) addressed the hurdles to innovation which range from under-investment in knowledge to poor access to finance, lack of know-how and fragmentation of efforts. In 2016, the joint EC & EEAS Communication on International Ocean Governance (EC 2016c) proposed action to improve the governance framework, advance towards a sustainable blue economy and strengthen international research and data.

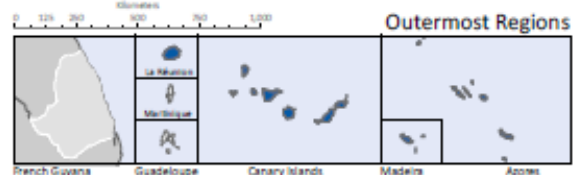
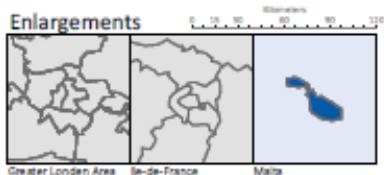
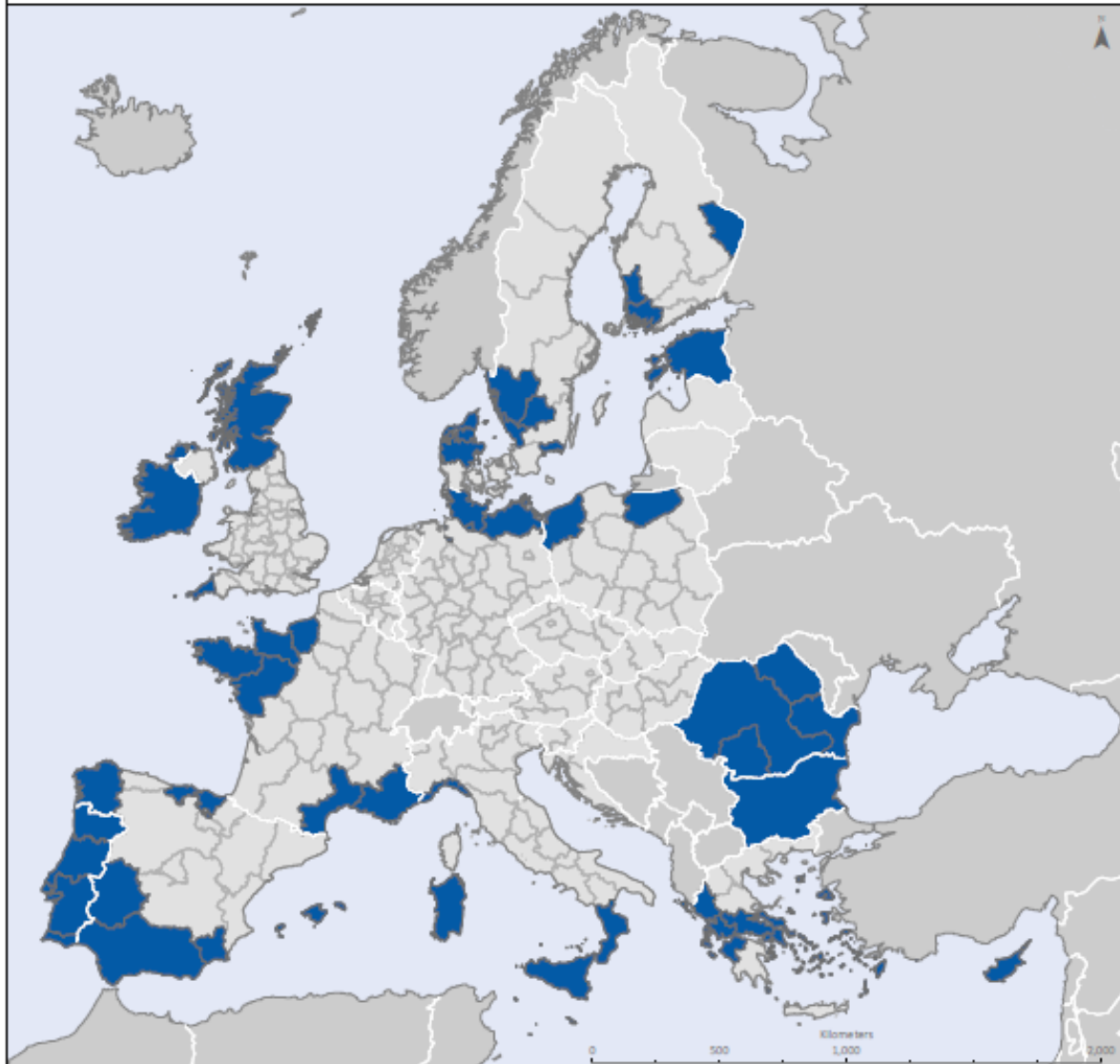
Blue growth industries include water transportation (sea, coastal and inland) together with related activities in logistics, production technology and engineering" (REID Consulting SPRL 2016). Within the domain of Blue Growth/Economy, the blue bioeconomy refers mainly to activities which concern the exploitation of marine living resources, including capture (fishing), processing to consumption, and include aquaculture, processing, marine biotechnologies and marine-related health products (CPMR 2016).

The marine biodiversity is considered as a rich source of novel natural compounds. Some of these compounds are already used in food, cosmetic, agricultural, chemical and pharmaceutical products, but their diversity has not been fully exploited. According to the Strategic Research and Innovation Roadmap of ERA-NET MBT (Marine Biotech), further opportunities exist for the use of ocean bioresources in markets for industrial enzymes, functional foods, cosmeceuticals, biomaterials, bioprocessing and medical devices (Hurst et al. 2016).

The EU Blue Growth Strategy (European Commission 2014b) emphasises the importance of marine bio-based products as alternative sources of carbon and energy, with specific reference to the role of renewable resources such as micro-algae. Several RIS3 strategies highlighted the role of the blue bioeconomy in smart specialisation (De Vet et al. 2016).

As can be observed in the map on the next page, there are EU Member States and regions that have R&I priorities in the field of blue bioeconomy, including water and hydric resources (please see Annex Document 8 for a list of relevant regions and countries).

EU-28 regions/Member States with Bioeconomy R&I priorities (2014-2020) related to Blue Bioeconomy



EU-28 regions/Member States with Bioeconomy R&I priorities (2014-2020) related to Blue Bioeconomy

■ R&I Priorities related to Blue Bioeconomy

January, 2017

Data: NUTS 2010

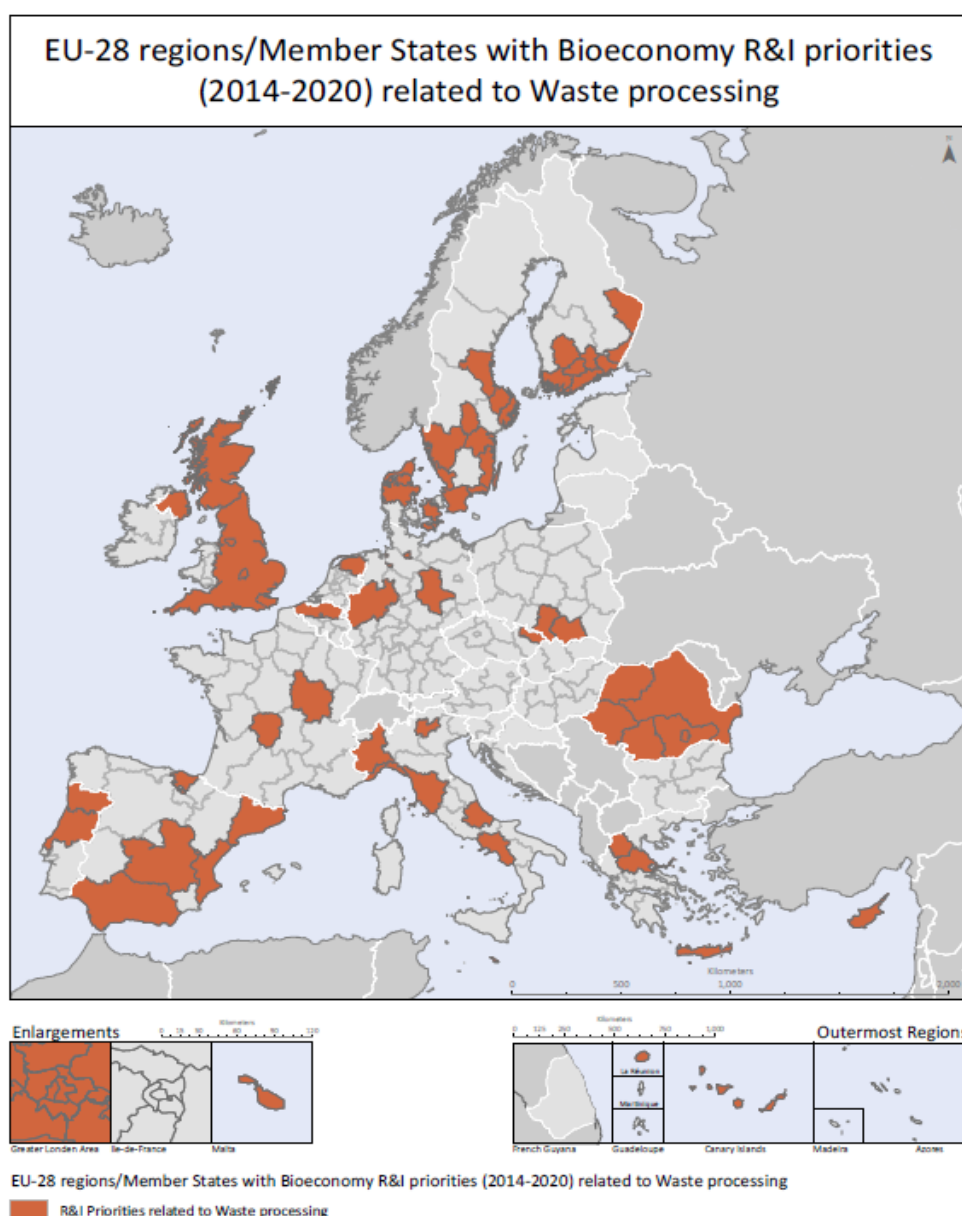
Source: 'Mapping of EU Member States'/regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy for 2014-2020' elaborated by Spatial Foresight, SWECO, ÓIR, Berman Group, Nordregio, Infyde for DG RTD, European Commission



4.1.4. Re-use of crops residues, agricultural by-products and organic waste

Waste processing in the bioeconomy refers mainly to put into value biomass such as crop residues, paper/wood/food waste and agricultural by-products that today might be considered as “waste” (ICCT 2013, Kretschmer et al. 2013). Maximising the number of consecutive re-use cycles and diversifying re-use across the value chain, is a way to maximise resource efficiency (Ellen MacArthur Foundation 2013) and to establish a circular economy (European Commission 2015a). Value added organic waste processing is still a relatively new business area. Projects such as AGRIFORVALOR (H2020) or BREAD4PLA (LIFE+) develop new value cycles. The focus of AGRIFORVALOR is turning waste, by-products and residues from agriculture and forestry into a valuable product or resource for industry through ‘Biomass Innovation Design Hubs’. The main objective of BREAD4PLA is to demonstrate, in a pre-productive continuous pilot plant process, the viability of polylactic acid (PLA) synthesis from waste products of the bakery industry and its use in the production of a 100% biodegradable film to be used in the packaging of bakery products.

The following EU Member States and regions have R&I priorities in the field of waste processing (2014-2020) (please see Annex Document 8 for a list of relevant regions and countries):



January, 2017

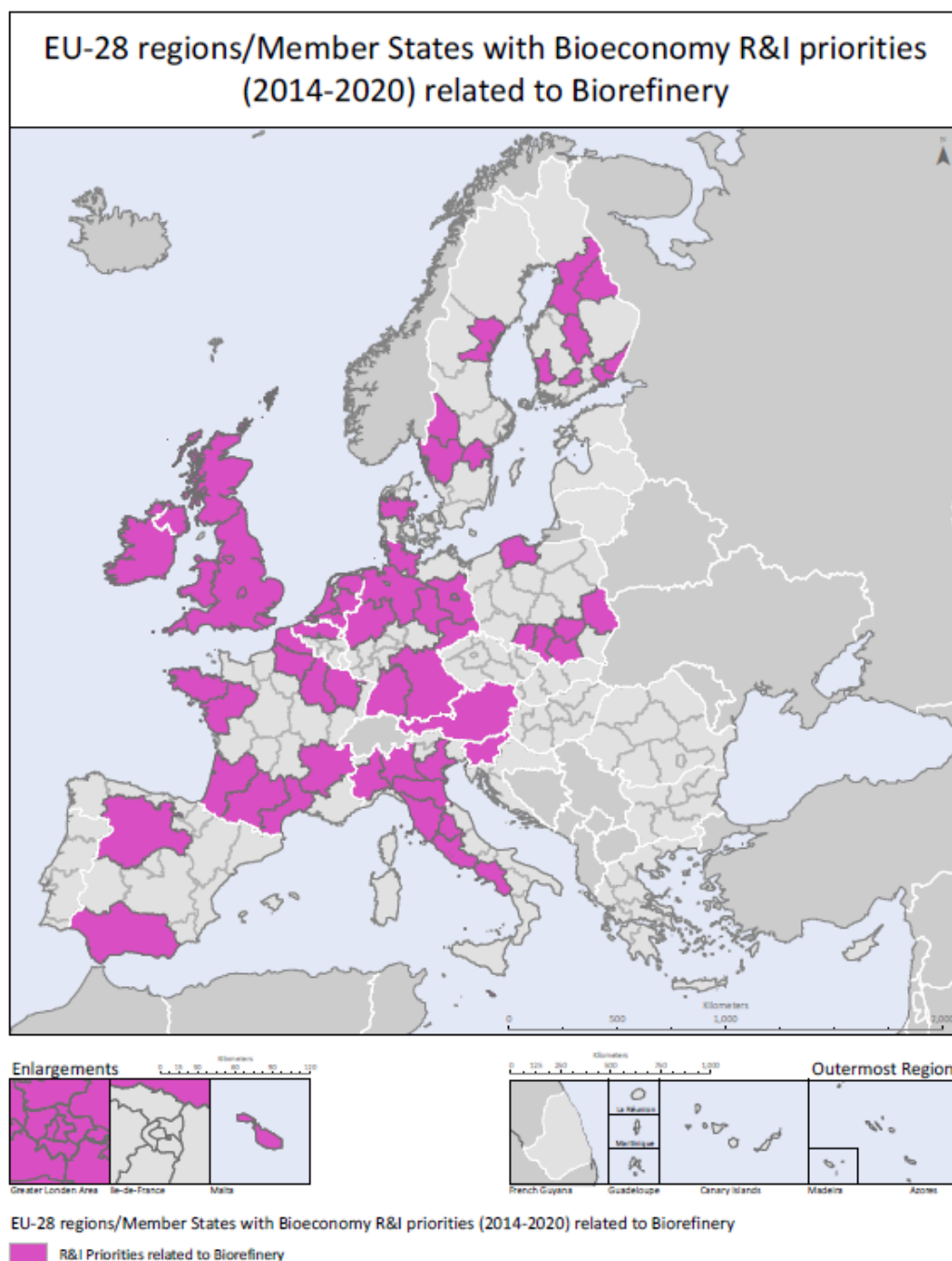
Data: NUTS 2010

Source: 'Mapping of EU Member States'/regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy for 2014-2020' elaborated by Spatial Foresight, SWECO, ÖIR, Berman Group, Nordregio, Infyde for DG RTD, European Commission



4.1.5. Biorefinery

Biorefining includes the application of bioprocesses for the integrated production of materials, chemicals, fuels and energy from biomass (Scottish Enterprise 2015). The integration of biorefining into industrial value chains is driven by either upstream players (producers and transformers of biomass) or downstream customers (producers of intermediates and final products) (Golembiewski et al. 2015). There are a range of biorefinery types in Europe depending on the biomass supply. Large-scale industrial biorefineries offer other products and serve other needs than small/medium scale integrated biorefineries or small, decentralised biorefineries likely to emerge in rural areas (Star-COLIBRI 2011). The following EU Member States and regions have R&I priorities in the field of Biorefinery (2014-2020) (please see Annex Document 8 for a list of relevant regions and countries):



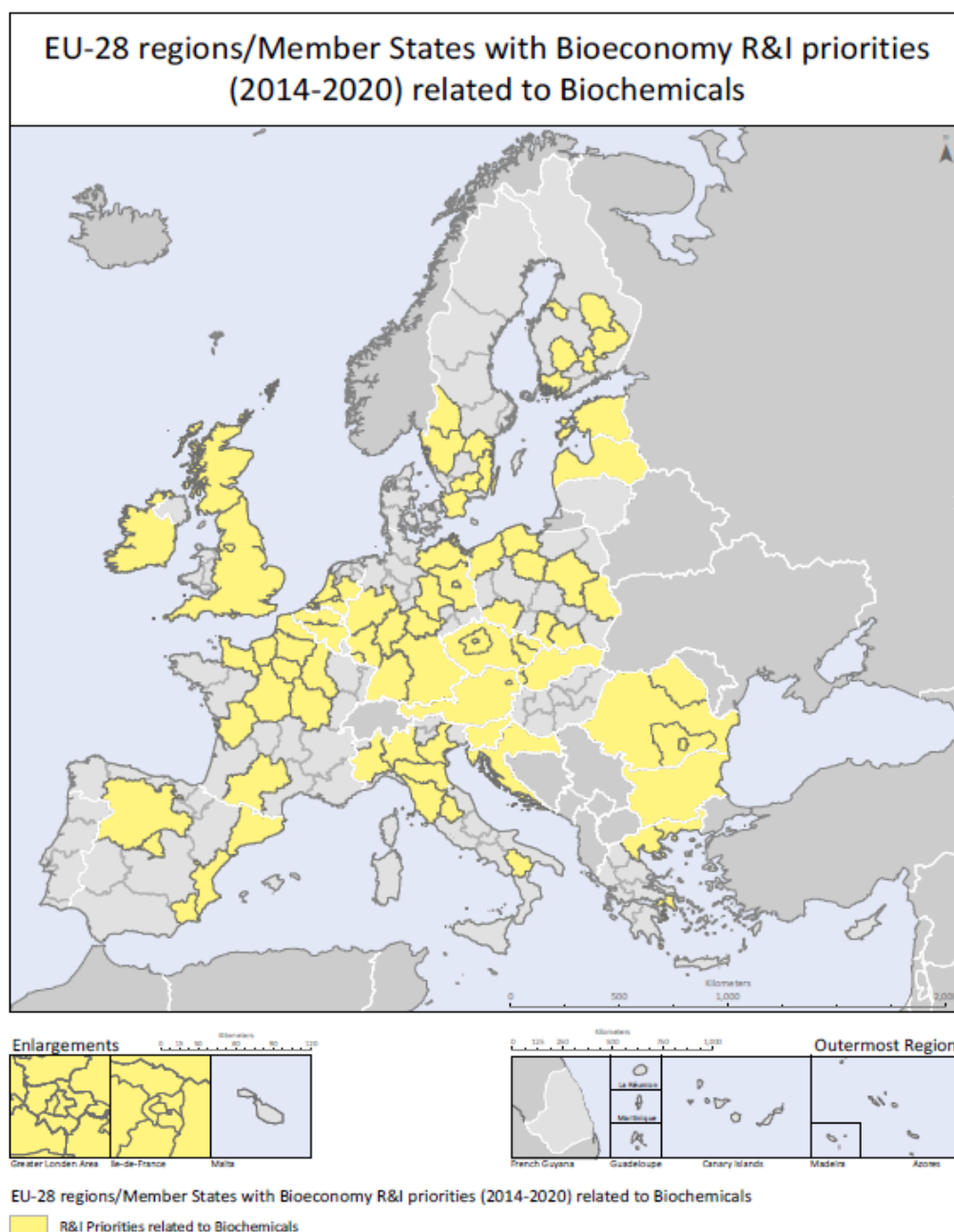
January, 2017

Data: NUTS 2010

Source: 'Mapping of EU Member States'/regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy for 2014-2020' elaborated by Spatial Foresight, SWECO, ÖIR, Berman Group, Nordregio, Infyde for DG RTD, European Commission

4.1.6. Biochemicals

Plastics production is the largest sub-sector of the petrochemicals industry. Plastics have shown an almost exponential growth during the past decades and currently over 200 million tonnes per annum are produced worldwide. Many studies have shown that bio-based chemicals and plastics have significant environmental performance advantages over petrochemicals, including lower GHG emissions (OECD 2014). Despite the benefits, there are also many actual and potential barriers to bio-based chemical and bioplastics production (OECD 2013). Among other issues, new and complex integrated biorefinery processes are necessary for the next generation of biochemical and bioplastics. Projects such as SUS3CHEM (Interreg) want to show that chemical innovations are important for many downstream industries and help to find solutions for societal challenges in areas such as new materials, energy, alternative feedstock, etc. The following EU Member States and regions have R&I priorities in the field of biochemicals (please see Annex Document 8 for a list of relevant regions and countries):



January, 2017

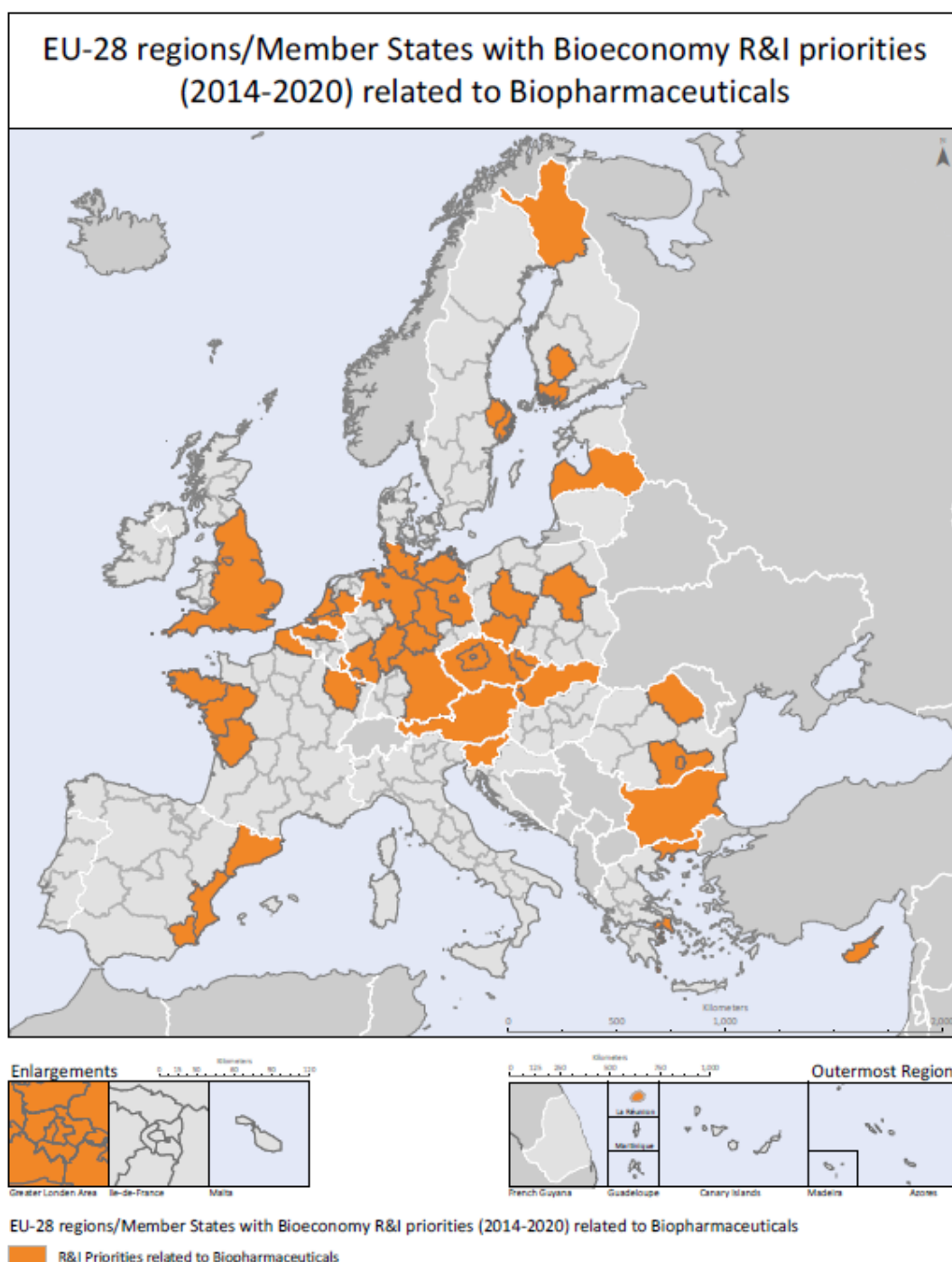
Data: NUTS 2010

Source: 'Mapping of EU Member States'/regions' Research and innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy for 2014-2020' elaborated by Spatial Foresight, SWECO, ÖIR, Berman Group, Nordregio, Infyde for DG RTD, European Commission

4.1.7. Biopharmaceuticals

The subsector of biopharmaceuticals focuses on biological medicinal products and covers diverse knowledge fields such as plant biology, nutraceuticals and functional foods (NFF), synthetic biology and the industrial production of biological drugs and health products. The subsector has clear synergies with other areas of medicinal biotechnology but it can also be part of the food value chain.

