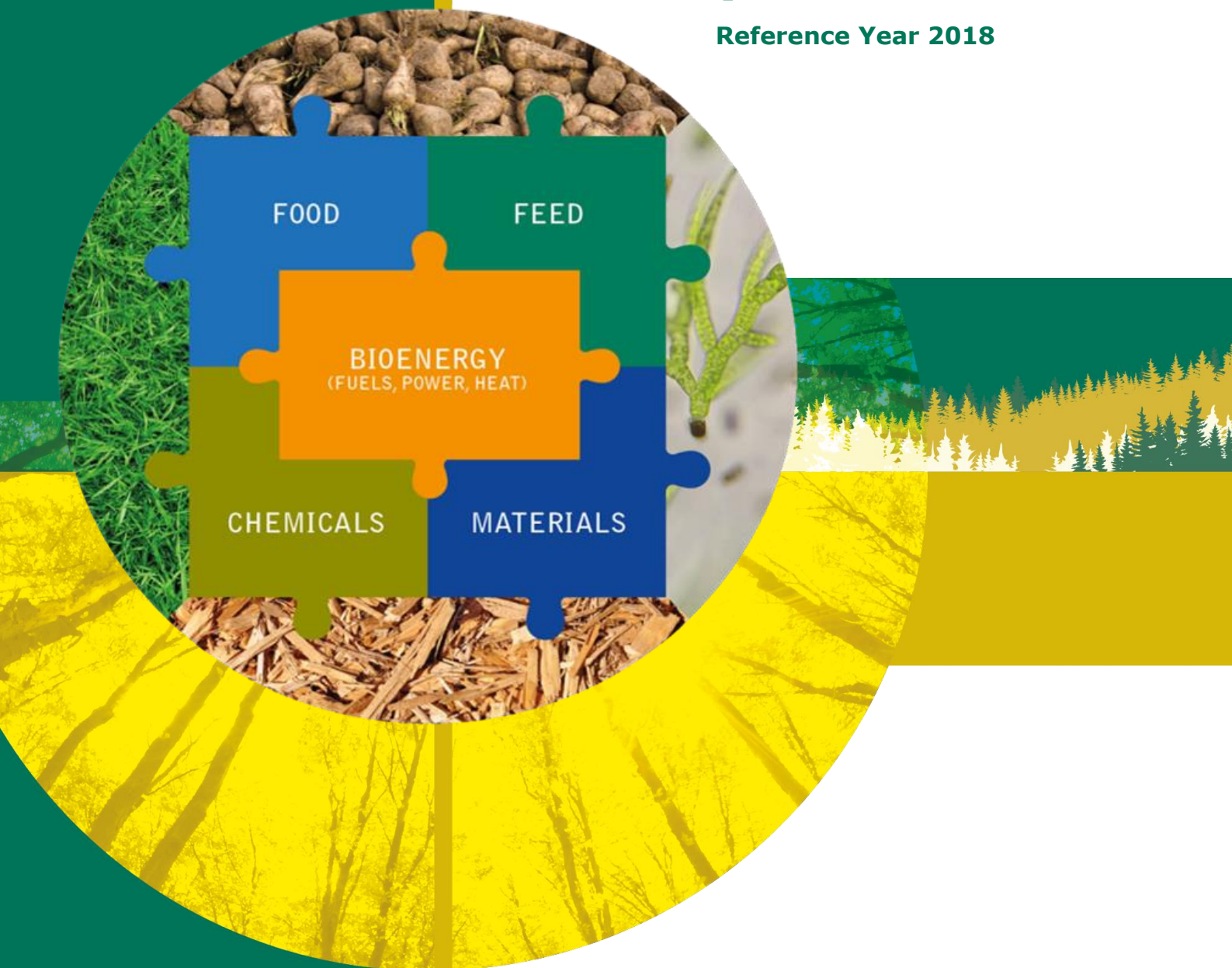


# Bioeconomy and biorefining strategies in the EU Member States and beyond

Reference Year 2018



This publication provides the results of a survey on bioeconomy and biorefining strategies in EU Member States and beyond, that was performed by IEA Bioenergy Task42 in close cooperation with the Joint Research Centre (JRC) of the EC and the Biobased Industries Joint Undertaking (BBI JU)