The following EU Member States and regions have R&I priorities in the field of biopharmaceuticals (please see Annex Document 8 for a list of relevant regions and countries):



January, 2017

Data: NUTS 2010

Source: 'Mapping of EU Member States'/regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy for 2014-2020' elaborated by Spatial Foresight, SWECO, ÖIR, Berman Group, Nordregio, infyde for DG RTD, European Commission

4.1.8. Territorial specialisation

Analysing the different thematic specialisations of bioeconomy R&I in European countries and regions – as presented in the previous sections, no clear territorial patterns for bioeconomy R&I emerge. However, some trends in specialisation can be observed. Agro-Food is the broad thematic focus area most frequently ranked first among the regions studied. Regions with this profile are located in Portugal, Spain, North-West of France, North of Germany, Sweden, Latvia, Lithuania, Czech Republic, Slovakia, Hungary, Romania, Bulgaria, Greece, Croatia, Slovenia and the majority of Italian regions.

Regions and countries with a thematic focus on “bio-based fuels and bioenergy” are mostly territories in Southern France, Southern Germany or Southern Poland, but also in Southern and Central Finland, Scotland, Ireland and Galicia (Spain).

A focus on “other bio-based industries”, including biorefinery, biochemicals and biopharmaceuticals, is envisaged by regions and countries located mainly in France, Austria, England, Poland, Estonia, Belgium and the Netherlands.

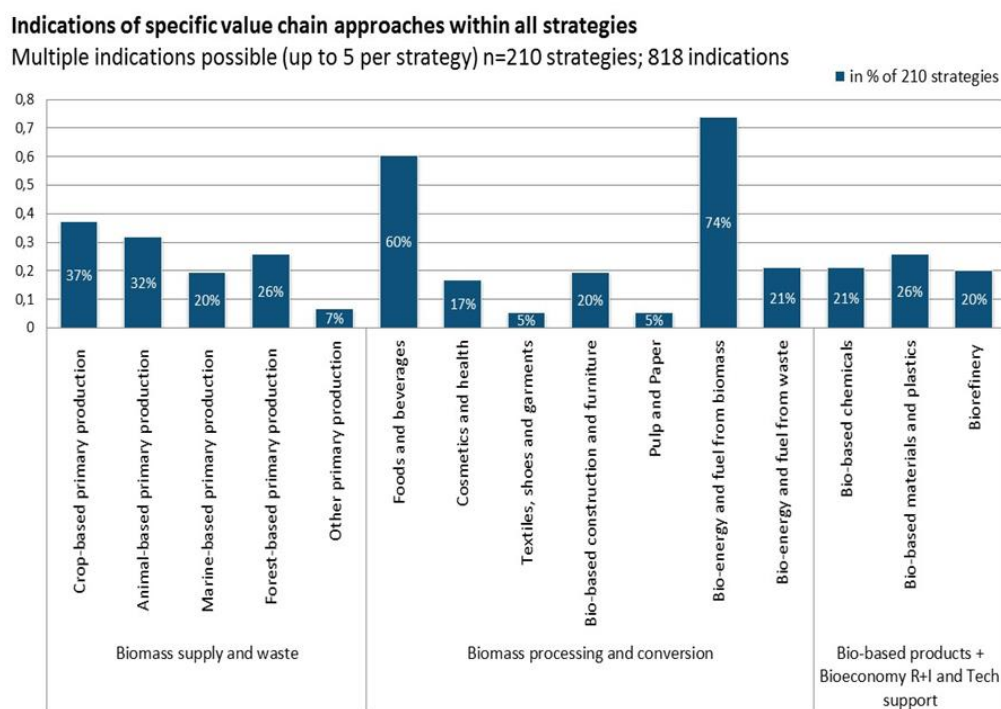
4.2. Value chain approaches of EU regions to the bioeconomy

The previous section looked into to strategic documents regarding bioeconomy from a thematic perspective. The regions’ bioeconomy strategies have also been analysed regarding different **value chain approaches**, differentiating the bioeconomy according to its principal value chains from biomass supply over biomass processing to the production of bio-energy and innovative bio-based products and bioeconomy R&I and technology support. Combinations of various approaches in one and the same region is possible, and – as the analysis showed –rather frequent¹⁶.

Most regions combine two or three value chain approaches. This indicates a considerable variety of approaches even within a single region or country and a low level of specialisation with regard to the bioeconomy value chain approach in Europe. Most regions include biomass processing and conversion (88% of all), followed by biomass supply and waste (66%) and bio-based products (57%). Bioeconomy R&I and Technology Support is only mentioned in 79 (38%) of the value chain approaches.

Looking closer at the specific bioeconomy value approaches (see Figure 4.2), some categories are clearly more prominent than others.

¹⁶ Please see the classification model in the Annex for further information on the value chain approaches and the classification in broad and specific priorities. Sometimes, value chain approaches go hand-in hand with the thematic focus (e.g. on bio-based products, on other bio-based industries with a specific focus on bio-based chemicals and biochemical products). However, sometimes the value chain approach indicates the orientation within a given thematic focus. E.g. a region can focus on agro-food, but within that on biomass supply (crop, vegetables), or on biomass processing and conversion (the elaboration of food products or beverages) or on bio-based products (nutraceuticals or new functional foods).

Figure 4.2: Specific bioeconomy value chain approaches of regions/countries


Source: Own elaboration

At first sight it is clear why biomass processing and conversion is as prominent as illustrated above: Two processing activities; “bio-energy and fuel from biomass” (74% of all indications) and “food and beverages” (60%) are most frequently selected as priorities.

“Crop-based primary production” is frequently part of the strategies (37% of all indications). Further, several specific value chain approaches (animal-based, marine-based, forest-based primary production, construction and furniture, bio-energy from waste, bio-based chemicals, materials and plastic and biorefinery) are indicated in 20-32% of all cases. Less prominent are “cosmetics and health” (17%), “other primary production” (7%), “textiles, shoes and garments” (5%) and “pulp and paper” (5%).

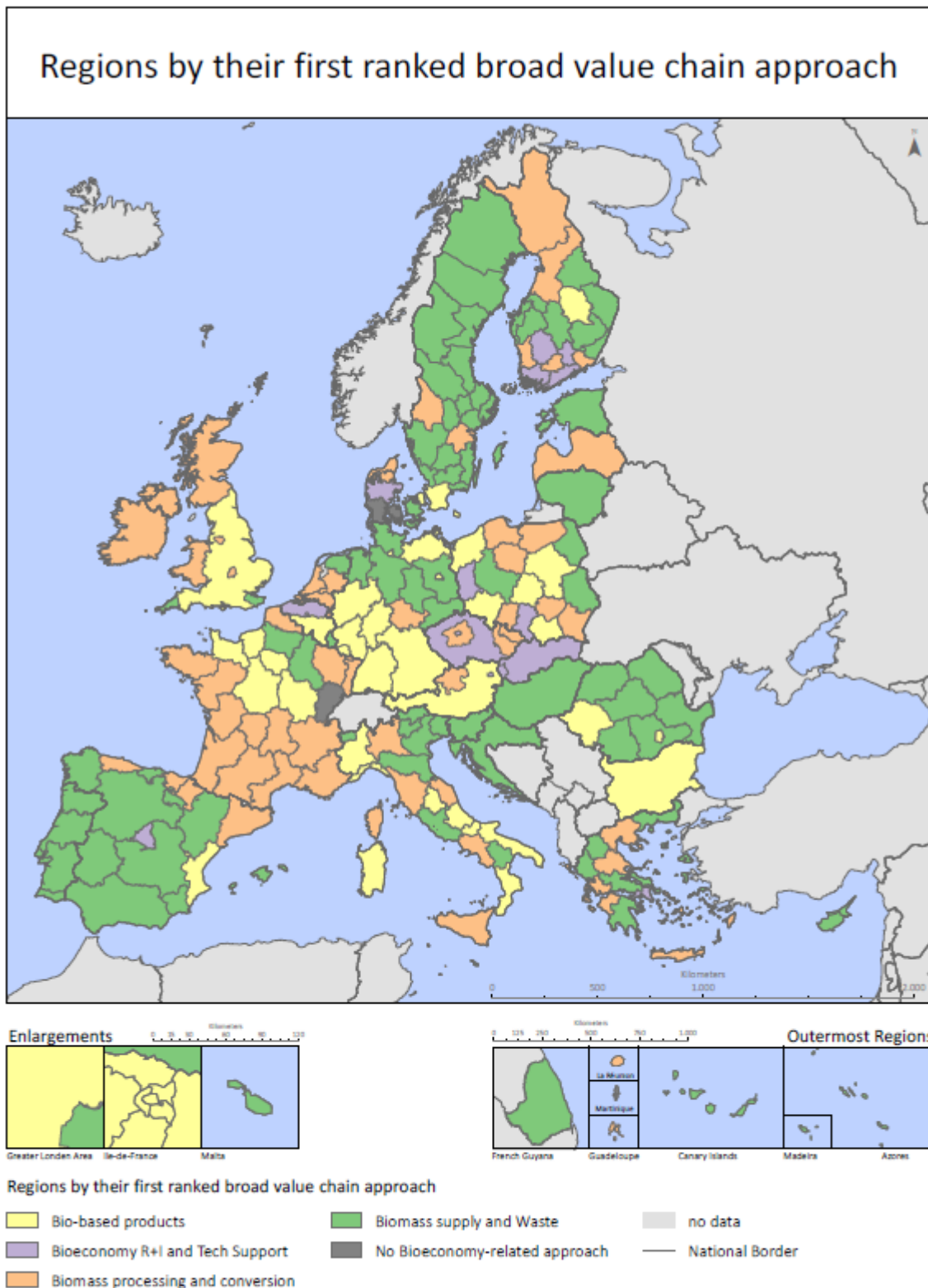
There is still a low level of specialisation according to the bioeconomy value chain approach in European regions. Regions/countries with “biomass supply and waste” as highest bioeconomy priority are much diversified regarding their specifications. Apart from primary production (i.e. “biomass supply and waste”) they cover also processing activities such as “foods and beverages” as well as “bio-energy and fuel from biomass”. Regions with strong focus on “biomass processing and conversion” have also more orientation on bioeconomy R&I, namely biorefinery. “Bio-based chemicals, materials and plastics” play a more important role in these regions than in regions focusing on “biomass supply and waste”. Regions with strong focus on “bio-based products” concentrate on “bio-based materials and plastics”, however “bio-energy from biomass” is an important aspect, too. Finally, regions with strong focus on “bioeconomy R&I support” do not address primary production, but to a certain degree “bio-based products” and “bioenergy and fuel” approaches.

Territorial specialisation

Assessing the territorial specialisation, Figure 4.3 highlights the first ranked bioeconomy value chain. Given the above observations of the overlapping occurrences of several value chains, this indicates the tendency rather than the overall value chain specialisation.

The analysis on value chain approach shows that for most regions and countries in Europe, bioeconomy priorities are predominantly centred on “biomass supply and waste”. These regions are geographically concentrated predominantly in Spain, Sweden, the Adriatic Sea (North-East Italy, Slovenia, Croatia), Central Finland, Northern Germany and Northern Netherlands, as well as in Hungary and Romania.

Figure 4.3: Territorial distribution of regions with similar bioeconomy value chain approaches



Data: NUTS 2010
Source: Mapping of RIS 3 on Bioeconomy, own survey

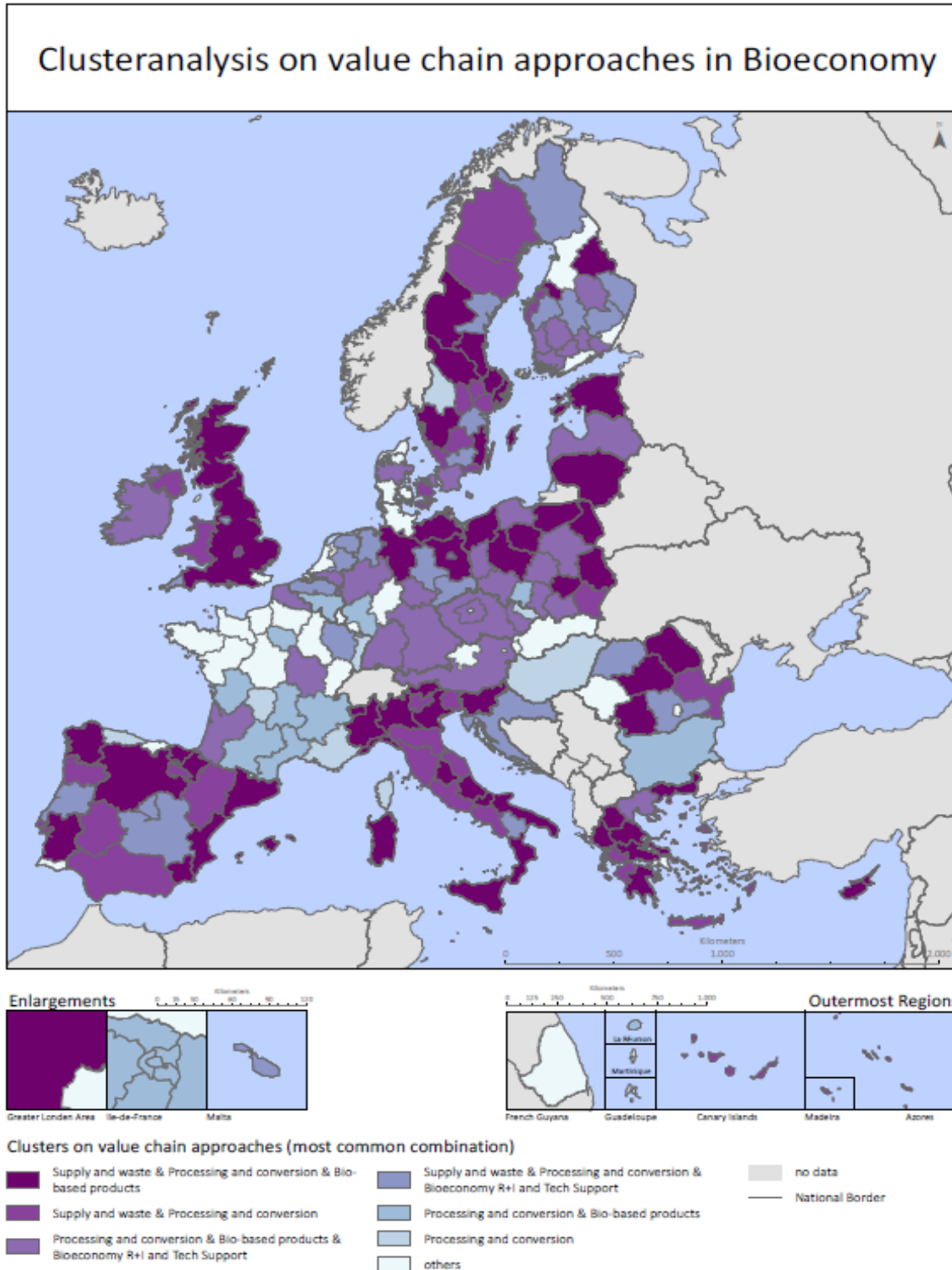
November, 2016

Source: Own elaboration

Regions with “biomass processing and conversion” at their first rank are to be found predominantly in the South of France and North of Spain, i.e. along the Pyrenees, in the Netherlands, partially in Northern Europe as well as in Poland, Greece and Latvia.

Concentration on “bio-based products” from a bio-industrial perspective is predominantly located in Southern and Western Germany, Austria, Northern France and England, as well as Bulgaria and some regions in Poland and Italy. Many areas with an strong industrial profile (or legacy) are among these regions.

Figure 4.4: Territorial distribution of regions with similar combinations of bioeconomy value chain approaches



Data: NUTS 2010
Source: Mapping of RIS 3 on Bioeconomy, own survey

November, 2016

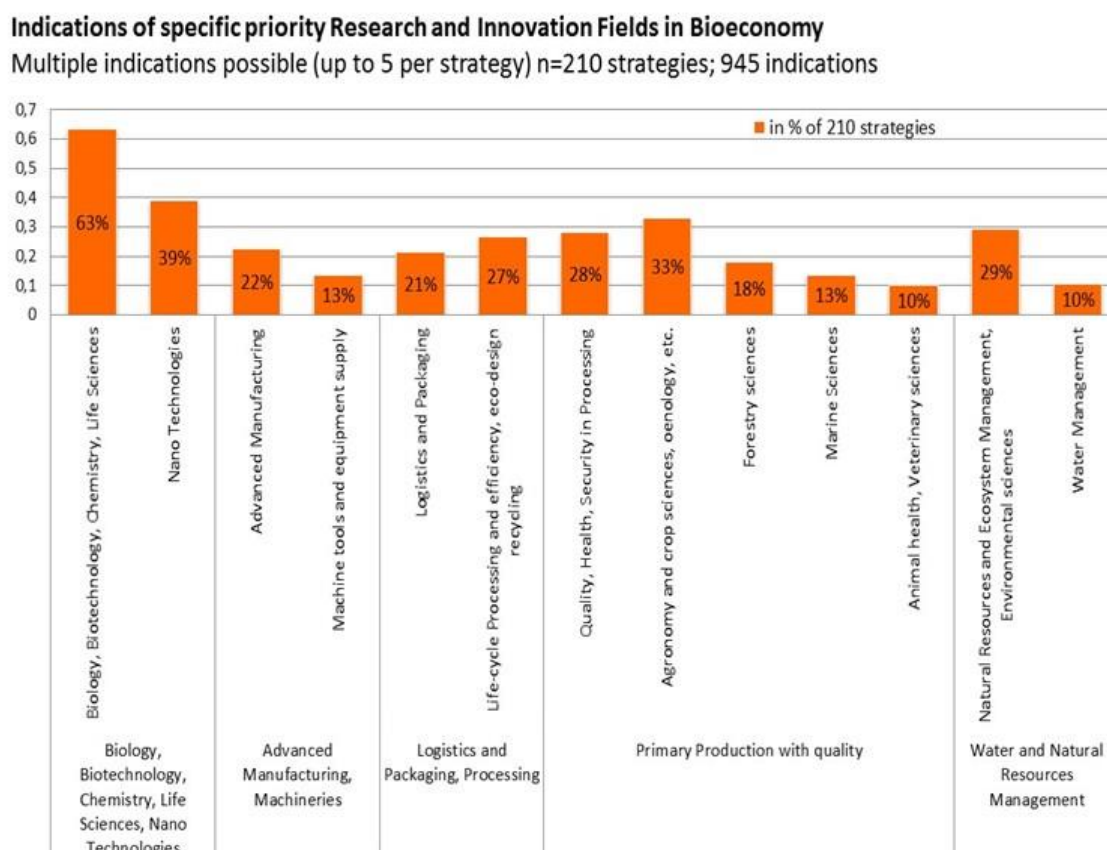
Source: Own elaboration

Regions focusing on R&I and technical support can be found, for instance, in Czech Republic, Slovakia, Belgium, the South of Finland but also in Poland and Spain. This indicated that a focus on R&I support with regard to bioeconomy is not necessarily linked to the maturity level or a focus on a certain thematic focus. Most often the value chain approaches supply and waste, processing and conversion as well as bio-based products are combined in the strategies (see Figure 4.4). Regions with such profiles are located in the UK, North and South of Italy, North of Germany and North of Poland, Estonia and Latvia, as well as many regions in Greece, Romania and Spain. The majority of other regions combines two value chains.

4.3. Regional bioeconomy specialisation according to R&I fields

The analysis examined also the different knowledge areas that are required for bioeconomy activities according to regional R&I priorities and plans. According to the information found in the regional and national RIS3 documents, there is a wide variety of knowledge and technological expertise needed for the different bioeconomy related activities. This is depicted in figure 4.5 below.

Figure 4.5: Specific bioeconomy R&I fields of EU regions/countries: total indications



Source: Own elaboration

63% of the regions foresee for 2014-2020 bioeconomy related research and innovation in the field “biology, biotechnology, chemistry, life sciences”. “Nano technology” is the second most prioritised R&I field (39%). However, not only biotechnology is important when it comes to bioeconomy related research and innovation. Depending on the focus and approach of a given region also other research fields are important. Within the broad R&I field of primary production the specific priorities that are most mentioned are “agronomy and crop sciences” (33%) as well as “quality, health and security in processing” (28%), but also other specific fields are relatively important.

In the R&I field of logistics and processing, “life cycle processing and efficiency, eco-design and recycling” is mentioned in 27% of all indications. Also, “logistics and packaging” is mentioned by 21% of all indications. The specific R&I field “advanced manufacturing” is also mentioned quite frequently (22%), indicating the prominent role of manufacturing of new machines and equipment for e.g. complex biorefinery procedures.

Also the R&I field “natural resources and ecosystem management, environmental sciences” (29%) is found among the more important specific themes for the bioeconomy is. Less important is R&I for “water management”, although it cannot be neglected (10%).

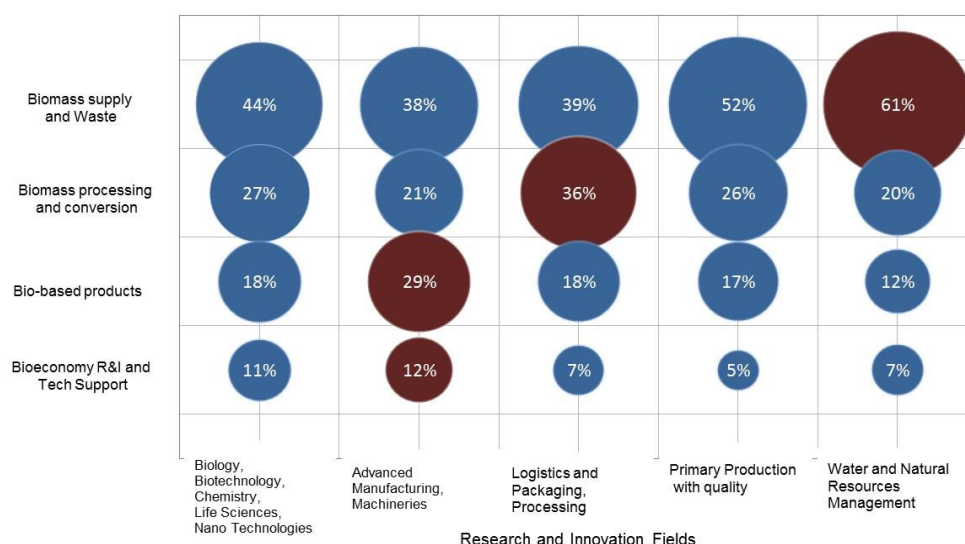
These results indicate the wide variety of knowledge and technological expertise that is needed for the different bioeconomy related activities. Bioeconomy cannot be reduced to “applied biotechnology” but requires expert knowledge and research in many different fields. The combination of research and innovation priorities varies depending on the thematic focus and value chain approach of each region. However, there are no simple typologies, as the distribution of combinations of R&I fields prioritised by the regions and countries is very wide.

The interdependence between the value chain approach of a region or country and the prioritised R&I fields indicates the multidisciplinary character of bioeconomy R&I. In relative terms, regions with a “biomass supply and waste” approach require R&I in all R&I fields, including “biology/biotechnology/nano”, “primary production” and “water and resources management”. R&I in “logistics, packaging and processing” as well as “biology/biotechnology/nano” is especially important in regions focusing on “biomass processing and conversion”. R&I in “advanced manufacturing” is relatively more relevant in regions or countries focusing on a “bio-based products” and a “bioeconomy R&I and tech supply” approach.

Figure 4.6: R&I fields by bioeconomy value chain approaches (%)

Bioeconomy-related R&I fields and bioeconomy value chain approaches

Share of indications of R&I fields in bioeconomy (all ranks) by bioeconomy value chain approach (1st rank) (n=441)



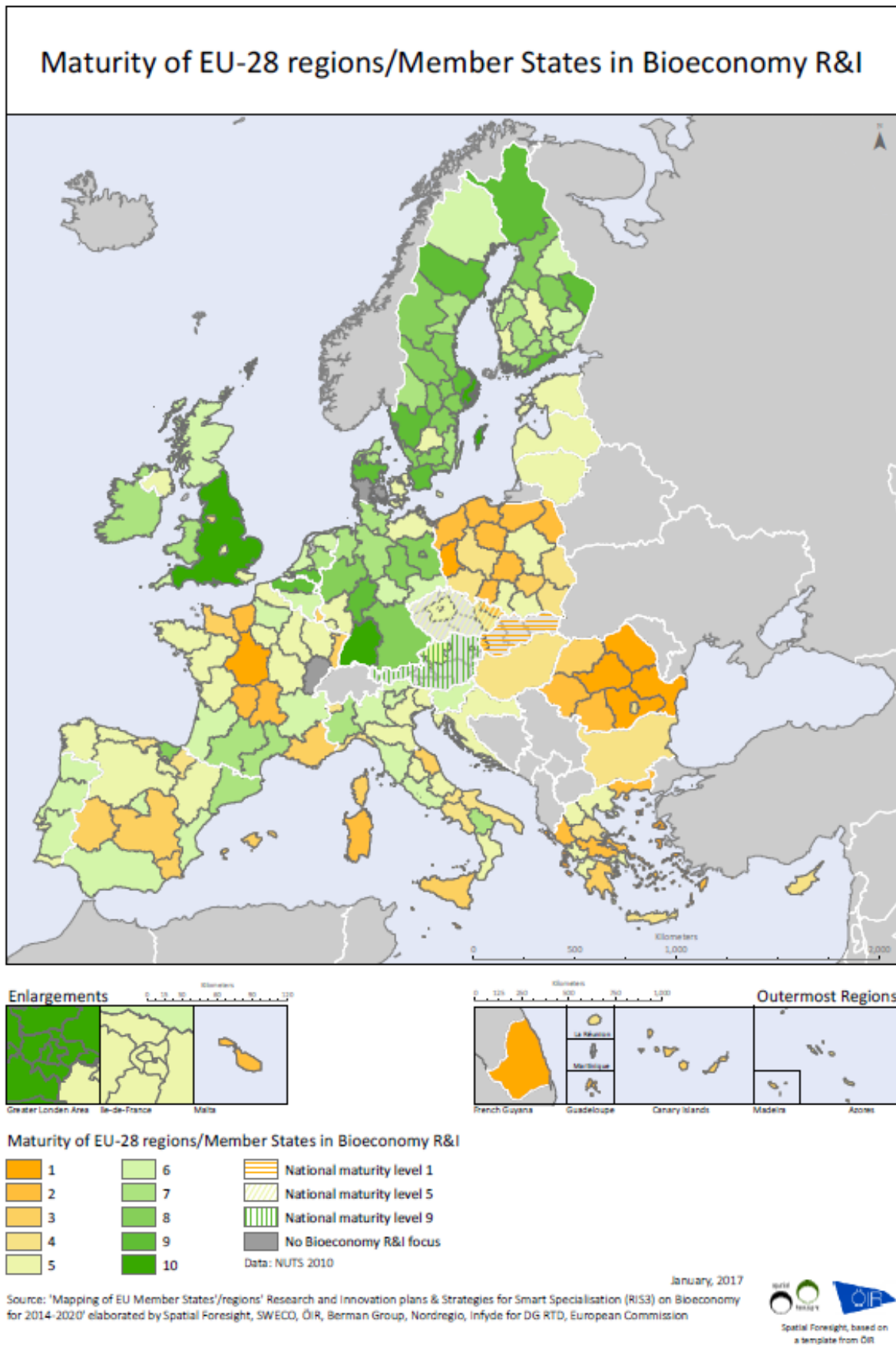
Source: Own elaboration

4.4. Maturity of regional bioeconomy R&I

To describe the bioeconomy R&I maturity level of the analysed regions and countries, a combined maturity index has been developed. The maturity index of the bioeconomy profiles in relation to the state of progress on contributing to R&I in bioeconomy is determined, a priori, based on the combination of four variables on innovation in bioeconomy. The first variable (max. 3 points) describes the general regional innovation capacity and activity based on the classification of the region according to the Regional Innovation Scoreboard 2014 (e.g. innovation leaders and followers, moderate and modest innovators). The second and third variable reflect the existence of specific bioeconomy strategies (max. 2 points) and/or bioeconomy related clusters (max. 2 points) in a given region or country, as an indicator for the current deployment of the bioeconomy at political and business level. A fourth variable (max. 3 points) describes the intensity level of bioeconomy related activities in a given region according to information in relevant documents. The four variables are equally weighted in order to give a straightforward and replicable description of bioeconomy research and innovation maturity.

The map below (figure 4.7) shows the territorial distribution of regions according to bioeconomy maturity.

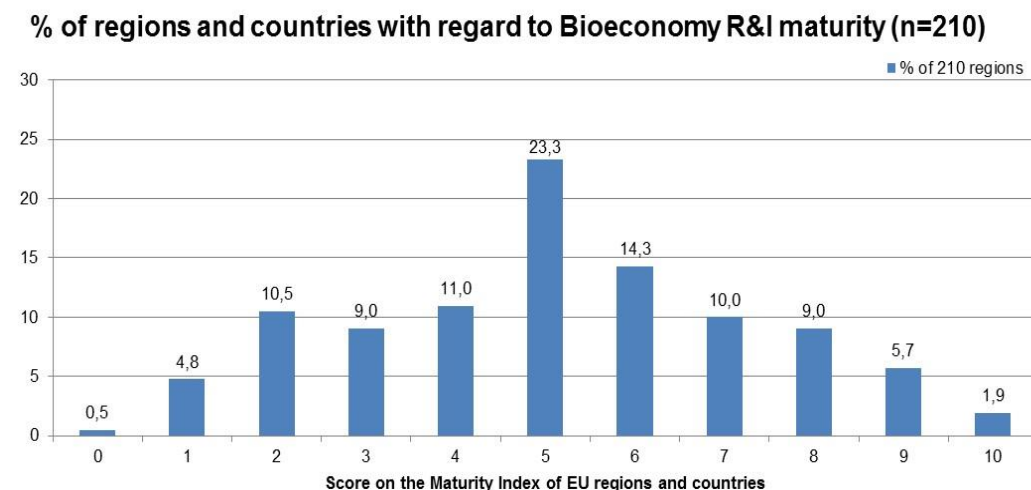
Figure 4.7: Territorial distribution of regions according to bioeconomy maturity



Source: Own elaboration

Three regions or countries have the highest bioeconomy maturity (10 points). These are England (UK), Baden-Württemberg (DE) and Stockholm (SE). They are followed by 11 regions with 9 bioeconomy maturity points: Flemish Region (BE), Hessen (D), Central Jutland (DK), Helsinki-Uusimaa, Pohjois-Karjala, Lappi (all FI), South Netherlands (NL), Uppsala län, Skåne län, Västra Götalands län, Västerbottens län (all SE) (see Annex document 8 for a list of all regions and countries).

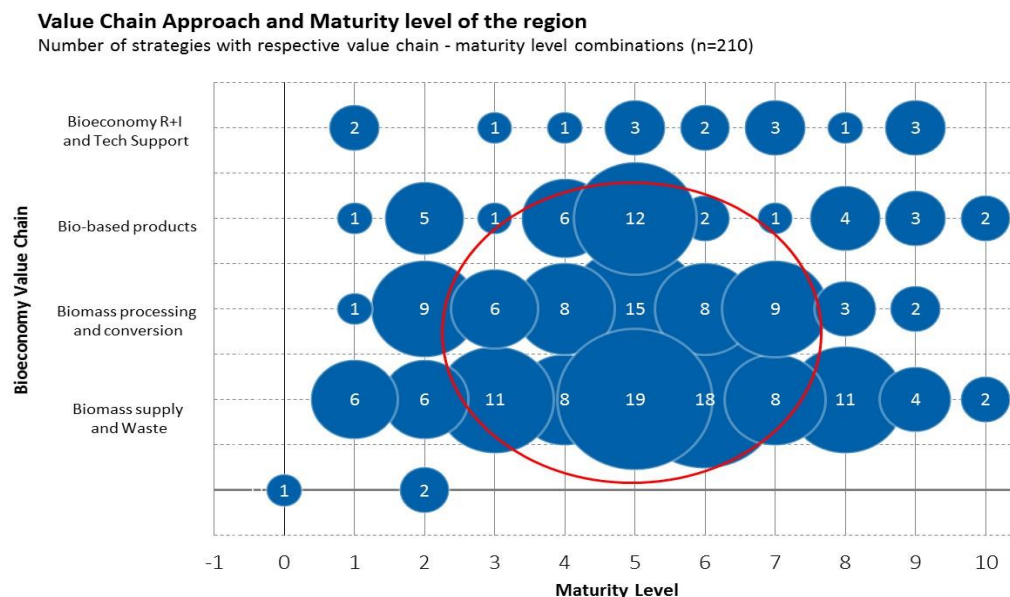
Figure 4.8: Distribution in % of bioeconomy maturity levels of EU regions/countries



Overall the picture of bioeconomy maturity is heterogeneous: Most regions and countries have a middle score (5 points) on the bioeconomy maturity index, while fewer regions and countries particularly low or high. There are 86 territorial units (41%) with a middle-high maturity (6-10 maturity points), compared to 49 regions (23.3%) with a middle maturity (5 maturity points) and 75 regions (35.7%) with a low maturity (1-4 maturity points). Regions or countries with a low bioeconomy maturity level tend to focus on value chain approaches “biomass supply and waste” and “biomass conversion and processing”.

There are however also some regions/countries with a high bioeconomy maturity level that focus also on these value chain approaches. Regions/countries with an approach to “bioeconomy R&I and tech support” at first rank tend to have higher levels of maturity (7-10 points). Nonetheless, there are also regions of lower maturity levels that also focus on R&I in bioeconomy.

The analysis shows that there is no significant relationship between bioeconomy maturity and value chain approaches in bioeconomy-related R&I in European regions and countries (see Figure 4.9). Also regions countries in a bioeconomy initial development stage already focus on bioeconomy R&I and technology support, maybe given to other regions in their own country. Apart from the R&I focus being somehow more likely in regions with higher maturity levels, there is no significant link between maturity levels and the bioeconomy value chain approach at first rank.

Figure 4.9: Value chain approach and bioeconomy maturity levels of regions/countries


Source: Own elaboration

4.5. Drivers and factors that stimulate the deployment of the bioeconomy in the EU regions/countries

There is a wide array of drivers that encourage European countries and regions to invest in the deployment of the bioeconomy. Drivers can be found in the regional resources and assets, not only natural but also related to industrial and scientific knowledge, that can be put into value through innovative techniques and processes. In many cases, the focus on bioeconomy is led by supply side components in the sense that the supply of biological resources or industrial knowledge is actively used for the deployment of the bioeconomy.

According to the analysed case studies, the main drivers of the bioeconomy in EU regions are based on endogenous factors. These are:

- Abundance of natural and biological resources (wood, water, biodiversity) that might contribute more to the generation of income and added value.
- Strong primary economic sectors (agricultural, fisheries, forestry), but sometimes with a low productivity level.
- Important agro-food, fish and or wood/paper value chains within the regional economic structure with a strong technological specialisation.
- Important chemical or other industrial sectors that look for a shift from fossil resources to biological resources and bio-based products.
- Well-developed business sectors that look for cooperation and public support in order to innovate, specialise and develop new products.
- Specialised higher education, research and innovation activities within the region that stimulate research and innovation for the bioeconomy.

The different drivers have an important influence on the way the bioeconomy is understood and promoted in the regions (e.g. resource driven, value chain -driven, business driven or knowledge driven).

However, there are also external factors that stimulate the bioeconomy. These are very diverse and can be seen as political decisions to increase competitiveness and to promote economic development, strategic decisions as a response to global structural changes, external influences or

as responses to environmental or territorial challenges (e.g. climate change, loss of biodiversity, avoiding population loss of rural and peripheral areas).

4.5.1. Endogenous drivers

Many regions derive their interest in the bioeconomy from the **abundance of natural resources** (water, air, soil, woods, water resources, local food etc.), sometimes in combination with existing industrial activities or with a knowledge potential based on the natural resources:

- *"The origins and the interest on Bioeconomy in the Extremadura Region starts from the endowment with natural resources and the real potential for bioeconomy development based on natural resources. [...] There is a regional capacity for the bioeconomy development due to environmental biodiversity, important water resources, and around 28 research groups and 289 researchers for the bioeconomy."* (Case Study Report Extremadura)
- *"In Lapland all business is by essence based on the surrounding nature and local natural resources. Despite its remarkable industrial development – the region is home to one of the EU's biggest industrial concentrations of forest and mineral refining – Lapland remains one of the regions with the cleanest water and air worldwide. It is also the largest certified region for harvesting natural products. The balanced mix of industrial expertise and commitment to sustainable development are at the core of refining natural resources in the Lapland region."* (Case Study Report Lapland)

For some regions, a **strong primary sector** is the main driver of the bioeconomy. This can represent the wish to improve the productivity and technological level of basic primary activities:

- *"Galicia has a strong potential for technological specialization and this potential is applied to the rural (agro-forestry) and marine environment as well as to biofuels sector."* (Case Study Report Galicia)

In many regions, there is also an effort to strengthen existing and **fully-developed value chains**, in particular concerning agro-food, fish and wood/paper industry:

- *"[There are regional] assets such as major access to raw materials (wood) with long fibres, world-leading companies within paper technology, active cluster organisations with long-term funding, leading edge research expertise within cellulose fibre-based packaging materials and access to world-class service research."* (Case Study Report Värmland)
- *"Historically and still today the fishing industry comprises a position of strength for the region, and aquaculture is a related growth area. The entire value chain is represented in the region, including specialised R&D environments."* (Case Study Report North Denmark)

Also more industrialised (even old-industrial) regions show a growing interest in bioeconomy. Here, the drivers are **existing industrial complexes** (e.g. packaging, machine-tool/metal or chemical) with a strong industrial and technological potential that either try to respond to new demands and open new markets with bio-based products or that look for more competitiveness through new and more efficient production processes:

- *"A network of stakeholders and structures connecting the territory to bioeconomy complete these basic agriculture assets. Two significant clusters are present in the region "the Industries & Agro-Resources" (IAR) performing in agro-resources and the cluster "Materials, innovation and green chemistry pole" (MATIKEM) focusing on green chemistry."* (Case Study Report Hauts de France)

Sometimes, a **well-developed business sector** leads regional innovation activities within the bioeconomy and looks for technological improvements and added value through innovation:

- *"The region is also highly specialized in food processing, in agricultural mechanical technologies, in food packaging and in quality catering industries. Several enterprises with a worldwide relevance working in the areas of food processing, food technologies, food packaging, cooling chain, integrated logistics, quality-food & wine production have their headquarters in Emilia-Romagna."* (Case Study Report Emilia-Romagna)

In other cases, existing research and development activities at universities and innovation centres stimulate the interest in the bioeconomy:

- *"The RDI supplying the needs of the sector in terms of higher education, research and technological transfer is relatively well represented by two public universities of which one with a strong biotechnology orientation. Furthermore, the same university started to develop a specialised M.Sc. in Bioeconomy and addresses a specialised public beyond the boundaries of the region."* (Case Study Report Region West, Romania)

4.5.2. External drivers

Among the external factors that stimulate the bioeconomy are political decisions to increase competitiveness and to promote economic development through the bioeconomy and similar approaches (e.g. the circular economy) or strategic choices for more sustainability as a response to global challenges. Also geopolitical trends or population dynamics can be important external drivers of change. Furthermore, opting for a more intensive bioeconomy development can be stimulated by the need to reduce the dependence of a region or country on imported raw materials and fuels within the international system of trade. Finally it can be a response to environmental or territorial challenges (e.g. climate change, loss of biodiversity, avoiding population loss of peripheral areas).

- *"Analysis shows that the potential for bioeconomy is underutilized in Estonia and the value chain based approach to the utilization of biomass is lacking. There is a need for developing smart, value adding and sustainable value chains. Thus the main interest in bioeconomy deployment in Estonia lies in increasing resource efficiency and generating higher value added from biomass."* (Case Study Report Estonia)
- *"The Lodzkie region is one of the most prominent regions in Poland, promoting itself as bioregion and supporting the development of the Polish bioeconomy sector. 27 August 2015 the regional parliament of the Lodzkie region established Lodzkie as first bioregion in Poland, meaning the establishment of the plan to transform Lodzkie into one of the most innovative regions in Poland with sustainable bioeconomy as strategic and integrated cornerstone. The recognition of Lodzkie as bioregion has put the region also in the role of coordinator of all Polish Bioregions."* (Case Study Report Lodzkie)
- *"The selection of Energy and sustainable environment area has been determined by the need to respond to such future challenges and trends as insufficient diversification of energy sources, high energy prices, uneconomical and inefficient use of energy, and lack of ecosystem sustainability."* (Case Study Report Lithuania)
- *"In the past few years a general positive political opinion-forming processes is seen in the field of bioeconomy at regional, national and EU-level. Politicians have recognized that bioeconomy will become an important part of future economy. It is anticipated that investments in bioeconomy lead to independence from fossil resources. Also, bioeconomy contributes to maintain infrastructure in rural areas and thus to strengthen rural areas, which is an important socioeconomic factor."* (Case Study Report Upper Austria)

4.6. Regional bioeconomy ecosystems in Europe

Regional bioeconomy ecosystems in Europe are, first and foremost, built around the usual stakeholders of regional innovation systems: Government and public administration, businesses and representatives of sectoral associations and business intermediaries, as well as academic, scientific and technological institutions.