**IEA Bioenergy**

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# Bioeconomy and biorefining strategies in the EU Member States and beyond

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## Preface

Food security, energy supply, and climate change are among the biggest global challenges in the next future. Radical changes in the economy are necessary to face these challenges. The Bioeconomy, including the deployment of various biorefining strategies, represents one of the pillars for a more sustainable global development. In 2012, the European Union (EU) and the USA adopted their respective strategies on Bioeconomy. Since then a number of national and international agendas have been developed. The Joint Research Centre (JRC), as coordinator of the European Commission's Knowledge Centre for Bioeconomy (BKC), in collaboration with the Biobased Industries Joint Undertaking (BBI JU), the Technology Collaboration Programme (TCP) Bioenergy of the International Energy Agency (IEA), and with input from other stakeholders, undertook a survey on the Bioeconomy progress status in the EU Member States. IEA Bioenergy Task42 cooperated in this survey by in particular extending the analysis to extra EU countries, and providing a database of the recently developed biorefineries.

The outcomes of the survey are available on the website of the Bioeconomy Knowledge Centre (BKC) (<https://biobs.jrc.ec.europa.eu/>), as web-based interactive dashboard, interactive overview maps and separate reports from the partner organizations, allowing a flexible approach for subsequent updates. The present report summarizes the main outputs of the survey, provides some snapshots of the status of the Bioeconomy in EU and non EU countries, and gives the current status of biorefineries deployment in the different countries. This report will be disseminated through the website of IEA Bioenergy (<https://ieabioenergy.com/>); whereas the biorefinery-related data will be placed on the IEA Bioenergy Task42 website (<https://task42.ieabioenergy.com/>).

# 1. BioEconomy strategies EU Member States and beyond

A detailed description of the methodology adopted for the Bioeconomy Survey is provided in a dedicated report called "Joint survey on Bioeconomy policy developments in different countries", available on line on JRC web site at:

[https://biobs.jrc.ec.europa.eu/sites/default/files/JRC112081\\_joint\\_survey\\_report\\_final.pdf](https://biobs.jrc.ec.europa.eu/sites/default/files/JRC112081_joint_survey_report_final.pdf)

and also on IEA Bioenergy web site:

<http://task42.ieabioenergy.com/publications/joint-survey-on-bioeconomy-policy-developments-in-different-countries/>

This chapter summarizes the results of the Bioeconomy Survey, related to the on-line questionnaire which was circulated by the European Commission to 28 Member States of the European Union and four H2020 Associated Countries (Iceland, Switzerland, Norway and Turkey). In particular it shows information at national scale on Bioeconomy strategy-policies, as for March 2018 based on survey respondents knowledge.

## 1.1. EU COUNTRY SPECIFIC BIOECONOMY POLICY STRATEGIES

The European country-specific overview of bioeconomy policy developments as of March 2018 is made available on the website <https://biobs.jrc.ec.europa.eu/> through an interactive overview map in the policy 'Topic' page, and separate reports from the partner organisations available through the "Knowledge Library" (figure 1.1).