The case study research shows that all these stakeholders are important. However, in some regions specific actors are more relevant than others for the deployment of the bioeconomy. Who is more active depends on the specific constellation of stakeholders in each region and the 'leaders' that drive the bioeconomy in each region. In general, it can be said that in more mature bioeconomy regions actors from all three areas cooperate and coordinate in formal and informal networks.

In particular, at the level of government, **coordination** among different policy areas (e.g. research and innovation, agriculture, environment) is needed to promote the bioeconomy:

- "A special working group has been formed for the implementation of the RIS3, comprised of different directorates of the Region of Crete, among others the Regional Directorate of Regional Planning, the Directorate of Environment and Spatial Planning, the Directorate of Agricultural Economy. The Coordinator of the working group comes from the Regional Directorate of Regional Planning and is responsible for the general support and implementation of the RIS3". (Case Study Report Crete)

Especially in strongly industrialised regions, but also increasingly in rural regions, **clusters** are an important tool to gather stakeholders around specific bioeconomy sectors/products. Clusters help e.g. "overcoming the region's lack of critical mass and integrating Lapland's industries into global value chains" (Case Study Report Lapland).

- "The Cluster organisation Paper Province that gather bioenergy suppliers, packaging suppliers, all the large equipment suppliers of the paper industry, a quarter of Sweden's pulp and paper mills and a number of small and medium-sized suppliers of services and components". (Case Study Report Värmland)

In comparison to traditional industrial clusters, bioeconomy related clusters often need to integrate also **producers** of biological resources, i.e. farmers and fishermen, as well as cooperatives, agricultural and export associations.

- "Agricultural cooperatives, which promote the local products and help producers cooperate are another bioeconomy related actor active in the region. They are potential implementers of agro-food bioeconomy innovations." (Case Study Report Crete)

Moreover, many regions count on **science and technology intermediary and transfer organisations** to bridge the gap between research and the development of new products and diffusion of innovation among companies, in particular SMEs. The intermediary organisations or 'bridges' are particularly important in the emergent field of bioeconomy, where cooperation among different sectors is required and many technologies are still rather immature. Intermediary organisations are, for example:

- "Palacky University Science and Technology Park is the location for innovative companies, providing business and research services, laboratories and access to University research infrastructure and University know-how. Among 41 companies located currently in the park 14 can be considered as bioeconomy related (34%), some of them being spin-offs from the University or start-ups originating at the University." (Case Study Report Olomouc-Central Moravia)

In addition to the usual stakeholders, the analysed bioeconomy related innovation systems present additional **emergent players** that seem to play a vital role in the promotion of the bioeconomy. Table 4.1 presents these specific and emergent stakeholders.

Table 4.1: Emergent players in regional bioeconomy systems

Function	Description	Example
Bioeconomy Strategy Councils	In some countries and regions, specific strategic bioeconomy panels or councils have been established to support the strategic planning of the deployment of the bioeconomy. They are considered by the regional stakeholders as valuable tools to coordinate public and private efforts and to link research, innovation and development of new technologies with public strategic and funding schemes. The Councils are also used to establish priorities based on regional (or national) assets, to define responsibilities and to discuss	"The Strategy Council Bioeconomy Weser-Ems ('Strategierat Bioökonomie Weser-Ems') connects as intermediary public and private interests and stakeholders. It consists of 25 stakeholders coming from enterprises, research institutions and public institutions. The council has aligned the support of the Bioeconomy, which has resulted in the Master Plan Bioeconomy. The objective of the Council of Bioeconomy is to define areas of cooperation and to discuss further potential and bottlenecks." (Case Study Report Weser-Ems)

Function	Description	Example
	potentials and bottlenecks.	
Bridges and links (thematic platforms, networks, projects):	<p>In addition to existing networks and sectoral cluster, many regions and countries analysed in our case study analysis express the need to work with additional bridging and linking bodies, such as thematic platforms, networks, projects. These bioeconomy platforms/networks have various functions, according to the analysed cases. First, they serve as meeting point and information centre to inform all relevant stakeholders and the public. Second, they usually have a more specific thematic focus within the bioeconomy (e.g. innovation in fisheries, a specific biorefinery technology). This focus allows a more detailed content-related coordination and collaboration of interested private and public actors. Third, within the complex framework of bioeconomy themes and activities these platforms are important regional and national 'islands of knowledge' that manage available and up-to-date knowledge on specific problems, solutions, technologies and pilot projects.</p>	<p><i>"National networks for fisheries and aquaculture in collaboration with the Central Denmark Region. Based on dialogues between the triple helix actors during 2014-2015, lists of more than 100 project initiatives and action plans have been developed for the fisheries and aquaculture industries."</i> (Case Study Report North Denmark)</p> <p><i>"There is also Czech Biogas Association, a national technology platform with more than 40 biogas industry members and leading R&D institutions from the whole Czech Republic and from abroad."</i> (Case Study Report South Bohemia)</p> <p><i>"The new Lappish Innovation platform - Centre of Arctic Smartness Excellence will be created to support cluster's needs and also feed innovations and ideas and work as a booster for innovations using the TRL (technological readiness level) classification implementation, in particular in development, testing and service design laboratories and facilities."</i> (Case Study Report Lapland)</p>
Specialised Technology, Research and Innovation Centres	<p>The wide thematic coverage of the bioeconomy and its innovative character makes it necessary to deepen the knowledge in specific fields. Many regions and countries analysed as case studies highlight specialised research, innovation and technology centres that work on applied technologies and (more or less) on the technology transfer to large companies and local SMEs.</p>	<p><i>"The Centre of Food and Fermentation Technologies (CFFT) (www.tftak.eu) CFFT is a R&D company that focuses on improving quality, functionality and stability of food, as well as developing and introducing new innovative food and fermentation technologies. CFFT has an extensive cooperation with research institutions and more than 40 industrial enterprises from different countries."</i> (Case Study Report Estonia)</p> <p><i>"The South Bohemian Research Center of Aquaculture and Biodiversity of Hydrocenoses (CENAKVA) is a new infrastructure and research project which has been built in Vodňany town upon experience and knowledge base of the Fisheries and Hydrobiology Research Institute of the Faculty of Fisheries and Water Protection. The infrastructure project started in 2010 and was finished in 2013."</i> (Case Study Report South Bohemia)</p>
Operational coordination bodies at local level	<p>Regional stakeholders indicated the need of strong coordination bodies at local or regional level, that have the aim to steer larger pilot projects, to coordinate the implementation of support programmes and to bring the available knowledge from the</p>	<p><i>"North Sea Science Park, Nordsøen forskerpark, actively participates in a variety of projects, all of which are intended to promote development and growth in the fisheries and aquaculture industries. An important task will involve fundraising for project proposals that have been developed by stakeholders in the network</i></p>

Function	Description	Example
	knowledge centres in Europe into the regions and to the local SMEs (including cooperative, farmer and fishermen).	<p><i>development process. [...] Nordsøen forskerpark will be instrumental in supporting the development and implementation of some of the proposed initiatives.</i>" (Case Study Report North Denmark)</p> <p><i>"Tehimpuls Association and the Agro Food Banat Crisana Cluster act as facilitators and multipliers of knowledge well connected with the researchers from the region's universities: Banat's University of Agricultural Sciences and Veterinary Medicine, Politechnica University, West University and Medicine and Pharmacy University".</i> (Case Study Report West Region, Romania)</p>
Cross-border and interregional cooperation	<p>Many stakeholders highlighted the importance of cross-border and interregional projects to promote the bioeconomy, in particular, to transfer practical knowledge into the region and to work on common problems with a cooperative approach. For the bioeconomy, different cooperation frameworks are relevant: from INTERREG to FP7/HORIZON2020 projects, but also LIFE and the EIT's Knowledge and Innovation Communities (KICs), in particular on Food, Climate and InnoEnergy.</p> <p>There are even cases of cross-border smart specialisation strategies (RIS3) that also focus on bioeconomy R&I. One example is the joint strategy between Galicia (Spain) and Norte (Portugal).</p> <p>Also macro-regional strategies are relevant for some regions to learn more about the bioeconomy. In particular in the Baltic Sea Region, the relevance of the Bioeconomy projects and working groups, as well as of specific funding schemes (e.g. BONUS) has been highlighted.</p> <p>The participation in European or interregional networks is equally important for most of the analysed countries and regions. The relevant bioeconomy networks include, in particular, the ERRIN network of innovative European regions with its Working Group on the Bioeconomy, but also ERIAFF, CPMR and the S3 Platforms on Energy and Agro-food. Many regions are also active in the Vanguard interregional initiative.</p>	<p><i>"Region Skåne is one of six partners in a project funded by the Baltic Sea Interreg programme; Smart Blue Regions, which seeks to enhance blue growth opportunities, i.e. bioeconomy related to the maritime resources, based on increased capacity of the regions to implement research and innovation strategies for smart specialisation (RIS3). [...] In the area of blue economy the project BUCEFALOS is worth mentioning. BUCEFALOS was a EU LIFE+ project in which the City of Malmö, Region Skåne and Trelleborg Municipality were investing about 3 million EUR to enable the region of Skåne to work towards the resource-efficient use of the excess aquatic biomass which is mainly treated as waste".</i> (Case Study Report Skåne)</p> <p><i>"The Cross-Border Smart Specialisation Strategy of Galicia - Northern Portugal (RIS3T) establishes strategic collaboration in bioeconomy related areas such as Biomass and marine energies and resources and agri-food and agri-environmental systems."</i> (Case Study Reports Galicia and Norte)</p> <p><i>"The European Commission's 'Action plan for the EU Strategy for the Baltic Sea Region' mentions bioeconomy as one of the main priorities, where marine energy, blue biotechnology and sustainable use of biomass are pivotal topics."</i> (Case Study Report Lithuania)</p> <p><i>"There is a long tradition of cooperation with other regions and actors from outside the region. Lodzkie is also active in the ERRIN Network, participates in the group for bioeconomy in the Vanguard initiative and participates in a number of EU projects".</i> (Case Study Report Lodzkie)</p> <p><i>"[...] Among networks in which Extremadura actively participates are: - ERRIN (European Regions Research and Innovation Network); - ERIAFF (European Regions for Innovation in Agriculture, Food and Forestry); EURADA (European Association of Development Agencies)." (Case Study Report Extremadura)</i></p>

Source: Own elaboration based on Case Study Reports.

4.7. Typology of regions according to their bioeconomy profile

The analysis of the different features of the bioeconomy in European countries and regions showed a huge interest in developing the bioeconomy in the next years. Almost all EU regions (98.6%) foresee R&I in at least some bioeconomy related area in their RIS3 2014-2020. This indicates the central importance of the bioeconomy for innovation and research in the following years.

However, the analysis also shows a wide variety of drivers, of bioeconomy sectors and subsectors, of regional capacities and maturity and of approaches to deploy the bioeconomy. This diversity in thematic orientation and value chain approach towards the bioeconomy makes the understanding of regional realities and the definition of support schemes more complex.

Nevertheless, a pattern of regional bioeconomy profiles has become visible. Six types of regional profiles are identified:

- Type 1: Regions with a research driven bioeconomy profile
- Type 2: Regions with a natural resources and heritage driven bioeconomy profile
- Type 3: Regions with a primary value chain bioeconomy profile (incipient)
- Type 4: Regions with a primary value chain bioeconomy profile (advanced)
- Type 5: Regions with an industrial biotech profile
- Type 6: Regions with an integrated and advanced bioeconomy profile.

The research showed that it is difficult to align all EU regions and countries to only one of the types of the typology. As confirmed by the analysis, most regions and countries have a mixed/heterogeneous approach to development of the bioeconomy. Further research might be necessary to confirm the validity of the typology proposed in this study, to examine type-specific needs of regions and countries and to develop tailored recommendations for each one of the bioeconomy profiles.

Table 4.2: Typology of regional bioeconomy profiles

Bioeconomy type	Bioeconomy drivers	Bioeconomy capacities (Maturity, R&I competences)	Approach to bioeconomy value-generation	Examples
Type 1: Research driven	<ul style="list-style-type: none"> Bioeconomy research at universities and research institutes 	<ul style="list-style-type: none"> Low-middle-high maturity R&I in biotechnology, biochemistry, nanotechnology, agronomy, engineering etc. 	<ul style="list-style-type: none"> Excellence in bioeconomy transdisciplinary research To offer R&I services and technology support 	Madrid Helsinki Lodzkie
Type 2: Natural resources and heritage driven	<ul style="list-style-type: none"> Abundant natural resources Marine and hydric resources 	<ul style="list-style-type: none"> Low bioeconomy R&I maturity R&I in natural resources, environmental sciences, tourism, leisure 	<ul style="list-style-type: none"> Ecosystem management and resilience Leisure and tourism Sustainable agro-food and bio-energy, bio-based products 	Canary Islands, Extremadura Latvia Bulgaria
Type 3: Primary VC focus - incipient	<ul style="list-style-type: none"> Strong primary (agricultural, fisheries, forestry) economic sectors 	<ul style="list-style-type: none"> Low maturity R&I in natural resources, agronomy, forest sciences, veterinary sciences, animal genetics 	<ul style="list-style-type: none"> Diversification of products, markets and R&I competences Higher added-value products To develop existing value chains To create decentralised small bio-refineries and other small-scale (mature) technologies 	Galicia Crete Norte PT West Romania
Type 4: Primary VC focus - advanced	<ul style="list-style-type: none"> Complete agro-food, wood or fisheries/ aquaculture value chains Innovative business environment and companies 	<ul style="list-style-type: none"> Middle-high maturity R&I in logistics, LCA/LCD, packaging, biotechnology, quality primary production, natural resources management 	<ul style="list-style-type: none"> Value aggregation Specialisation in value chains New products from available biomass and residues R&I on bio-refineries and bio-based products (algae, fibres) 	Emilia-Romagna Värmland Weser-Ems Lappi
Type 5: Industrial Biotech focus	<ul style="list-style-type: none"> Strong industrial sectors that focus on bio-based products (e.g. chemical) Innovative companies 	<ul style="list-style-type: none"> Middle-high maturity R&I in nanotechnology, biochemistry, chemistry, engineering, advanced manufacturing, LCA/LCD 	<ul style="list-style-type: none"> Technological conversion To develop new value chains To integrate fossil-based and bio-based technologies To develop circular approaches 	North-Rhine-Westphalia Nord-Pas-de-Calais
Type 6: Integrated Bioeconomy development	<ul style="list-style-type: none"> A combination of drivers (e.g. agro-food with industrial sectors, industrial biotech and natural resources, industrial biotech/agro-food/bioenergy) 	<ul style="list-style-type: none"> High maturity R&I in agronomy, forest sciences, veterinary sciences, animal genetics, nanotechnology, biochemistry, advanced manufacturing, LCA/LCD 	<ul style="list-style-type: none"> Transition To develop new value chains To develop combined value cycles with primary/industrial sectors To develop new bio-based manufacturing technologies To develop circular approaches 	South Holland Flanders Skåne Scotland

Source: Own elaboration

5. IMPLEMENTING THE BIOECONOMY IN THE EU REGIONS/COUNTRIES

This chapter describes the bioeconomy policy frameworks in the European regions including the strategic understanding of regional bioeconomy policies and the importance of existing European funding frameworks. The findings build on the mapping of RIS3 documents and ESIF Operational Programmes as well as on the analysis of case studies of European regions and countries.

5.1. Regional bioeconomy policy frameworks

The vast majority of European RIS3 strategies foresees support for bioeconomy R&I. Most of them under the heading of agro-food or energy R&I. The case studies show that the support can be either strategic with clear priorities in the bioeconomy field – in particular in the regions with a general bioeconomy strategy (e.g. circular economy, green/sustainable chemistry, blue economy) , or embedded in one or several existing strategic frameworks as national or regional sectoral support to innovation in agriculture, fisheries, specific industries, waste management etc.

With regard to specific measures and funding modalities, RIS3 strategies propose a wide array of measures. Due to the diversity in thematic priorities and the general character of many support measures/programmes (i.e. not only oriented towards bioeconomy companies or sub-areas), it is impossible to establish a complete compendium of support measures and funding volumes. However, examples in the case studies illustrate the variety of existing measures. Most RIS3 strategies and other strategic R&I frameworks organise their funding plans according to programmes and/or economic sectors. Since the bioeconomy in most cases receives an unidentified share from a variety of programmes/schemes and covers also different sectors, it is difficult to calculate funding volumes for 2014-2020.

5.1.1. Bioeconomy as strategic or horizontal policy

Some countries and regions follow a strategic approach to support the bioeconomy. The analysis shows that 19 Member States already have a bioeconomy strategy (or a similar strategic document¹⁷) in place¹⁸ or are in the process of developing a strategy¹⁹. Moreover, 49 of the analysed regions have developed a regional bioeconomy strategy or a similar comprehensive document²⁰ (see Annex Document 8 for lists of Members States and regions).

In cases where a regional bioeconomy strategy or a similar strategic understanding exist, there are usually support structures in place to strengthen the bioeconomy.

- *"Within the region of Weser-Ems, a manifold of strategic plans, master plans and projects do coexist. Many of them do address at least one aspect of the Bioeconomy due to the general economic specialisation of the region. The most relevant document in terms of Bioeconomy is the Master Plan Bioeconomy 2020 ('Masterplan Bioökonomie 2020') published by the Strategy Council Bioeconomy Weser-Ems. It intersects at the applied and theoretic level by picking up objectives from the RIS Weser-Ems and RIS3 of Lower Saxony and sets concrete targets in terms of projects."* (Case Study Report Weser-Ems)
- *"The regional authority of Skåne has developed an action plan for the regional bioeconomy until 2030, which will bring together actors and enhance the prospects for a transition to a bio-based economy in Skåne. The size of the regional bioeconomy is estimated to embrace 3 200 companies with a total turnover of 107 billion SEK (approximately 10 billion euro) and approximately 33 000 employees. The largest bioeconomy sub-sector in Skåne, in terms of turnover, is food processing (34%) followed by energy supply (15%), construction (13%), wood, paper and furniture (12%), agriculture (12%), manufacturing and reparation*

¹⁷ For example, a Strategy for Green Growth (Portugal) or a Low-Emission Economy (Poland).

¹⁸ Austria, Bulgaria, Germany, Denmark, Spain, Finland, France, Ireland, Italy, The Netherlands, Portugal, Poland, Sweden, Slovenia, UK.

¹⁹ Hungary, Estonia, Latvia, Romania.

²⁰ in this case we considered only real bioeconomy strategies (called "bioeconomy strategies") or somehow innovative bioeconomy-specific strategic documents. In this case, we did not count the overall RIS3 strategy as a bioeconomy strategy, even if it had bioeconomy-related content or objectives. Neither did we take into account common sectoral strategies, e.g. for innovation in agro-food, fisheries, chemistry, even if those in many places are slowly converting towards a more holistic bioeconomy-perspective. The final selection of regions with bioeconomy strategies is therefore subjective and can imply certain errors due to a lack of available information or different translations of the bioeconomy concept into different languages.

of machinery for agriculture, forestry and food processing (6%), and water and sanitation (6%). However, within the framework of Smart Specialization, the region of Skåne supports the innovation climate in three strategic priority areas; Smart Materials, Smart Sustainable Cities and Personalized Health. None of these areas are specific directed towards bioeconomy, but especially in the Smart Materials area substantial synergies with bioeconomy can be found." (Case Study Report Skåne)

- "In Slovenia, the RIS3 and national R&I priorities are oriented towards the Government framework program for the transition to a green/circular economy. The green economy is Slovenia's long-term strategic direction and an opportunity for the development of new green technologies, green jobs, more efficient management of natural resources, promotion and development of Slovenian knowledge. Also, in Slovenian's Industrial Policy framework (2014-2020, biotechnology and other related technologies are prioritised. Agro-industry and sustainable food production is considered to be one of key industrial sectors when dealing with these issues." (Case Study Report Slovenia)

In some countries and regions, a strategic framework for the bioeconomy is under development.

- "The National Sectoral Plan for Research and Development in Agriculture and Rural Development of the Ministry of Agriculture and Rural Development for the period 2015-2018 (ADER) has programmed transversal resources to support the research and innovation in bio-economy". "Specific input is expected from the project (nationally funded) 'Research regarding the identification of development priorities for bio-economy in Romania for the period 2016-2030'. An initiative for creating a National Board/College for Bio-Economy supported by the Academy of Agricultural Sciences and Forestry, Romanian Academy and the Agricultural Universities from Romania is under development." (Case Study Report region West, Romania)
- "The Bioeconomy strategy and respective R&D funding schemes along it are expected to be launched before 2020." (Case Study Report Estonia)

However, not all countries or regions follow this explicit strategic approach to support the bioeconomy. In the regions and countries without an explicit bioeconomy strategy, the bioeconomy support is often embedded in one or several other strategic documents or funding programmes. These are mainly specific national or regional R&I strategies and plans, sectoral innovation strategies and plans (e.g. innovation in agriculture, fisheries, specific industries, waste management) or strategic frameworks partially covering bioeconomy (e.g. circular economy, green/sustainable chemistry, blue economy). This accounts for also the RIS3 strategies, where the bioeconomy in most cases is inserted in different programmes, priorities or pillars.

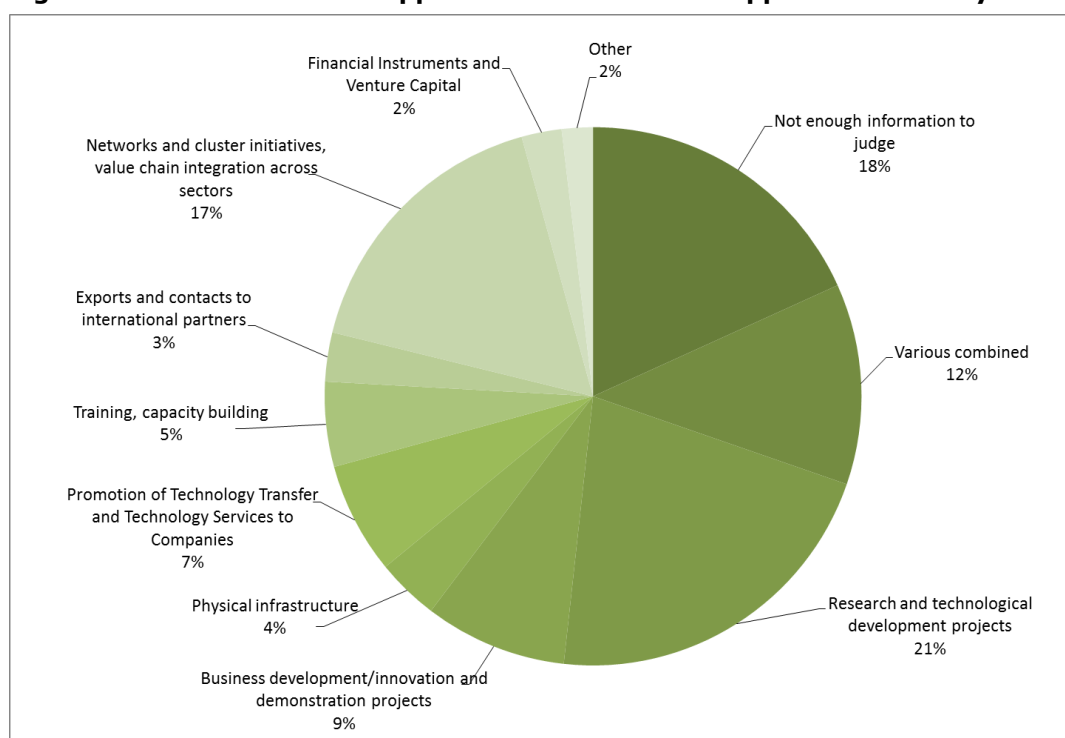
- "The bioeconomy is not explicitly named within the smart specialization plan, but it is a priority sector for all RIS3 instruments, where all the Galician R&D&I entities participate. In addition, all the working groups elaborate their plans taking into account the elements of the bioeconomy. This includes models for natural resource management, management and valorisation of the primary sectors." (Case Study Report Galicia)
- "There are no specific support measures for bioeconomy related research and innovation in Estonia today. Several support measures are available for the growth areas of smart specialisation, which include effective use of resources, and have been relevant for implementing the bioeconomy related R&I initiatives." (Case Study Report Estonia)
- "Three related and integrated sector strategies frame the bioeconomy in Poland. These are the Strategy for innovation and efficiency of the economy, Strategy for Energy Safety and environment and the Strategy for sustainable development of agriculture, rural areas and fisheries. In addition, several research agendas support bioeconomy in Poland." (Case Study Report Lodzkie)
- "Bioeconomy is part of some priority axes of the RIS3 strategies approved in the two former regions Picardie and Nord-Pas-de-Calais. The RIS3 strategy of Picardy region dedicates a specific axis to bioeconomy 'Bioeconomy and territorial biorefinery', split in two specific objectives. The first specific objective plans to develop agro-industry and vegetal-based chemistry, supporting R&D activities, industrial demonstrators and promoting start-ups (in their early development phases). The second specific objective is dedicated to biorefinery and methanisation technologies. In Nord-Pas-de-Calais, there is no specific priority axis dedicated to bioeconomy in RIS3 strategy, however bioeconomy is mentioned

in the document within the sections related to materials and chemistry and indirectly when considering textile, polymers and composite materials. Two axes address more specifically the issues related to the bioeconomy, i.e. 'Chemical, Materials and Recycling' and 'Energy'." (Case Study Report Hauts de France)

5.1.2. Policy instruments and funding modalities

The analysis of RIS3 strategies and related documents shows a wide range of instruments and modalities to support the bioeconomy is anticipated by the regions for the 2014-2020 funding period, from support to physical infrastructure to promotion of technology transfer, technology services, training and capacity-building. While funding may often be provided through grants, the analysis indicates that there is broader variety of funding modalities including financial instruments and venture capital to bundle resources and to raise more investments. However, available information is in many cases not sufficient. Hence, data presented in figure 5.1 below should only be used as indication and should not be considered representative for all European regions and countries.

Figure 5.1: Modalities and support instruments that support bioeconomy R&I



Source: Own elaboration

Bioeconomy is considered in many regions as an important field of specialisation of regional R&D activities planned for 2014-2020.

- *"The action plan for regional RIS3 implementation has been put together with understanding then needs of biotechnology and currently there are 8 interventions in the biotechnology planned for 2017 out of a total number of 61 projects envisaged for the following year which is the largest specialisation field in the 2017 action plan."* (Case Study Report South Bohemia)

A mix of support policies and programmes for different aspects of the bioeconomy is common, but the term 'bioeconomy' as such is not always used. This means that specific programmes or instruments exist within sectoral policies (e.g. agricultural, industrial or environmental).

- *"The term 'bio-economy' is usually not used as such in Greece and often other terms, such as eco-innovation or agricultural innovation are more familiar. Thus, relevant studies on bioeconomy as such are difficult to find for the region of Crete. As for the scope of the study, bio-economy is considered as a rather broad term comprising a number of sub-*

sectors, there are a few national strategies and action plans, mainly related to innovation”.
(Case Study Report Crete)

With regard to specific measures and funding modalities, some RIS3 strategies propose a wide array of measures addressing different areas of the bioeconomy. For example, the Slovenian RIS3 is dedicated to support the national shift towards a circular economy. The bioeconomy is one important element of this shift. The example of the Slovenian RIS3 'Slovenia's Smart Specialisation Strategy - S4' shows the variety of measures that are available for the bioeconomy related sectors and stakeholders. The following policy mix is envisaged by the Slovenian RIS3 strategy:

- Support for basic science
- Research, development and innovation in value chains and networks
- Support to investments for development and demonstration of products
- Complementarity with Horizon2020 and international initiatives
- Better utilisation and development of research infrastructure
- Specific measures for sustainable food production and sustainable tourism
- Human resources measures (researcher, competences for innovation and creativity)
- Support to entrepreneurship, creation, growth and internationalisation of companies, in particular SMEs (Grants to SMEs, Cluster Policy etc.)
- Other measures (Innovative and Green public procurement, tax relief, reducing administrative burden etc.)

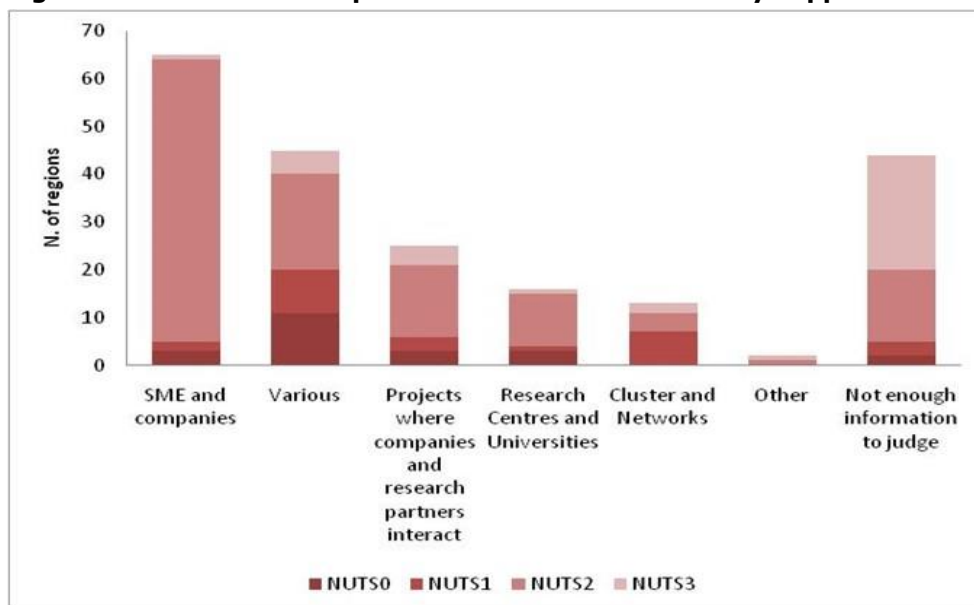
The case studies contain other examples of the mix of instruments and funding modalities that support the bioeconomy. One example is from Extremadura:

- *"Extremadura Avante offers, among others, the following funding modalities: Agrotech startup; Innovation Dynamizers Program (Programa de Dinamizadores de Innovación); Innovation Bonds and Technology Vouchers (Bonos de Innovación y Vales Tecnológicos)."*
(Case Study Report Extremadura)

In many cases, the support to bioeconomy R&I is channelled through existing SME and innovation support frameworks at national and/or regional level. Priorities (e.g. for the bioeconomy or economic sectors) are sometimes defined, but sometimes programmes are open for all themes:

- *"The Estonian national research funding is based on a bottom-up approach to financing, meaning that the specific research topics of the call are rarely defined and prescribed, allowing for wider interpretation by the applicants."* (Case Study Report Estonia)

With regard to **targeted recipients** for bioeconomy support measures, most of the analysed regions/strategies focus on SMEs and companies as prioritised recipients. Figure 5.2 shows the distribution of different recipients among the regions studied.

Figure 5.2: Main final recipients of foreseen bioeconomy support measures


Source: Own elaboration

Many regions focus on various target groups at the same time, instead of considering one or the other group as being most relevant. Another relevant target group are projects that involve both business and research partners.

5.1.3. Funding sources and volumes

A wide variety of planned **funding sources** for RIS3 and bioeconomy R&I was identified. The RIS3 of Crete (Greece) is a good example to show the most prominent funding sources for a RIS3. This applies also to bioeconomy-related measures.

- "The region is open to several funding opportunities and committed to implement the RIS3. For the RIS3 implementation, a number of funding sources are already mobilised. Funding sources are not only the Regional ERDF Operational Programme, but also some of the priorities of the national Operational programme on Entrepreneurship, Competitiveness and Innovation (ERDF), the Rural Development Programme and the actions of Horizon 2020."* (Case Study Report Crete)

In many cases, not only the ERDF but also ESF programmes are used to fund innovation projects specific for the bioeconomy (training, education, new competences). Most of the analysed cases mention a plan to use funding of the Rural Development Programmes (EAFRD) and some even of the Fishery Operational Programmes (EMFF) to support certain measures of the RIS3 strategies, in particular in the agro-food, bioenergy, fisheries and aquaculture areas.

- "Innovation Fund Denmark was set up by the Agency as an independent body. It is the main national body supporting RTDI activity." In addition, the Danish AgriFish Agency, under the auspices of the Ministry of Environment and Food, is the Managing Authority for the EMFF and EAFRD. The AgriFish Agency also manages the GUDP - The Green Development and Demonstration Programme. GUDP is a national programme. The purpose of the programme is to ensure green and economic sustainability in the Danish food sector while solving some of the climate and environmental problems facing society, and that the food industry will continue to create growth and secure jobs in Denmark. The target group for the GUDP programme include research institutes, food producers, entrepreneurs, industry associations, etc. in the food industry. The programme provides grants for applied research, development, demonstration and network projects. Development and demonstration projects can be granted a total of DKK 0.25-15 million for a period of up to four years. Network projects can be granted up to 50% of the eligible costs with a total grant of DKK 0.25-2 million in a period of 1-2 years."* (Case Study Report North Denmark).

Due to the diversity in thematic priorities and the general character of many support measures/programmes (i.e. not only oriented towards bioeconomy companies or sub-areas), it is

difficult to establish an estimation of **funding volumes** for the bioeconomy. However, there are some examples, where a rough estimation is possible.

- *"As detailed in the RIS3 strategy, the "Agro-food system" is funded by ERDF, ESF, EARDF, Sectoral Regional Funds and other national and European funds (Horizon 2020). Hence, the total funding available for the agro-food sector is estimated around 740 million euro over the period 2014-2020."* (Case Study Report Emilia-Romagna)

In Crete, 40.6% of the RIS3 budget is allocated to the priority fields "Agro-food" and "Environment", i.e. EUR 133.9 million of a total of EUR 330.16 million. For other cases, rough estimations of a part of the bioeconomy related funding are possible:

- *"The National Rural Development Programme is programming the amount of 1.958.334,49 EUR total public and private investments at national level for Energy from Renewable Sources for the Priority/DI 5C Facilitating the production and the use of renewable energy sources, sub-products, wastes, residues and other non-food raw materials for bioeconomy".* (Case Study Report Region West, Romania)
- *"The Extremadura Bioenergy Plan 2015-2020 counts with EUR 27.5 million of investment and whose measures will be co-financed with ERDF and EARDF."* (Case Study Report Extremadura)

According to the Spanish Bioeconomy Strategy, EUR 1781.8 million (of that EUR 1110.7 million in grants and EUR 671.1 million in loans) is planned to promote the bioeconomy between 2016 and 2020. 11.5% (EUR 205.9 million) is H2020 funding, 62.9% (EUR 1120.34 million) comes from ERDF and national innovation funding, 2.3% (EUR 40.55 million) from the Spanish RDP and 23.3% (EUR 415 million) from the regions and RIS3.

5.2. Relevance of EU funding frameworks to strengthen the bioeconomy

The examples of the previous section indicate relevance of EU policy frameworks for funding bioeconomy development, in particular referring to ESIF and Horizon 2020. The information gathered in RIS3 documents for EU28 shows that 67% of the regions and countries explicitly mention ESIF co-funding to support their bioeconomy activities. Given that information on ESIF co-funding of R&I activities is usually not split per sectors and that some bioeconomy activities are included under different Thematic Objectives of ESIF Operational Programmes (low carbon, SME, environment), the actual number of regions planning to use ESIF co-funding might be even higher. Moreover, from the data gathered it can be derived that 77% of the regions foresee H2020 co-funding for bioeconomy related activities. H2020 is mentioned as funding source in almost all RIS3 strategies, however, due to competitive character of the calls, it is difficult to announce at this stage a concrete figure for the period 2014-2020.

5.2.1. ESIF support to implement and strengthen the bioeconomy

The European Structural and Investment Funds (ESIF) are an important funding source for bioeconomy related activities for many RIS3 strategies. In particular, ERDF, EAFRD and EMFF are used by the regions and countries. Also ESF is used, but to a smaller extent. The case studies offers numerous examples of ESIF funding for the bioeconomy:

- *"Previously there was a National Programme on Biotechnology 2009-2012, financed by ESIF which partly overlapped with bioeconomy. [...] Indirect support to the bioeconomy research is also available through RITA programme supported by the ERDF and launched in 2016. The programme aims to increase the role of the state in strategic management of research and increase its capabilities in planning and conducting socially relevant research. RITA provides support to strategic R&D activities, such as socio-economical interdisciplinary applied research; and support to knowledge-based policy formulation. A bioeconomy research project is currently being implemented in the framework of this programme that will provide policy-relevant knowledge and analysis needed for future planning and policy formulation on bioeconomy".* (Case Study Report Estonia)
- *"The Ministry of Rural Affairs runs a programme on Applied Agricultural Research and Development 2015-2020 that supports agriculture-related research projects (Ministry of Rural Affairs 2015). Support to cooperation and innovation activities, product processing and development are available for farmers and local producers under the Estonian Rural*

Development Programme. Increasing resource efficiency and environmentally friendly production have been important cross-cutting themes". (Case Study Report Estonia)

- *"The Spanish RDP (EAFRD) allocates 2.000.000 EUR for "Grants for the creation of supra-autonomous operational groups in relation to European Partnerships for Innovation for Agricultural Productivity and Sustainability (EIP-AGRI)." (Case Study Report Extremadura)*
- *"EMFF is a funding source which is being used for development projects in the aquaculture and fisheries sectors." (Case Study Report North Denmark)*
- *"There is funding from the Finnish ERDF Operational Programme "Sustainable growth and jobs 2014-2020 – Finland's structural funds programme for innovation. Also financing from European Agricultural and Maritime and Fisheries Funds are important enablers for Lapland's bioeconomy development. [...]From the Arctic Smartness Clusters, the Arctic Industry and Circular Economy Cluster and the Arctic Smart Rural Community Cluster have a special focus on different themes of bioeconomy. The clusters have created individual strategies with concrete objectives with the help of European Cluster Observatory, and these strategies are expected to be released in December 2016. An ongoing follow-up project, Arctic Smartness Excellence (ASE), funded from the ERDF, aims to take Smart Specialising Clusters from Lapland to European arenas." (Case Study Report Lapland)*

5.2.2. H2020 support to implement and strengthen the bioeconomy

Most of the case study regions and countries refer also to funding from the 7th Framework Programme or from Horizon 2020, when it comes to bioeconomy related R&I projects and networks.

- *"The ongoing efforts in Lapland in the field of bioeconomy innovation have pinpointed access to Horizon 2020 projects under bioeconomy theme as one of the aspects requiring further attention and addressing. At the current stage, applications have been submitted e.g. in the field of novel rural business models." (Case Study Report Lapland)*
- *"The Biomass Usage Innovation Network was founded in 2016 after months of preparatory and organisational work has its origins in AGRIFORVALOR, a European-wide project supported by the Horizon 2020 programme. Although the pilot area has been selected in South-East Hungary the network aims at national coverage and has involved central agencies in Hungary". (Case Study Report Central Hungary)*
- *"Other H2020 programmes/initiatives –at least partially- related to bioeconomy to which Emilia-Romagna participates are: - SC2 - Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy, - SME INSTRUMENT, MARIE CURIE, NMPB - Call for nanotechnologies, advanced materials, biotechnology and production, - SPREADING EXCELLENCE, ENVIRONMENT." (Case Study Report Emilia-Romagna)*

Many regions mention different ERA-NET networks/projects and the JPIs (Joint Programming Initiatives) as relevant for their bioeconomy deployment.

- *"The Ministry of Rural Affairs of Estonia provides funding to the international research cooperation networks ERA-NET projects since 2011. The Ministry is the main Estonian representative in the ERA-NETs on bioeconomy (ERA-Net SUSFOOD, ERA-Net CORE Organic, ERA-NET C-IPM, ERA-NET Plus "Climate Smart Agriculture: adaption of agricultural systems in Europe" and ERA-NET Cofund FACCE SURPLUS). It also participates in several JPIs. The Estonian Research Council has participated in several ERA-Nets that are partly financed by the ESIF. Currently, the ERC participates in CoBioTech CoFund only. Occasionally, the bioeconomy-related topics have been addressed in other ERA-Nets like M-ERA-NET 2, e.g. addressing materials research and innovation." (Case Study Report Estonia)*

Several regions mention the ERA-NET Co-fund FACCE SURPLUS as an important tool to stimulate bioeconomy research and innovation, in particular through pilot projects and the exchange and transfer of knowledge with other regions.

- *"FACCE SURPLUS (Sustainable and Resilient agriculture for food and non-food systems) is an ERA-NET Cofund, formed in collaboration between the European Commission and a partnership of 15 countries in the frame of the Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI). Denmark is represented by the Danish Agency for Science, Technology and Innovation. One of the main objectives of the H2020-supported ERA-NET Cofund, FACCE SURPLUS, is to improve the collaboration across the European Research Area in the range of diverse, but integrated, food and non-food biomass production and transformation systems, including bio-refining."* (Case Study Report North Denmark)

Other ERA-NETs that have been highlighted by the analysed cases are: Susfood2 – Sustainable Food Production and Consumption, CoBioTech– Biotechnology, BESTF3 – Bioenergy, SUSAN – Sustainable Animal Production Systems, Martera – Maritime and Marine Technologies for a New Era, WaterWorks – Sustainable water use in agriculture, to increase water use efficiency and reduce soil and water pollution.

5.2.3. Synergies between ESIF and H2020

In addition to pure H2020 funding and ERA-NETs, the importance of synergies between ESIF and H2020 funding could be observed in several of the analysed cases.

- *"In 2014, the region (through OT1 of ERDF OP) financed High Technology Network (HTN) techno-poles Labs for the realization of feasibility studies aiming to improve the quality of projects submitted under the new Horizon 2020 Programme."* (Case Study Report Emilia-Romagna)
- *"ESIF and Horizon2020 funding has also been combined through the ERA-Nets: management costs come from Horizon2020 while calls can be financed by the ESIF. This does not apply to the ERA-NETs that are co-financed from the national funds and Horizon2020."* (Case Study Report Estonia)
- *"Even though assessing the utilisation of regional synergies between ESIF and H2020 funding is not yet tangible, it is worth noting that e.g. the Arctic Bioeconomy Project run by the Regional Council aims at improved project coordination and better strategic, integrated use of territorial funds and investments."* (Case Study Report Lapland)

However, synergies between ESIF and H2020 or other programmes are not always easy to achieve, mainly due to the different funding objectives and frameworks of the calls.

- *"Synergies between Horizon2020 and ESIF are not being achieved in Denmark. There is not a holistic approach to investments in RTDI initiatives. The interviewee stresses that it is relevant to activate regional development authorities to utilise opportunities from Horizon2020, including their own participation in initiatives."* (Case Study Report North Denmark)
- *"Estonian authorities have to some extent exploited positive synergies between ESIF and Horizon2020 projects through using infrastructure acquired from former projects financed by the ESIF in the Horizon2020 projects. At the same time considering the competitive tendering system, it is impossible to plan for such synergies in advance."* (Case Study Report Estonia)

The emergence of synergies between the different ESIF (ERDF, ESF, Cohesion Fund, EAFRD and EMFF) but also between ESIF and H2020 benefit from establishing for the 2014-2020 funding period a Common Strategic Framework for EU Cohesion Policy. This strategic and operational integration favours the complementary funding of projects, in particular with regard to ERDF and EAFRD funding for bioeconomy related research and innovation activities.

An important example of synergies between H2020 and ESIF funding is the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI)²¹ that was launched by the European Commission in 2012. It aims to foster a competitive and sustainable agriculture and forestry sector. To achieve this aim, the EIP-AGRI brings together innovation actors (farmers, advisers, researchers, businesses, NGOs and others) within local EIP Operational Groups. Together

²¹ <https://ec.europa.eu/eip/agriculture/en>

they form an EU-wide EIP network. 3 200 EIP Operational Groups will be funded by EAFRD during this funding period 2014-2020. The EIP-AGRI initiatives build on combining two types of funding, the EAFRD-funded Rural Development programmes (RDPs) and H2020. The analysis of the early implementation of the EIP has shown that *"its premise on the development and dissemination of innovative farming practices which address both productivity and sustainability is seen as valid and important. [...] Its uptake has been impressive, in particular for a newly introduced measure. The EIP is being implemented in 26 Member States, in 96 out of a possible 111 RDPs"* (Coffey et al. 2016). The EIP-AGRI network is run by the European Commission (DG Agriculture and Rural Development) with the help of the EIP-AGRI Service Point. EIP-AGRI Focus Groups are temporary groups of selected experts focusing on a specific subject, sharing knowledge and experience. They are important thematic platforms that support the exchange of knowledge on specific themes such as forest biomass, nutrient recycling, protein crops or short food supply chains. Each group explores practical innovative solutions to problems or opportunities in the field, and draws on experience derived from related useful projects.