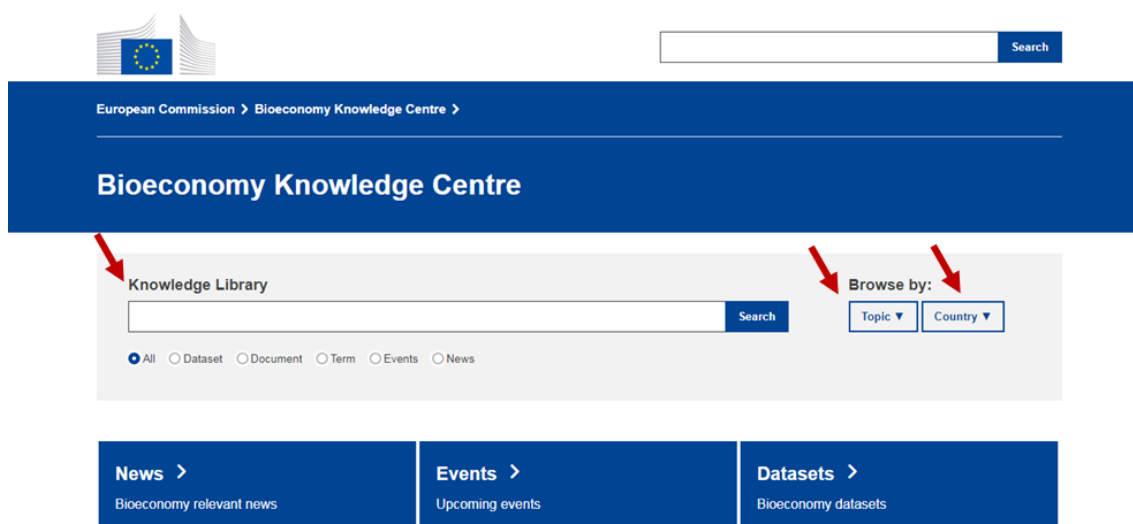


Figure 1.1 - Website homepage of the Bioeconomy Knowledge Centre with highlighted the Topic and Country drop-down menus and the search bar "Knowledge Library".

The information on bioeconomy policy developments concern:

- institutions involved in the development of the bioeconomy at national level;
- status of national bioeconomy strategies and definitions of bioeconomy;
- information on dedicated national strategies, such as goals, sectors included (agriculture; aquaculture; biobased chemicals and materials; biobased electricity; biobased textiles; biofuels; biotechnology; fisheries; food; forestry; organic waste; pulp and paper; wood, wood products and furniture; and other), stakeholders involved, existence of monitoring framework, etc.;
- other bioeconomy-related strategies;
- bioeconomy strategies at regional level;
- other relevant bioeconomy-related information (e.g. funding and educational programmes, certification schemes and incentives for biobased products, etc.).

The tables 1.1 and 1.2 show an overview of the available information on Bioeconomy policy developments as of March 2018 for each country that answered to the survey research.

		DE	FR	IT	UK	ES	PL	NL	SE	IE	BE	AT	FI	DK	PT	EL	RO	CZ	HU	SK	BG	HR	LT	LV	SI	EE	CY	LU	MT	CH	NO	IS	TR		
Other national bioeconomy strategies		yes	yes	yes	yes	ud	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	nd	nd	yes	nd	yes	yes	yes	yes	yes	yes	yes	yes	yes	nd	yes	
Regional bioeconomy strategy(ies)		yes	nd	yes	yes	yes	yes	yes	nd	yes	yes	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd		
Bioeconomy funding programmes		Bio-based industrial sector		yes	yes	no	yes	yes	no	yes	yes	no	yes	yes	no	nd	nd	no	no	no	nd	nd	no	nd	no	no	nd	nd	yes	nd	yes	yes	nd	nd	
		Bioeconomy R&I		yes	yes	yes	yes	yes	yes	no	no	no	yes	yes	yes	nd	nd	yes	no	no	nd	nd	no	nd	no	no	nd	nd	yes	nd	yes	yes	nd	nd	
		Infrastructure investments		yes	no	no	no	yes	no	yes	no	yes	yes	yes	no	yes	nd	nd	yes	no	yes	nd	nd	no	nd	yes	no	nd	nd	yes	nd	no	no	nd	nd
		Other		no	no	no	no	yes	no	no	no	yes	yes	no	no	yes	nd	nd	no	no	no	nd	nd	yes	nd	no	yes	nd	nd	no	nd	yes	no	nd	nd
Educational programmes on bioeconomy		nd	yes	yes	yes	yes	yes	yes	nd	no	yes	yes	yes	nd	yes	yes	yes	yes	no	nd	nd	no	no	yes	yes	yes	nd	nd	nd	nd	nd	nd	nd	no	
National register bio-refineries or bio-based industries		no	no	yes	no	yes	nd	yes	nd	yes	yes	nd	nd	no	nd	nd	nd	no	nd	no	nd	nd	yes	no	no	no	no	nd	nd	nd	no	no	nd	nd	
National certification schemes for biomasses and bio-based product		no	yes	yes	nd	nd	yes	nd	yes	yes	yes	yes	nd	yes	yes	no	yes	no	nd	no	nd	yes	no	no	nd	no	nd	nd	nd	nd	nd	nd	nd	nd	
Incentives for bio-based products		no	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	yes	yes	no	no	nd	no	no	yes	no	yes	nd	yes	nd	no	no	nd	yes		
		yes	Available data				no	No available data				nd	No answer				ud	Under development				op	Other policy initiatives				os	Other related strategies							