Many regions and countries promote actively the generation of synergies between ESIF and H2020 funding²² in the current funding period. This can be done through an improved planning and programming of initiatives and strategic projects. Another mechanism to produce synergies is through bridging/connecting programmes to facilitate for applicants to benefit from ESIF combines with H2020 funding or if they have not been selected for H2020 funding but still have a project proposal that is relevant at national or regional level. Some of the cases studies participate in the 'Stairway to Excellence (S2E)' programme, which supports 13 regions in developing and exploiting the synergies between H2020 and ESI Funds for projects evaluated as being excellent (but due to budget constraints cannot be funded under H2020). Concrete mechanisms to award ESIF grants for excellent projects have been or are being developed in many EU Member States and regions within the 'Seal of Excellence' scheme (e.g. Italy, Finland, Czech Republic, Scotland, Lombardy, Spain, France).

- *"The Operational Programme Competitiveness POC has thematic funding within the Action 1.1.3 "Creating synergies with the H2020 RDI actions and with other international programmes" (under PA1, Specific Objective 1.2 "Increase the participation in EU research"). The funding scheme will support ESIF projects for (1) ERA Chairs, (2) "Teaming" and (3) creating support centres for drafting H2020 (or other international programmes) project proposals."* (Case Study Region West, Romania)
- *"Recently a number of actions contributing to synergies between the national and international sources have been implemented. Targeted incentives aimed at facilitation of national participation in FP7/Horizon 2020 are now available, for example; the compensation of application preparation and VAT costs and compensation of international partner search and information campaigns in firms and technology centres to stimulate and facilitate participation in Horizon 2020. The Ministry of Education and Science are planning more activities in order to facilitate synergies between ESIF and Horizon 2020 funding, including - Co-financing from the national funds to Lithuanian applications selected by the Horizon 2020; - Funding for projects that were positively evaluated, shortlisted, but not funded under Horizon 2020; - Funding for parallel labs located in Lithuania and partnering countries."* (Case Study Report Lithuania)
- *"The main mechanism allowing funding synergies in the region is the Seal of Excellence quality label that is awarded to project proposals which were submitted for funding by one or more SMEs under Horizon 2020, passed stringent selection and award criteria but could not be funded due to budget constraints. It highlights proposals which deserve funding from alternative sources. According to Eurostat, Emilia-Romagna has a high number (between 70 to 144) of SMEs that have been awarded (within June 2016) by the Seal of Excellence Scheme; resulting one of the EU regions with the highest number of certified SMEs."* (Case Study Report Emilia-Romagna)
- *"The regional actors are also engaged in a proposal for the Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI) under the coordination of Natural Resources Institute of Finland (LUKE) and the national Ministry of Agriculture and Forestry. The present call for proposals aims to improve collaboration and cooperation across the European Research Area in the area of sustainable intensification of food and*

²² About the potential of synergies between ESIF and H2020, see BIC (2014) and European Commission (2014c).

non-food biomass production and decentralised transformation systems, in particular small scale multi-input, multi-product biorefinery concepts.” (Case Study Report Lapland)

A specific form of synergies between different funding sources represents the Bio-Based Industries Joint Undertaking (BBI-JU) as a public (EU) and private partnership. The BBI-JU was established in 2014 as Joint Technology Initiative within H2020 and is responsible for the implementation of open calls for proposals for research and innovation actions, as well as coordination and support actions. Some regions consider this initiative as valuable for their bioeconomy deployment.

- *“The Bio-Based Industries Joint Undertaking (BBI-JU) is a EUR 3.7 billion Public-Private Partnership between the EU and the Bio-based Industries Consortium. Operating under Horizon 2020, it is driven by the Vision and Strategic Innovation and Research Agenda (SIRA) developed by the industry. A representative from the Danish Agency for Science, Technology and Innovation is represented in the states representatives group, and two companies – Novozymes and Dong Energy – participate in BBI.” (Case Study Report North Denmark)*

5.2.4. Complementary support through other EU Programmes

The analysis shows that European countries and regions also use a variety of other EU programmes for the purpose of bioeconomy promotion, even if they are not as widely used as ESIF and H2020. Among these EU programmes are, in particular, the following:

- Interreg (ERDF),
 - LIFE (and LIFE+),
 - Intelligent Energy Europe,
 - CIP (in 2007-2013, now in 2014-2020 COSME),
 - ERASMUS+.
- *“The actions and projects under the regional bioeconomy strategy can, apart from ESIF, also be funded by many other financial sources (Horizon 2020, BONUS Joint Baltic Sea Research and Development Programme, the LIFE programme, Education and Culture programmes, etc.), as well as national, regional, private sources.” (Case Study Report Skåne)*
 - *“Interreg funding is deemed vital for collaborating across the borders and generating the critical mass and joint infrastructure for bioeconomy innovation and business collaboration in the northern hemisphere. The Regional Council of Lapland is involved in various EU programmes promoting cross-border cooperation. EU Programmes such as Kolarctic ENPI CBC, Interreg North, Northern Periphery and Baltic Sea Region, among others, offer funding for cross-border projects with a potential for collaboration around bioeconomy activities”. (Case Study Report Lapland)*
 - *“NICHE is a project funded under the Interreg Europe programme 2014-2020. It brings together seven partners from different countries with the aim to develop a view of best practice in relation to innovation and how organisations can apply technology to increase their capacity for innovation. One of the project’s objective is to increase the adoption of research and innovation solutions by food-related businesses. NICHE aims to promote open innovation in the food sector where partners and stakeholders can share their experience and knowledge, work together and trigger innovation in the sector.” (Case Study Report Crete)*
 - *“The RIS3 cross-border Strategy NORTE-Galicia has 2 bioeconomy priorities (energy from biomass and the sea and agro-food and biotechnology. Many measures will be implemented through Interreg projects.” (Case Study Report Norte)*
 - *“Funded by LIFE, Adapt2Clima aims at increasing knowledge regarding the vulnerability of the EU Mediterranean agriculture to climate and to support decision making for adaptation planning. The project comprises three of the largest islands of the Mediterranean, Crete,*

Sicily and Cyprus and has established networking opportunities with other projects.” (Case Study Report Crete)

- *“Also, the following LIFE projects have contributed to generate and transfer knowledge about the bioeconomy in Extremadura: iCirBus-4Industries ‘Innovative Circular Business on Energy, Water, Fertilizer & Construction Industries towards a Greener Regional Economy’, SAVECROPS, COMFOREST, WALEVA, FERTINOWA”. (Case Study Report Extremadura)*
- *“EU projects have helped fund and support stakeholders establishing strong cross-border links, such projects include BERST “BioEconomy Regional Strategy Toolkit” and the Poly4Eml project. Poly4Eml is one of 6 projects awarded funding by the European Commission (DG Enterprise and Industry) within the Competitiveness and Innovation Framework Programme (CIP) call ‘Clusters and Entrepreneurship in support of Emerging Industries’”. (Case Study Report Slovenia)*
- *“Erasmus+ funding is currently being used for developing regional educational/training environments for bioeconomy”. (Case Study Report Lapland)*

5.3. National and regional bioeconomy projects and initiatives

Although there are several European and national programmes and strategies to stimulate the bioeconomy, considerable bioeconomy deployment takes place in the regions at sub-national level through bioeconomy projects and initiatives promoted by regional and local public authorities, by clusters and private companies or by universities, research centres or technology and innovation service providers. Some of them use European and/or national co-funding, but also local and regional resources are put into value.

The analysis of case studies identifies numerous bioeconomy projects that can be grouped in seven different areas. Sometimes projects are connected to several areas or combine different fields in integrated programmes:

1. Knowledge generation
2. Knowledge transfer, engagement, stakeholder networks
3. New generation and re-definition of value chains and value cycles/demonstration/technological readiness
4. Public awareness and dissemination of information
5. Bioeconomy coordination, governance and platforms
6. Education
7. Learning from other regions, alliances

5.3.1. Knowledge generation

The generation of knowledge through research and innovation projects and knowledge infrastructure and networks is a starting point for many regions when it comes to deploy the bioeconomy. Most regions focus on the creation and enhancement of specialised research and innovation centres, but also on research programmes or the promotion of regional actors within European Research projects (H2020, EIT-KIC etc.).

- *“In 2011, the Danish Shellfish Centre in collaboration with the private company Vilsund Blue a/s completed a study on the possibility of using compensation farmed mussels, smaller than the minimum size for fished mussels, for human consumption production. It was a sub-project of the more comprehensive project “Mussels – Mitigation and Feed for Husbandry” (MuMiHus) funded by the Strategic Research Council and led by Danish Shellfish Centre. The purpose of the larger MuMiHus project was to develop cost-effective compensation farming, identify its ecological effects and to develop management tools related to compensation farming. The sub-project was co-financed with regional development funds (DKK 500,000) by the Growth Forum of North Denmark, six*

participating municipalities and their common local Council (In Danish: Limfjordsrådet). The role of the municipalities in the project was to disseminate the results to relevant political and technical forums and to promote alternative use of compensation farmed mussels. The purpose of the study was to identify whether compensation farmed mussels can be used for industrial processing. The study demonstrated that mussels grown on lines or similar can reach a size that makes them interesting for further industrial processing, and with relatively simple equipment it is possible to exploit this resource industrially. The regional representative highlights this R&D project due to the new knowledge that has been developed in the field of using mussels as compensation, knowledge that can be utilised elsewhere in Europe". (Case Study Report North Denmark)

- *"The South Bohemian Research Center of Aquaculture and Biodiversity of Hydrocenoses (CENAKVA) is a new infrastructure and research project which has been built in Vodňany town upon experience and knowledge base of the Fisheries and Hydrobiology Research Institute of the Faculty of Fisheries and Water Protection. The project was co-financed by the ERDF operational programme Research and Development for Innovation, from its priority axis 2. Regional R&D centres, with the South Bohemia University as the beneficiary. Total costs amounted about EUR 10.15 mil, of which 8.6 mil was funded from ERDF and the rest from the Czech state budget. The operational costs and costs of research projects and programmes are financed from multiple resources among which various public grants represent a majority. In 2015 almost 30% of funds (about EUR 1 mil) were provided by the National sustainability programme. The sustainability programme is funded by the ERDF from the new OP Research, Development and Education 2014-2020. About 5% of the Centre's funding was gained by participation in international projects in 2015 and about 6% provided contractual research projects. The mission of the Centre is to develop high quality science, research and applications in the field of fishery, aquacultures and sustainable freshwater management system, all focused on fish farming and in-land waters, mostly in Europe. The Centre participated in European research (FP7) projects, such as AQUAEXCEL, FISHBOOST, TRAF00N AND ORAQUA. The Centre is an example of the growth of the specialisation (in this case in fish farming, freshwater ecosystems). Establishing of the CENAKVA in 2010 shows how concentrated support from the ERDF allowed the Faculty of Fisheries to improve its laboratories, strengthen its research and attract more researchers from abroad. It also brought in new opportunities for international collaboration and for participation in international projects, such as FP7." (Case Study Report South Bohemia)*

5.3.2. Knowledge transfer, engagement, stakeholder networks

There are several initiatives in the analysed regions and countries that focus on an enhanced technology and knowledge transfer from research institutes to the business sector and on increased engagement of the local/regional business community, in particular SME, in specialised bioeconomy related stakeholder networks. The networks usually try to establish trust and stable linkages between research centres, innovation agents and companies through innovative clusters or competence centres. Science and Technology Parks or Regional Innovation Agencies are important promoters of such networks and transfer processes.

- *"The 3N 'Network on Renewable Resources and Bioeconomy' is non-profit competence centre. The network fosters an increase in development and use of renewable resources in substantial and energetic forms. The competence centre has specialised in the research of four primary areas; new resources, substantial use of new resources, energetic use of new resources and Bioeconomy which are each split up in different thematic sub-areas. Currently, 32 enterprises are member of the self-sustaining 3N competence centre. It is one of the partners involved in the 'Bioeconomy in the non-food sector' project. The competence centre provides access to research and innovation activities to enterprises, situated in Weser-Ems. The involved enterprises, which were initially not capable of supporting research activities can thus profit from the work of the competence centre. Additionally, because of the networking of shared interests, the partners do get an insight into so far unknown innovative potentials. The project is financed by its members and by diverse projects (INTERREG, ERA-NET, national/regional funding)". (Case Study Report Weser-Ems)*
- *"The Kompetenzzentrum Holz GmbH (Wood K plus) is a leading non-university research institute for new materials and process technology for wood and wood-related renewable raw materials. Its core competencies include materials research and process technology along the complete value chain, from the raw materials to the finished products. The*

competence centre develops methods and basics and performs applied research on the economy-science interface. Relevant Austrian companies and scientific bodies have bundled their strengths in the Kompetenzzentrum Holz. Currently it cooperates with 150 companies and 50 scientific research institutes. The total budget amounts to around 10 million Euros. Its aim is to establish national and international projects with a research volume of at least 12 million Euros per year by 2020. 50% of the budget is handled via the COMET programme. The remaining 50% are handled via EU funding programs, national research funding (FFG), funding from the „Innovative Upper Austria 2020“programme and projects direct financed by industrial companies.” (Case Study Report Upper Austria)

- *“The Romanian Sustainable Energy Cluster is a NGO Association founded in 2011 by 23 members, persons, businesses and public or private institutions, reaching today a total of 63 members of which: 49 SMEs, 3 large enterprises, 8 universities and research institutions and 3 public authorities. The central objective of the association is represented by the promotion of the West Region on long term as leader in renewable energy, energy efficiency and new sustainable energies. The cluster itself was the result of an ESIF funded project “Development of the Innovative Cluster ROSENC” and in January 2016 received the Silver Label Certificate of the European Secretariat for Cluster Analysis. Presently the Cluster implements the InnoCatalist project/approach as model for Collaborative Innovation, bridging innovation and practice. This type of approach and especially the constant animation efforts cover for one of the most demanding element in innovation transport, bridging the research and practice levels. The model is not only tested and therefore replicable but highly recommended for regions where the innovation is lagging in reaching the relevant actors and fails to generate the expected outcomes.” (Case Study Report West Region, Romania)*

5.3.3. New generation and re-definition of value chains and value cycles/ demonstration / technological readiness

An important area for regions to support the bioeconomy is the generation of new value chains from scratch (mainly from research and through spin-off companies) as well as the modification of existing value chains and the creation of value cycles based on biological resources to either use other input material to produce well-known products or to find methods and techniques to produce new bio-based products. This requires not only knowledge, but also testing and demonstration facilities, infrastructures, labs, and collaboration with farmers, researchers, technologists, large companies, entrepreneurs, science and technology parks etc.

- *“The project MultiBiorefinery is funded by the National Government as well as by the ERDF within the ‘Sistema de Apoio à Investigação Científica e Tecnológica (SAICT): Programas de Atividades Conjuntas (PAC)’. It has an overall cost of about 3 million EUR and will be executed from 2017 to 2019. The project leader is the Centre of Biological Engineering (CEB in a PT acronym), a research centre located at the University of Minho (Braga). MultiBiorefinery aims at fostering Portuguese bio-based economy by bringing value to forestry, agro-food, and fisheries wastes and by-products. It is the goal to develop and use multi-purpose strategies and sustainable innovative technologies, namely industrial biotechnology and green chemistry, for by-products valorisation towards a truly integrated biorefinery dealing with multiple feedstocks. A series of case study of by-products from forest (*Eucalyptus globulus* stumps and knots, and *Pinus pinaster* bark and needles), agriculture (melon, winery and tomato by-products), and fisheries (fish bones, salt-cured codfish wastewater, cooking waters and head-space of cooking tanks from canning industry) will be transformed into added-value products using advanced cascading conversion technologies. The main end products will include biopolymers such as bacterial cellulose, and polyhydroxyalkanoates and a platform of biocompounds with biological activity, and even commodity chemicals and biofuels”. (Case Study Report Norte)*
- *“The Microalgae biorefinery project has two objectives: (1) to verify and put into market algae-based product line thus creating the example for waste water treatment plants which can prove its operational advantages and (2) to integrate the new technology into an existing value chain which will allow to use biomass produced in waste water treatment plant to be turned into sources of new bio-based products. The project has been supported by the Climate-KIC initiative, the EU’s largest public private partnership addressing climate change through innovation to build a zero carbon economy. Climate-KIC is supported by the European Institute of Innovation and Technology. The project is led by Pannon Pro Innovations, a Hungarian consulting company, the technology has been implemented in Budapest Sewage Works which has already invested in a pilot scale algae production unit at*

the North Budapest Waste Water Treatment plant. The project has got other partners providing development and innovation concepts and technology support, among others Wageningen University (The Netherlands), INRA Laboratory of Environmental Biotechnology (France), and University of Valencia (Spain). The project will target waste water treatment companies demanding a solution that can make their operation more sustainable, efficient, reduce emissions and provide additional revenues at the same time. The project started to demonstrate two breakthrough technological and commercial concepts, which were (1) integration of algae technology into a municipal waste water treatment plant to enhance water quality and biogas yield and (2) production of a new products based on algae biorefinery. The technology solution aims at turning certain waste water treatment effluent into added value algae biomass by recovering of nutrients, capturing CO₂ of biogas plant and embedding sunshine. Through B2B business model the project will also secure link to different algae processors to harvest the value. The project will result in a commercial offer for the waste water treatment sector in order to turn certain streams of waste water treatment into algae biomass while removing the excess nutrients of waste water effluent. The Microalgae biorefinery project is an example of public-private partnership and of development of small scale functional technology in real industrial conditions in order to demonstrate its feasibility and to establish a basis for further development of the technology itself.” (Case Study Report Central Hungary)

- *“MoRe (Market of Olive Residues for Energy) was a project under the Intelligent Energy Europe initiative. The project aimed at addressing the problems of olive oil producers, offering a way to solve the problem of waste by using it for energy purposes. The core of the project was the creation of chains for energy from olive residues, by involving public and private players, identifying problems and solutions and actions”. (Case Study Report Crete)*
- *“The project Trash2Cash was developed in collaboration between the Technological Institute, Nordsøen Forskerpark and a network of fisheries Municipalities. The project was granted DKK 3.2 million from the Growth Forum of North Denmark (regional development funds) and DKK 9.5 million from the Market Development Fund (managed by the Danish Business Authority) for the period 2012-2015. Enterprises and other participating actors contributed with own funding of DKK 8.5 million. The project proposal was developed based on previous work co-financed by the EMFF and partly based on ideas developed in the network of fisheries Municipalities and dialogues with the industry. The overall purpose of the project was to uncover the potentials for better utilisation of products and by-products from the fishing industry. Six sub-projects were implemented including enterprises in all of the involved municipalities.” (Case Study Report North Denmark)*
- *“In 2013, the cluster ‘Paper Province’ was awarded a strategic project by the Swedish Innovation Agency, VINNOVA. The initiative is co-funded by a triple helix partnership consisting of the Paper Province members, Karlstad University, Region Värmland, the County Administrative Board, Local authorities and the Swedish Forest Agency. The vision of the initiative is for Paper Province to become a leading European competence node for a forestry based bio economy in ten years’ time. The aim is to create a large scale demonstrator that from a service and systems perspective coordinates and demonstrate bio economy in practice. The objective is to set the stage for the 1000 new jobs and 25 new businesses during one decade. The vision is to generate large number of projects, both national and international, including Horizon2020.” (Case Study Report Värmland)*

5.3.4. Public awareness and dissemination of information

Many regions develop small or large-scale awareness-raising and dissemination activities to support the deployment of the bioeconomy. Especially, the regions which are positioning themselves as ‘R&I support and service providers for the bioeconomy’, such as Lodzkie in Poland and Hauts de France, use events to gather together stakeholders and to raise visibility on their own R&I activities. Events are also an important tool to bring together all stakeholders of the bioeconomy innovation ecosystems.

- *“The “Plant based Summit” is a unique biannual event dedicated to bio-based chemical products. The 4th edition of the event will be organised in 2017 in Lille. It will gather for two days more than 700 regional and international stakeholders from the entire plant-based chemical value chain. The industries participating to the event will be mainly related to: cosmetics, plastics, painting, detergents, energy, automotive, civil engineering, agro-food, paper, adhesives, lubricants and consumer goods. The main objective of this event is*

to speed-up the development of bioeconomy activities by gathering companies at the same place working in similar value chains. Moreover, plant-based summit represents the occasion to explore business opportunities and share information.” (Case Study Report Hauts de France)

- *“The Marshall’s office of the Lodzkie region organises annually a bioeconomy congress in the city of Lodz. The purpose of the Congress is to create a friendly atmosphere around the innovative, effective and competitive approach to activities intended to support the development of bioeconomy. The objective of the Congress is to bring its participants up to date on current strategies and initiatives that enable the development of bioeconomy in the European Union, as well as to intensify the collaboration between regions of Central and Eastern Europe. Representatives from business circles, regional governments, academic communities, business environment organisations and institutions from Poland and from abroad, are present during these congresses. The Lodzkie region receives inter alia support from the ERDF for the organisation of the congress.” (Case Study Report Lodzkie)*

5.3.5. Bioeconomy coordination, governance and platforms

The diversity of bioeconomy stakeholders in a given region and the need to bring them together and generate formal and informal spaces for knowledge exchange and transfer, for knowledge management and for preparing and taking joint decisions on strategic priorities, funding and implementation can be observed in most regions, although not all regions have established already relevant governance mechanisms. These mechanisms can be strategies (e.g. on bioeconomy, on food innovation or the RIS3 strategy itself), strategic councils, integrated pilot projects to prepare an ad-hoc governance, as well as supportive platforms and communities (web-based, but also real groups).

- *“CLiQ (Creating local innovation through a quadruple helix) was funded under the Interreg IVC 2007-2013. It aimed at strengthening local and regional authorities’ policy and capacity to support innovation in medium-sized cities. A successful factor of the project has been the cooperation combination of the Triple Helix, i.e. the cooperation between governance level, universities and industry together with civil society. A best practice coming from Crete regards the development of the ‘Innovation Pole of Crete – I4CRETE’. The aim of the initiative was to enhance the relationships and cooperation between businesses, local universities, technological and scientific fields on the island”. (Case Study Report Crete)*
- *“The project BioTecNorte - Underpinning Biotechnology to foster the north of Portugal bioeconomy’ is funded by the national government and by the regional authorities, as well as by the ERDF within the ‘Programa Operacional Regional do Norte (Norte 2020). It has an overall cost of EUR 3.5 million and will be executed from 2016 to 2019. The project leader is the Centre of Biological Engineering (CEB in a PT acronym), a research centre located at the University of Minho (Braga). The project foresees the following research activities planned under three research lines. These research lines are closely related with NORTE 2020 Smart Specialization Strategy. The project aims at structuring all relevant research activities for fostering northern bio-based-economy, by bringing value to resources, wastes and by-products, aligned with the circular economy and industrial symbiosis concepts”. (Case Study Report Norte)*
- *“Polish Technology Platform of the Bioeconomy (PTPB) is a science and technology cluster established in 2014 bringing together 70 members from Bioeconomy Industry and Research Institutes from Academia units. The main activity of the cluster is concentrated in the following areas: functional foods, biopolymers and bioplastics, biorefineries and biofuels, maritime bioeconomy, forest bioeconomy and wood-based industries, primary production, biotransformations, the impact on climate and new, bio-based materials used to wrap or protect goods. The main mission of PTPB is to promote networking and events in the bioeconomy in order to increase the competitiveness of the bioeconomy industry.” (Case Study Report Lodzkie)*
- *“The Galicia Biotech platform is supported by the ESF, the Regional Government and IGAPE, the regional development agency, in collaboration with Bioga, the non-profit business association which binds together the organizations of the biotechnology sector value chain based in Galicia.” (Case Study Report Galicia)*

- *"Gate2Biotech is a portal currently administered by the South Bohemia Agency for Innovation Enterprising. It was created in order to provide a platform for biotechnological community in Czech Republic and Central Europe. Gate2Biotech collects and provides information about wide array of topics in biotechnology: (i) public and private innovation infrastructure relevant to biotechnology, (ii) biotech companies, service providers and suppliers, (iii) research institutes (public and private), (iv) government agencies and NGOs, (v) biotechnology projects, (vi) information sources – articles, books, journals, (vii) legislation and (viii) events in the biotech field in Czechia and abroad. The portal provides also information about training opportunities, school programmes or scholarships for students and career development or job opportunities for professionals in biotechnology."* (Case Study Report South Bohemia)

5.3.6. Education

The new and interdisciplinary character of bioeconomy research and innovation requires also new approaches to education, training and capacity development. Some regions develop new, highly specialised or integrated/multidisciplinary education offers to satisfy skill needs of the bioeconomy.

- *"The Lapland University of Applied Sciences has launched a renewable energy study module worth 30ECTS."* (Case Study Report Lapland)
- *"University of Applied Sciences Upper Austria, Campus Wels: Bachelor and Master's degree in food technology and nutrition. The Upper Austria food cluster has struggled for a long time (about 9 years) for establishing the course in 2013."* (Case Study Report Upper Austria)
- *"The Master program in Biotechnology is realized at the International Faculty of Engineering in close cooperation with Faculty of Biotechnology and Food Sciences. It is characterized by interdisciplinary nature, which assures preparation of specialists who can combine chemical, biological and engineering/technical knowledge".* (Case Study Report Lodzkie)

DG MARE's Blue Career Programme: Applied Blue Biotechnology Master II

The two-year Master's degree, named 'Applied Blue Biotechnology Master II', which will be open to students with four years of higher education and will take place at the University of La Rochelle (FR), will involve scientific training on Blue Biotechnology. This is the exploration and use of marine organisms to develop new products. Along with the Atlantic Arc Commission, the project also involves academic organisations and Small and Medium Sized Enterprises (SMEs) from France, Portugal, Spain and the United Kingdom, as well as the Apprenticeship Formation Unit and the Lifelong Training and Employability Department from the University of la Rochelle. This unique public-private partnership, which has a budget of just under EUR835,000 and is being financed by DG Mare under the "Blue Career" call for proposals, will ensure that students obtaining the Master's degree will fulfil the needs of the SMEs and are ready for the workplace.

Source: <http://cpmr.org/atlantic-arc-leads-innovative-partnership-to-develop-blue-biotechnologies-masters-degree/>

5.3.7. Learning from other regions, alliances

Many regions benefit from knowledge transfer from other projects. Most regions are aware that bioeconomy R&I requires alliances with other regions and stakeholders in order to avoid duplication of efforts and to reduce the time needed to develop/evolve technologies and products ready to launch.

- *"Adapt2Clima aims at increasing knowledge regarding the vulnerability of the EU Mediterranean agriculture to climate and to support decision making for adaptation planning. The project comprises three of the largest islands of the Mediterranean, Crete, Sicily and Cyprus and has established networking opportunities with other projects. Started in 2015, it plans to raise awareness on the issue, develop climate change adaptation strategies for the project areas, assess the vulnerability of the pilot areas and estimate the future climate changes in the three areas of focus and their selected agricultural areas".* (Case Study Report Crete)

- *"Bioeconomy in the non-food sector' is a cross-border cooperation project under the umbrella of the INTERREG V-A programme between Germany and the Netherlands. With EUR 3.9 million support, it is additionally financed by public means from both partner countries. The project comprises four different thematic work packages about a) innovative products and materials, b) new green routes, c) bio-based products for residential construction and d) knowledge transfer about bioeconomy in the non-food sector. Within these four work packages, the project brings together 49 enterprises, organisations, competences and universities between 2015 and 2018. The key objective is to link research facilities with SMEs, which do not have the financial means to invest in research and innovation". (Case Study Report Weser-Ems)*

5.4. Needs and bottlenecks on the way to deploy the bioeconomy in the regions

Despite the achievements made so far, there are still obstacles and bottlenecks for regions to further deploy the bioeconomy. Based on the case studies, eight fields of difficulties can be identified:

1. Needs related to strategic planning and leadership
2. Needs related to knowledge transfer, knowledge management and communication
3. Needs related to technological convergence and new value chains, in particular the engagement of SMEs into these processes
4. Needs related to access to finance, risk sharing and synergies in funding and investments
5. Needs related to regulations, standards and norms
6. Needs related to education, training and skills
7. Needs related to public awareness and acceptance
8. Bottlenecks related to external factors.

5.4.1. Needs related to strategic planning and leadership

Especially regions and countries that do not have already a specific bioeconomy strategy or roadmap express the need for such a strategic guidance. They ask for better coordination with existing R&I priorities and more specific support programmes for the bioeconomy. There is not only the need to have short-term support, but also a long-term strategic framework (e.g. common understanding of the bioeconomy) and a clear distribution of roles (e.g. which Ministry/public authority is in charge of the bioeconomy). These needs are linked to ask for a certain leadership/public policy for the bioeconomy at national, but also at regional/local level. In particular when it comes to important decisions on investments in infrastructure or on cluster support, the governments and supporting agencies need to prioritise thematic areas or value chains/cycles. This is especially important in regions yet without a bioeconomy strategy.

- *"First of all there is a lack of common understanding and common definition of what bioeconomy is which makes the cooperation between the main stakeholders difficult. The relevant policy fields, such as agriculture, energy, research and education etc. needs to coordinate; at the moment there are sometimes conflicting policies from the different policy fields. A national target related to bioeconomy needs to be defined. N.B. The national Bioeconomy Strategy is supposed to be published in summer 2017." (Case Study Report Latvia)*
- *"According to the interviewees, lack of a bioeconomy strategy is perceived as the main obstacle to providing funding, as well as to managing and steering the bioeconomy activities in a systematic way. A need for creating a strategic framework binding the areas of bioeconomy and a comprehensive plan with a long-term perspective (2030 and 2050) was recognized by many stakeholders." (Case Study Report Estonia)*

- *"Priorities of targeted/oriented research in the region are not much developed and the biotechnology, though a strong implicit specialisation, is not explicitly recognised either in University or research institutes goals."* (Case Study Report South Bohemia)
- *"Insufficient specialisation of the regional economy in general which leads to a small bioeconomy sector; it leads, among others, to difficulties in identification potential actors for clusters in this field and generates low regional demand for research from research organisations, such as University centres/institutes."* (Case Study Report Olomouc-Central Moravia)

5.4.2. Needs related knowledge transfer, knowledge management and communication

Another important need expressed by many regions is the transfer and communication of knowledge, research results and also new innovative methods and techniques to the business community (SMEs) as well as to farmers and other primary producers. The transfer is hampered by lacking 'links' or 'bridges' and by more basic elements such as a common 'language' or a systematic overview of research results and available knowledge (i.e. knowledge management systems for the bioeconomy).

- *"What has been reported as a bottleneck is the missing link between the research community and the companies. This is mainly due to a lack of cooperation culture between the two areas. It has often been the case that the research sector has approached at times several businesses to fund their ideas, but the other way round was hardly ever the case. These are two different worlds that need to be brought together. [...] The collection of all available material, such as projects, initiatives, ideas, good practices would be very helpful to bring the bioeconomy forward. Such a database is currently missing, but would contribute in showcasing the potential and added value of such practices in future."* (Case Study Report Crete)
- *"In the food sector, the region has little research activities. The group of high-potential, innovative regional companies in the food industry should be linked to the appropriate players in the research sector. Since regional competences in the area of nutritional research are only in the development phase, complementary capabilities are to be integrated through trans-regional research cooperation."* (Case Study Report Upper Austria)

The experience highlighted by e.g. the region of Skåne shows how wide this need for knowledge transfer and communication is and how it helps to deploy the bioeconomy:

- *"Increased and improved communication is a prerequisite for the increased development and use of bio-based products and services. It comes in a variety of levels: the business-consumer, business-companies, universities, companies, business-public sector, etc. Example of activities: Increase awareness of new opportunities within bio-based products, Create demand for bio-based products, Create arenas where different parts of the value chain can meet and exchange ideas, Demonstrations and mutual learning."* (Case Study Report Skåne)

5.4.3. Needs related to technological convergence and new value chains, in particular the engagement of SMEs into these processes

One of the most important bottlenecks for the bioeconomy deployment in the regions is the challenging implementation of new and modified value chains and of the technological conversion that influences many downstream and upstream business and production processes. Here, the challenge is that relevant experiences can only be compared and transferred to a certain extent, while local/regional challenges usually need specific solutions (with regard to type of biomass used, the use of sidestream and by-products, the conversion method, the products to be generated etc.).

Another challenge is the involvement of SMEs and the outreach to the majority of companies at local/regional level with regard to the technological and process conversion. SMEs do not usually have sufficient resources to develop a second business line based on "bio", as large companies might do. Here, the use of intermediary organisations (e.g. associations, cluster) is primordial to

engage SMEs from the start and to achieve and gather evidence on technological maturity and readiness of new processes or technologies.

- *"An important aspect of the development of the regional bioeconomy is the creation of markets for existing products and innovation. Here the public sector has an important role to fill since it can create market niches through the means of directed public procurements."* (Case Study Report Skåne)
- *"Most actors in bioeconomy are locked-in in the lower levels of value chains or are small (in national or international context) with limited resources for research and innovation and, particularly, with limited potential for innovation other than technology one focused on cutting production costs. The needs of companies are different from the focus (and often high-quality) of research at the University".* (Case Study Report Olomouc – Central Moravia)
- *"In order to enable the bioeconomic sector to produce competitive products at a large-scale, more investments in research infrastructure are essential prerequisites, e.g. pilot plants. In the Upper Austrian food sector there are little research resources available. The companies are not able to compete with the research departments of large corporations such as Nestle and Danone. Due to concentration tendencies in the trade sector, the profit margins for the enterprises are very low. This leaves little resources for research."* (Case Study Report Upper Austria)
- *"In terms of innovation in bioeconomy in Slovenia, two major gaps are evident. The first is moving innovations from TRL 4 to TRL 6. This step requires industrial proof of concept testing which is very costly. The second is moving products from TRL 6 to the market, because this, likewise, is an expensive step. Moving such innovations to market requires, accordingly, innovative marketing and resources for launching the product".* (Case Study Report Slovenia)
- *"Innovation infrastructure needs to be built on the basis of collaboration of public and private sectors, such as public open access laboratories and experimental workshops and pilot plants."* (Case Study Report Latvia)

In addition, several specific needs have also been identified:

- *"Challenges in relation to the agro-food and bioeconomy sector for the region will be - closing of productive cycles (through green chemistry and material reuse for constructions, bio-energy or bio-fertilizers production), - optimize water management along the supply chain (e.g. reduce use of water and reuse water used in food-chain processes, application of filtration and ultrafiltration techniques with biodegradable nanomaterials and anaerobic membrane, etc.), -promote sustainable agriculture (e.g. biomass management), - valorise by-products and wastes in the food chain: industrial symbiosis and circular economy, application of enzymatic processes and bioconversion of by-products, application of green chemistry to food ingredients composition and techniques for the stabilization and conservation, - use of sustainable processes for the food industry: e.g. cooling chain management, - production of innovative and sustainable packaging: e.g. smart and environment-friendly materials for packaging."* (Case Study Report Emilia-Romagna)
- *"Challenges in agro-food sector: Innovative formats; Functional foods; Sustainable agricultural production; Food security; Innovative companies; Critical mass in the scientific sector. [...] Challenges in management of natural resources: public sensitization on the sustainable and efficient management of natural resources; policy adaption to climate change; industrial development of Extremadura in line with efficient and sustainable use of natural resources."* (Case Study Report Extremadura)

5.4.4. Needs related to access to finance, risk sharing and synergies in funding and investments

Another major need observed in many regions is access to finance and sharing the risk associated to the innovations involved in bioeconomy deployment.

- *"Access to finance remains a pressing regional issue for bioeconomy R&D and entrepreneurial discovery processes, especially with regards to risk capital."* (Case Study Report Lapland)
- *"There is a critical need for more and specific regional financial instrument to support the R&I in bioeconomy."* (Case Study Report Extremadura)
- *"There is only scarce national funding (no specific funding programmes, so far) but tough competition for it."* (Case Study Report Estonia)
- *"Investing in research is associated with a certain risk for companies – it is not certain that the new product will compete successful in the market. The Upper Austrian food cluster, for example, supports companies to split the risk and to create research infrastructure."* (Case Study Report Upper Austria)
- *"In other cases, the private / company sector is usually reluctant to invest in risky innovations. The word innovation still 'scares' companies, as they fear the risk of investments in the field. In addition to that, the overall environment of financial crisis poses some challenges for the future. The financial capability of many companies is low and banks are also often reluctant to lend for risky investments."* (Case Study Report Crete)
- *"According to the representative from the Danish Agency for Science, Technology and Innovation the awareness from the regional development authorities in Denmark of BBI, FACCE SURPLUS and other opportunities from Horizon2020 is low. This includes the opportunity of regions to participate in the initiatives and to co-finance initiatives with regional development funds and ESIF. The engagement of regions could be expected to also generate more interest and awareness among Danish-based companies to participate in Horizon2020 initiatives."* (Case Study Report North Denmark)

Additional obstacles have been identified with regard to creating better synergies among the available funding instruments:

- *"The regional bodies detected difficulties in combining the resources from various OP or administrative obstacles in seeking synergies of ERDF and other R&I programmes, national or international ones."* (Case Study Report South Bohemia)
- *"Creating synergies between the national programmes and different research communities is seen crucial for fostering bioeconomy deployment. Sharing of infrastructure and knowledge, as well as combining different funding possibilities for applied and fundamental research should be more actively promoted."* (Case Study Report Estonia)

5.4.5. Needs related to regulations, standards and norms

In some cases a need for a better coordination and preparation of regulations, standards and norms has been expressed. This refer to the complex regulative framework of ESIF and other EU funding programmes, but also to a need for better legislation and incentives in the field of bioeconomy research (e.g. sharing risks, options for researchers to create start-ups/spin-offs).

- *"The main impeding factors identified are related to regulative frameworks and the regional actors have voiced the need to cut red tape both at national and EU levels. The current frameworks are favouring centralised systems which are not beneficial for vast, sparsely-populated Lapland. In order to advance bioeconomy and smart specialisation in Lapland, more attention should be given to decentralised systems and dynamics between centralised and decentralised systems."* (Case Study Report Lapland)
- *"There is national legislation which requires researchers to cover all the costs associated with the intellectual property even before the commercial value of the product is proven. Potential losses in the market for individual researchers are significant if the product turns out to be financially unfeasible or unsuccessful. Thus, it reduces the number of researchers pursuing the commercialisation of their research. This issue could potentially be addressed by allowing the transfer of intellectual property rights from the research institution to the researcher at the initial stage of the commercialisation process."* (Case Study Report Latvia)

- *"Another main bottleneck for the development of bioeconomy in the region is perceived to be a lack of national and EU-legislation creating economic incentives for a transition to a bioeconomy (e.g. relating to bio-based jet-fuel). The market forces are not perceived as sufficient for speeding up this process."* (Case Study Report Värmland)

5.4.6. Needs related to education, training and skills

The need for skilled people and for specific education and training offers is an issue in many regions. This is sometimes not a bioeconomy specific need but rather a general problem linked to innovation capacities in research and science institutions and in businesses. In addition, regions and countries do not have specialised education for bioeconomy specialists.

- *"Concerning development of bioeconomy the shortage of people with secondary or higher degree in engineering and science is a problem. More specific Latvia needs to: develop cross-sectoral interdisciplinary research by joining and consolidating resources, develop education at University and vocational education level."* (Case Study Report Latvia)
- *"Shortages have been identified especially in the field of vocational education which would have the potential produce future entrepreneurs and work force/operators for the regional bioeconomy sectors."* (Case Study Report Lapland)
- *"Another obstacle derives from the lack of appropriate staff. Starting at school young people should be introduced to technical issues. The Johannes Kepler University at Linz (JKU) does not have bioeconomy in its profile, currently the focus is on medicine, polymer engineering technologies and mechatronics. The field of bioeconomy could be installed in the Chemical institutes: e.g. materials, composite materials."* (Case Study Report Upper Austria)
- *"The R&I generators, the knowledge brokers and the business sector have serious needs in terms of capacity building for research management. Parallel to project management and research administration skills training and coaching for improving the quality of project proposals' quality is required."* (Case Study Report West Region, Romania)
- *"The knowledge of the challenges and opportunities with bio-based production must increase. By investing in education, students from various disciplines may acquire basic knowledge in bioeconomy in order to improve the ability of business and industry to switch to sustainable production in a number of areas. Examples of activities: Increase knowledge of bioeconomy in a number of higher education institutions and programs, initiate cross-sector collaboration within academia and between academia and businesses."* (Case Study Report Skåne)

5.4.7. Needs related to public awareness and acceptance

Regions and countries also ask for better information and participation of the general public, including all potential stakeholders in existing and new/modified value chains (farmers, SMEs, consumers, consumer associations, environmental NGOs, media, waste collection and management, citizens, schools and public services etc.). Raising the awareness on the positive effects of the bioeconomy and a circular economy is an important goal in several projects and/or strategies. In order to promote new and more bio-based products, it is necessary to generate social acceptance among the general public and to assure quality and availability of the new products.

- *"While the main obstacle to a full development of a bioeconomy sector in a long term is mainly related to cultural aspects. It appears necessary to increase the awareness among citizens from the benefits the bioeconomy can generate over time. Public opinion awareness raising should aim also avoiding further opposition of citizens to bioeconomy related interventions and avoid potential conflicts among traditional and bio-based industries."* (Case Study Report Emilia-Romagna)
- *"A lack of popularisation of RDI activities in the region and science communication with the general public thus leading to insufficient awareness of the population (and businesses) of the region and elsewhere about the research excellence and about the knowledge generated in the region."* (Case Study Report South Bohemia)

5.4.8. Bottlenecks related to external factors

Some regions observe that the successful deployment of the bioeconomy depends also on external factors that can be bottlenecks, such as fossil-fuel prices and availability.

- *“In a long-term outline, the development of bioeconomy depends mainly on the world fossil-fuel prices. The vegetal-based products are currently much more expensive than the fuel-based products, which prevents the full development of the supply chain. To be competitive, bio-based products need to be turned into high-quality materials with important added value to compensate the large price gap”. (Case Study Report Hauts de France)*
- *“From the economics point of view, electricity prices are too low to encourage investments in bioenergy. The competition with conventional energy sources is intense.” (Case Study Report Upper Austria)*

6. CONCLUSIONS: DEPLOYMENT OF THE BIOECONOMY AT REGIONAL LEVEL

In most European countries and regions, bioeconomy related research and innovation (R&I) is one of the strategic priorities for 2014-2020. 207 of the 2010 analysed regions and countries (98.6%) include bioeconomy related aspects in their 2014-2020 R&I priorities and plans.

However, bioeconomy R&I is approached in many different ways in the strategies. In fact, there is a **huge thematic variety** with regard to bioeconomy related R&I, even within regions/countries. The range of R&I activities that are somehow linked to the bioeconomy is very wide. Aspects and denominations of bioeconomy (in the different languages) at national and regional level vary greatly (from low-carbon, over sustainable agriculture, food innovation, green chemistry, eco-innovation, green growth, circular economy to blue growth).

This diversity in bioeconomy related issues makes it difficult to establish general guidelines or recommendations. However, according to the different aspects linked to bioeconomy development, a **typology of regional bioeconomy profiles** has been elaborated:

- Type 1: Regions with a natural resources and heritage driven bioeconomy profile
- Type 2: Regions with a research driven bioeconomy profile
- Type 3: Regions with a primary - value chain bioeconomy profile (incipient)
- Type 4: Regions with a primary value chain bioeconomy profile (advanced)
- Type 5: Regions with an industrial biotech profile
- Type 6: Regions with an integrated and advanced bioeconomy profile.

Future analysis and recommendations to regions about their bioeconomy deployment should take into consideration the specificities of these regional profiles and the different objectives and needs related to it.

The vast majority of European RIS3 strategies foresees **support for bioeconomy R&I** in the time period of 2014-2020, most of them in the category of agro-food or energy R&I. The analysis of RIS3 strategies and related documents shows that there is a wide range of instruments and modalities to support the bioeconomy in studies time period. The variety reaches from support to physical infrastructure to the promotion of technology transfer, technology services training and capacity-building. Also financial instruments and venture capital are foreseen to bundle resources and to raise more investments. However, many countries and regions seem to be in the need of an overview of available funding sources (ERDF, EAFRD, H2020, etc.) for bioeconomy deployment. Regions that already have an established bioeconomy strategy in place have a better overview of priorities and needs and can hence more easily create synergies and complementarities at local and regional level.

In addition to pure H2020 funding and ERA-Nets, the importance of **synergies between ESIF and H2020 funding** could be observed in several of the analysed cases. The 2014-2020 common strategic framework favours the complementary funding between the different ESIF, in particular ERDF and EAFRD, but also synergies with H2020. However, synergies between ESIF and H2020 or other programmes are not always easy to achieve, mainly due to the different funding objectives and frameworks of the calls. Many regions and countries actively promote the generation of synergies between ESIF and H2020 funding in the current funding period. Mechanisms to award ESIF grants for excellent projects have been or are being developed in many EU Member States and regions within the 'Seal of Excellence' scheme (e.g. Italy, Finland, Czech Republic, Scotland, Lombardy, Spain, France). Specific forms of synergies between different funding sources represent the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) and the Bio-Based Industries Joint Undertaking (BBI-JU) as a public (EU) and private partnership. Some regions consider these initiatives valuable for their bioeconomy deployment.

In addition to European and national programmes and strategies to stimulate the bioeconomy, considerable bioeconomy deployment takes place at sub-national level through **bioeconomy projects and initiatives** promoted by regional and local public authorities, by clusters and private companies, or by universities, research centres or technology and innovation service providers.

Some of them use European and/or national co-funding, but also local and regional resources are put into value.

Regional bioeconomy ecosystems in Europe are built around governments and public administration, businesses and representatives of sectoral associations and business intermediaries, as well as academic, scientific and technological institutions. Especially in strongly industrialised regions, but also increasingly in rural regions, clusters are an important tool to gather stakeholders around specific bioeconomy sectors/products. In comparison to traditional industrial clusters, bioeconomy related clusters often need to integrate also producers of biological resources, i.e. farmers and fishermen, as well as their associations, i.e. cooperatives. In particular, at governmental level, **coordination among different policy areas** (e.g. research and innovation, economic/industry development, agriculture, environment) is needed to promote the bioeconomy. In addition, new bioeconomy related organisations, such as bioeconomy strategy councils, thematic platforms and networks, operational coordination bodies, specific technology centres etc. might be useful to link different players in bioeconomy ecosystems and to develop bridges between different communities and sectors.

The regions and countries analysed in the case studies represent diverse **needs and bottlenecks** in the deployment of bioeconomy:

- Needs related to strategic planning and governance,
- Needs related to value chain/cycle development, in particular SME engagement,
- Needs related R&I on technologies, knowledge transfer, education and new bioeconomy skills,
- Needs related coordinated funding and synergies between instruments,
- Needs related to public awareness and acceptance,
- Bottlenecks related to external factors.

The analysis shows that less than half of countries and regions in Europe (35.7%) have a **low level of bioeconomy maturity**, i.e. they cannot fully exploit the potential (i.e. jobs, growth, resource efficiency, rural development) of the bioeconomy on their own. Some general **challenges** for the general deployment of the bioeconomy are:

Knowledge about regional bioeconomy preferences in Europe, and subsequently, decision-making and further action regarding bioeconomy R&I is limited because of a **lack of common definition/classification** of the bioeconomy, both at large and in its relevant subsectors (agro-food, blue bioeconomy, forest-based bioeconomy, biochemical etc.). This hampers also the development of common sustainability criteria, standards and regulations that are necessary to develop new products and to introduce changes in existing value chains.

There is still a **limited strategic understanding of the bioeconomy** at regional level. Even if already 19 Member States have a bioeconomy strategy (or a similar strategic document) in place or are in the process of developing one, only 49 of the analysed regions have developed a regional bioeconomy strategy or a similar comprehensive document.

Another obstacle to a wider deployment of the bioeconomy is the **fragmentation into separate policies** that only sporadically are embedded in integrated bioeconomy related frameworks. This is not only true for the regional level, but affects also national policy frameworks and European policies and strategies with a subsequent lack of harmonised legislation. One of the major challenges for future growth of the bioeconomy is to overcome the gap/contradictory interpretations between research, industrial/SME, regional development, agricultural/fisheries and environmental/energy policies.

There are already a lot of knowledge platforms and networks in place. However, **a structured knowledge transfer** among regions and all relevant stakeholders is still at a low level. For instance, ERA-NETs and JPI engage many researchers and national research authorities, but the involvement of regional and local authorities, ESIF Managing Authorities or the business community is rather low hampering knowledge transfer. Initiatives like the EIP-Agri try to involve diverse stakeholders in operational groups and focus groups but need active involvement and promotion at local and regional level.

With regard to technology development and R&I, **biorefining processes and applications** seem to be key for the regions in defining new and modified value chains in many different areas. Research and development is needed to find mature solutions for specific territorial conditions and contexts. This should be better reflected in R&I support policies.

Funding is available from many different sources to support the bioeconomy from the EU level. However, stakeholders ask for **more synergies and better coordination** among programmes to enhance the access to funding for different types of project promoters, including local and regional authorities, cluster, rural innovation partnerships, as well as SMEs.

To sum up, a further development of bioeconomy related R&I activities of EU regions and Member States would require:

- a common definition/classification of the bioeconomy, for bioeconomy related economic and research activities and for bioeconomy maturity in EU regions that allows for monitoring and benchmarking bioeconomy deployment and support knowledge transfer.
- a coordinated support from the EU level to cities and regions in strategic planning and communication within a streamlined and integrated EU strategy and policy framework for the bioeconomy. Also the knowledge exchange between Member States and among regions should be supported.
- strategic planning and leadership to coordinate, align and combine efforts on R&I (engaging industrial/SME, research, agriculture/fishery and environmental stakeholders), according to the different bioeconomy profiles and maturity levels.
- a more specialized support on the development of value chains according to the different bioeconomy profiles and maturity levels. Cross-border and interregional cooperation (twinning, networks) with regions of a similar profiles are already a valued tool.
- support in engaging also the traditional sectors and SMEs in conversion processes (technology, business) towards the bioeconomy.
- support on developing transdisciplinary and specific bioeconomy competences and skills, both for research and academia and in businesses.
- better access to finance for small scale demo activities and pilot plants until new value chains and new technologies reach a sufficient TRL level to be market-ready.
- more synergies and better coordination in funding and investments, in particular between ESIF and H2020.
- activities to raise public awareness and acceptance in regional bioeconomy ecosystems and overall society about the potential benefits and perceived threats of the bioeconomy for cities and regions. Participatory approaches should be used to develop solutions for potential conflicts at local and regional level regarding land use, management of natural resources, and biotechnological research.

7. POLICY RECOMMENDATIONS: FUTURE SUPPORT TO THE DEPLOYMENT OF THE BIOECONOMY AT NATIONAL/REGIONAL LEVEL

Regarding a better deployment of the bioeconomy at national and regional level in Europe, the following **recommendations** is derived from the results and analysis of the study.

The recommendations regard the following domains:

- a. Bioeconomy strategic planning and governance,
- b. Value chain/cycle development, in particular SME engagement,
- c. R&I on technologies, knowledge transfer and new bioeconomy skills,
- d. Coordinated funding and synergies between instruments,
- e. Public awareness and acceptance.

Recommendations
<p>A) More and better bioeconomy strategic planning and governance at national and regional level</p>
<p>A.1) The regions with a middle and low level of maturity, in particular in Central and Eastern and in South Europe, need to develop their bioeconomy ecosystems, in particular bridging elements and platforms between traditional (agro-food, fisheries) sectors, industry, science and research, technology as well as public administration. This requires analysis of the existing potential and of the current and prospective value chain approach. Integrative bioeconomy ecosystems have to be developed. Specific 'bridging links' (e.g. thematic platforms, regional networks, flagship projects, specialised innovation centres, science parks) have to support the interaction of stakeholders and ensure knowledge transfer, knowledge management and communication. Rural innovation partnerships, linking existing local action groups, operational groups and regional innovation systems, can help to promote innovation in most prominent subsectors (agriculture, fisheries, forestry, food).</p>
<p>A.2) Strategic planning and governance is crucial to deploy the bioeconomy. The development of a common regional vision for the bioeconomy, priority-setting, and coordination among research, industrial and agricultural policies is key to develop regional bioeconomy support frameworks that can be co-funded by national and EU funds.</p>
<p>A.3) Twinning, partnerships and interregional cooperation between regions with the same bioeconomy profile/approach can facilitate learning and knowledge transfer. Cooperation projects and partnerships with a bioeconomy focus shall be promoted within existing cooperation programmes and in macro-regional and sea-basin strategies.</p>
<p>B) Support to value chain/cycle development and engaging SMEs</p>
<p>B.1) New bioeconomy technologies and business processes require still important investments to lower operational costs and generate benefits. Technological readiness is still low. Support schemes are needed not only for high-end solutions but also to increase the technology readiness level (TRL) of small-scale technologies that can be useful also in regions with a low bioeconomy maturity (e.g. for rural biorefineries, wastewater recycling, use of agricultural and fishery by-products, sustainable aquaculture, bio-packaging).</p>
<p>B.2) Pilot facilities/plants and development/demonstration plants to support upscaling activities are needed for new/niche value chains (e.g. biofuel from algae, green gas through bacteria etc.). Support for new infrastructure and equipment is needed, in particular in low-maturity regions. In addition, knowledge exchange and analysis of existing pilot and demonstration plants and infrastructure facilities is needed in order to better exploit existing ones and enable decision-making on building new ones. Moreover, a European platform (e.g. within the S3 platform) for small/scale and/or multi-input biorefineries to showcase different approaches to biorefining and different business opportunities, could show how to adapt to diverse regional perspectives, offer access to finance for demo scale activities, coordinate the use of existing research facilities and demonstration plants and avoid duplication of infrastructure.</p>
<p>B.3) In order to optimise/convert existing value chains and to integrate different chains into regional value cycles, local/regional stakeholders – SMEs, in particular – must be actively engaged and supported, e.g. through voucher programmes for the use of pilot facilities and demo plants or open access demo infrastructure. Not only the primary producers have to be involved, but also stakeholders upstream and downstream of the core bioeconomy business (supplies, machinery, equipment, energy, water, processing, logistics, local energy suppliers as clients for bioenergy, wastewater treatment, retail and distributors etc.).</p>

C) Develop R&I on technologies, knowledge transfer and new bioeconomy skills

C.1) It is important to shorten the learning curve for new value chains through knowledge diffusion in thematic networks, platforms, cooperation projects, transfer of results etc. These platforms, e.g. S3 platforms, should involve all relevant stakeholders. In particular, low and middle maturity regions should be encouraged and supported in developing necessary capacities to join these platforms. Existing partnerships (e.g. EIP AGRI, BBI-JU) networks, initiatives and platforms (e.g. ERA-NETS, ERRIN, ERRIAFF, Vanguard, CPMR, S3 platforms, macro-regional initiatives) regarding bioeconomy should be better promoted in order to further stimulate learning and knowledge transfer to regions with a lower bioeconomy maturity.

C.2) There is a need for capacity-building and support schemes (administration) for participation in existing networks and platforms for smaller countries and regions with a low bioeconomy maturity.

C.3) Knowledge transfer and mutual learning between regions could be enhanced through more specific thematic platforms. Thematic networks and working groups for bioeconomy related R&I within the agro-food sector, as the most important bioeconomy sub-sector in EU regions, should be promoted to streamline common interests and prepare joint programming and R&I activities (e.g. on crops, horticulture, seeds, animal husbandry, dairy, bread and pastries, NFF, beverages, starch biomass, sugar biomass, water management, packaging). Networks and working groups could embrace a range of sub-sectors and value chain elements in order to optimise and modify into value cycles and create closed loops.

C.4) Bioeconomy support to R&I has to focus on multi- and transdisciplinary (not only biotech) projects to promote the generation of value cycles and closed loops. This requires integrated research but also transdisciplinary education (both university as well as vocational and continuous training) and skills for the bioeconomy.

D) Coordinate funding and synergies between instruments

D.1) There is a need to generate synergies and improve coordination in funding and investments, in particular between ESIF and H2020 and the instruments of ERA-Nets and Era-Net Co-funds, JPI, EIP, KIC, S3 platforms, BBI-JU. These funding sources and activities that are already taking place, including the Seal of Excellence scheme, have to be disseminated and communicated to all relevant national and regional stakeholders in regional bioeconomy ecosystems, as they offer valuable funding opportunities and help to establish thematic platforms and networks within bioeconomy domains. Initiatives to coordinate and bring together funds and stakeholders, such as ERA-PLATFORM, have to be strengthened and further developed in order to enhance visibility and facilitate participation of regions and smaller countries.

D.2) Local and regional policymakers have to be aware of the potential benefits and approaches to the bioeconomy in their region, and should increase their knowledge on how existing funds (ESIF, H2020, ERA-Nets, COSME, LIFE+ etc.) can be used and synergies generated to stimulate the bioeconomy at regional level. A better communication of good practices and project results might be necessary.

E) Raise public awareness and acceptance

E.1) Regions need guidance and support in order to engage civil society and consumers. Activities are needed to raise awareness on potential benefits of new/modified value chains in industrial/agricultural sectors, as well as on the benefits of a circular economy and on the cascading use of biological resources and residues/by-products. Negative perceptions and fears should be better analysed and addressed. Bioeconomy standards and labels should be developed to give an overview on positive and negative features of bio-based and recycled products. Protection of consumer rights has to be considered as an important aspect to enhance acceptance of bio-based and recycled products. Overall, advancing towards citizen-friendly value chains and cycles should be one objective of bioeconomy deployment.

According to the typology of regional bioeconomy profiles that has been developed in this study, more specific recommendations for the different types of regions are proposed. This includes four of the five above domains. Recommendations on coordinated funding and synergies refer more to the European level rather than depending on the type of region concerned:

Table 7.1: Needs of EU regions to deploy the bioeconomy, according to their bioeconomy profile and approach

Bioeconomy Type	Approach to bioeconomy value generation	Strategy and governance	Value cycle development	Technology and skills	Awareness and public acceptance
Type 1: Research driven	<ul style="list-style-type: none"> • Excellence in Bioeconomy transdisciplinary research • Offering R&I services and technology support 	<ul style="list-style-type: none"> • Develop a portfolio of technologies and services that can be offered to industry and SMEs 	<ul style="list-style-type: none"> • Offer knowledge and advise on how to add value in existing value chains (new products, side-streams) and how to establish value cycles and to close loops 	<ul style="list-style-type: none"> • Scientific research to analyse costs and benefits of bio-based products and bioeconomy • Research has to be tested in development and demonstration projects (living labs). 	<ul style="list-style-type: none"> • Scientific research to analyse costs and benefits of bio-based products and bioeconomy
Type 2: Natural resources and heritage	<ul style="list-style-type: none"> • Ecosystem management and resilience • Leisure and tourism • Sustainable agro-food and bio-energy, bio-based products 	<ul style="list-style-type: none"> • Establish a regional bioeconomy council in order to coordinate support and close regional loops • Develop a regional bioeconomy vision • Offer support schemes to generate added value in biomass production (quality, energy) and through ecosystem services (tourism) • Develop networks of rural innovation partnerships 	<ul style="list-style-type: none"> • Develop and add value to existing value chains (e.g. agriculture, food, wood, hydric and maritime, tourism and heritage) through innovation, quality, new products, more efficiency in production, design, packaging, marketing) • Develop new value chains based on local products (wastewater, agricultural by-products, fibres, algae, oils, seaweed etc.) with small-scale infrastructure and available technologies 	<ul style="list-style-type: none"> • New but mature technologies need to be introduced as a standard. • R&I should focus on process and product innovation, marketing and training on existing technologies and quality standards. • There is a need for enhancing skills on innovation capacities in business, industry, and primary producers. • Existing technologies need to be adapted to local/regional biomass supplies and technical capacities. 	<ul style="list-style-type: none"> • Raise awareness on the need to innovate and on the potential benefits of bioeconomy value chains • Raise awareness on new cascading uses of biological resources and residues/by-products • Raise awareness on the benefits of closed loops and the circular economy
Type 3: Primary VC focus – incipient	<ul style="list-style-type: none"> • Diversification of products, markets and R&I competences • Higher added-value products • To develop existing value chains • To create decentralised small Bio-refineries and other small-scale (mature) technologies 	<ul style="list-style-type: none"> • Bring together biomass supply with industrial conversion of biomass (bioeconomy networks) • Establish a regional bioeconomy council in 	<ul style="list-style-type: none"> • Identify and close regional loops (e.g. agro-food with residues/waste and energy and fuel production, maritime 	<ul style="list-style-type: none"> • R&I should focus on the optimisation of value chains and new technologies (biorefineries), as well as on the conversion 	<ul style="list-style-type: none"> • Raise awareness on the potential benefits of new/modified value chains in industrial/agricultur
Type 4: Primary VC focus – advanced	<ul style="list-style-type: none"> • Value aggregation • Specialisation in value chains • New products from available biomass and residues • R&I on bio-refineries and bio-based products (algae, fibres) 	<ul style="list-style-type: none"> • Bring together biomass supply with industrial conversion of biomass (bioeconomy networks) • Establish a regional bioeconomy council in 	<ul style="list-style-type: none"> • Identify and close regional loops (e.g. agro-food with residues/waste and energy and fuel production, maritime 	<ul style="list-style-type: none"> • R&I should focus on the optimisation of value chains and new technologies (biorefineries), as well as on the conversion 	<ul style="list-style-type: none"> • Raise awareness on the potential benefits of new/modified value chains in industrial/agricultur

Bioeconomy development in EU regions

Bioeconomy Type	Approach to bioeconomy value generation	Strategy and governance	Value cycle development	Technology and skills	Awareness and public acceptance
Type 5: Industrial Biotech focus	<ul style="list-style-type: none"> Technological conversion To develop new value chains To integrate fossil-based and bio-based technologies To develop circular approaches 	<p>order to coordinate support</p> <ul style="list-style-type: none"> Promote technological conversion (bring together researchers with innovative companies in clusters) 	<p>with NFF and algae, wood with paper, packaging and fibre-products)</p> <ul style="list-style-type: none"> Introduce circular management (waste, logistics, production) 	<p>from fossil-based to bio-based technologies.</p> <ul style="list-style-type: none"> R&D with pilot plants is required to discuss and improve on technical maturity (TRL) of new technologies. Biotechnology, nanotechnology, engineering and other relevant skills are needed in multi-disciplinary teams. 	<p>al sectors.</p> <ul style="list-style-type: none"> Raise awareness on the benefits of a circular economy and the use of bio-products Raise awareness on new cascading uses of biological resources and residues/by-products
Type 6: Integrated Bioeconomy development	<ul style="list-style-type: none"> Transition To develop new value chains To develop combined value cycles with primary/industrial sectors To develop new bio-based manufacturing technologies To develop circular approaches 	<ul style="list-style-type: none"> Develop a portfolio of technologies and services that can be offered to industry and SMEs 	<ul style="list-style-type: none"> Circular management of closed value cycles and regional/national loops Offer advice on circular management to other regions 	<ul style="list-style-type: none"> R&D with pilot plants is required to discuss and improve on technical maturity (TRL) of new technologies. Skills in circular management should be developed. 	<ul style="list-style-type: none"> Raise awareness on the benefits of a circular economy and the use of bio-products

Source: Own elaboration

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AGROCYCLE – Horizon 2020 Project – www.agrocycle.eu

BBI-JU – www.bbi-europe.eu/

BERST - Bio Economy Regional Strategy Toolkit (7th FP Project) - <http://www.berst.eu/>

BERST Regional Profile Database - <http://berst.databank.nl/>

BIO-TIC – 7th FP Project - <http://www.industrialbiotech-europe.eu/>

BREAD4PLA – LIFE project – www.bread4pla-life.eu/

EIP-AGRI – <https://ec.europa.eu/eip/agriculture/en>

ERA PLATFORM (for the Bioeconomy) – www.era-platform.eu

ERRIN Network – www.errin.eu/

ERRIAFF Network – <http://eriaff2014.blogspot.de/p/eriaff-network.html>

EU Bioeconomy Observatory - <https://biobs.jrc.ec.europa.eu/>

PLASTICE – Interreg Project on sustainable plastics: <http://www.sustainableplastics.eu/>

Star-COLIBRI – 7th FP Project - www.star-colibri.eu

SUS3CHEM – Interreg project - www.interregeurope.eu/s3chem/

VANGUARD Initiative - www.s3vanguardinitiative.eu/

ANNEX DOCUMENTS

1. Collected raw data – Survey of European countries and regions with a RIS3 strategy (in MS Excel).
2. Task 2 Report: Analysis of collected raw data. (in MS Word)
3. Task 3 Case Study Summary Report (in MS Word)
4. Individual Case Study Reports for 22 cases (folder with 22 MS Word documents)
5. List of contact persons that contributed to the case study analysis (in MS Excel)
6. List of main EU-28 national/regional contact points dealing with Bioeconomy R&I and their contact details (in MS Excel)
7. Presentation of a summary of Study results, conclusions and recommendations (in MS Powerpoint)
8. Regional Specialisation of Bioeconomy-related R&I 2014-2020 in the EU (in MS Excel)

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The study "*Mapping of EU Member States' / regions' Research and Innovation Plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy*" maps the intended priorities and activities of EU Member States (MS) and regions with regard to research and innovation (R&I) on bioeconomy. This information helps to identify specialisation patterns of European regions and countries (e.g. agro-food, blue bioeconomy or bio-based chemicals). Moreover, European regions and countries have been classified according to a bioeconomy maturity index, developing six different types of regional bioeconomy profiles. The study shows that bioeconomy related R&I is a priority for most of European countries and regions in the time period 2014-2020. The majority of EU regions/countries (207; 98.6%) include bioeconomy related aspects in their 2014-2020 R&I priorities and plans. However, many regions in Europe (35.7%) still have a low level of maturity. They cannot fully exploit the potential of the bioeconomy on their own (i.e. jobs, growth, rural development). The study presents recommendations for better strategic planning, enhanced value-chain development and R&I on technologies, better knowledge transfer and skills, more efficient coordination of funding and synergies between instruments, as well as proposals to raise public awareness and acceptance.

Studies and reports