Table 1.1 - Overview of the available information on bioeconomy policy developments as of March 2018, for each country that answered to the survey research.

		DE	FR	IT	UK	ES	PL	NL	SE	IE	BE	AT	FI	DK	PT	EL	RO	CZ	HU	SK	BG	HR	LT	LV	SI	EE	CY	LU	MT	CH	NO	IS	TR				
National institutions involved in bioeconomy		Lead Ministry(ies)	yes	yes	yes	yes	yes	yes	yes	yes	nd	nd	yes	yes	yes	nd	yes	yes	yes	nd	nd	yes	yes	yes	yes	yes	yes	nd	yes	nd	yes	yes	nd	yes			
		Other Ministry(ies)	yes	nd	yes	yes	yes	yes	yes	nd	yes	nd	yes	yes	yes	yes	yes	yes	yes	nd	nd	nd	yes	nd	yes	yes	yes	nd	nd	nd	yes	yes	nd	yes			
Other Institutions		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	nd	yes	yes	yes	yes	yes	nd	yes	nd	yes	nd	yes	nd	yes	nd	yes	nd	yes	nd	nd	nd				
National bioeconomy definition		yes	yes	yes	yes	yes	no	yes	yes	no	yes	yes	yes	yes	no	yes	no	no	no	no	no	nd	no	no	yes	yes	yes	nd	no	nd	yes	yes	nd	yes			
Status of national policies on bioeconomy		yes	yes	yes	ud	yes	op	ud	op	yes	op	ud	yes	op	os	os	op	op	op	ud	op	op	op	ud	yes	op	ud	os	os	os	os	yes	op	os			
National bioeconomy strategy information					Goal	7	4	9	nd	5	nd	nd	nd	4	nd	nd	3	nd	nd	nd	nd	nd	nd	nd	3	nd	nd	nd	nd	nd	4	nd	nd				
					Actions	3	> 3	> 3	nd	> 2	nd	nd	nd	> 3	nd	nd	2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	> 2	nd	nd	nd	nd	nd	2	nd	nd	
					Sectors included	12	> 13	> 13	nd	13	nd	nd	nd	> 13	nd	nd	13	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	12	nd	nd	nd	nd	nd	13	nd	nd	
					Monitoring framework	yes	no	yes	nd	yes	nd	nd	nd	no	nd	nd	yes	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	no	nd	nd	nd	nd	nd	nd	no	nd	nd
					Stakeholders involved	5	> 4	> 4	nd	> 4	nd	nd	nd	> 4	nd	nd	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	4	nd	nd	nd	nd	nd	nd	5	nd	nd
		yes	Available data			no	No available data			nd	No answer			ud	Under development			op	Other policy initiatives			os	Other related strategies														

Table 2.2 - Overview of the available information on bioeconomy policy developments as of March 2018, for each country that answered to the survey research.



Dedicated bioeconomy strategies already exist at national level or are being developed in many of the Member States of the European Union (figure 1.2).

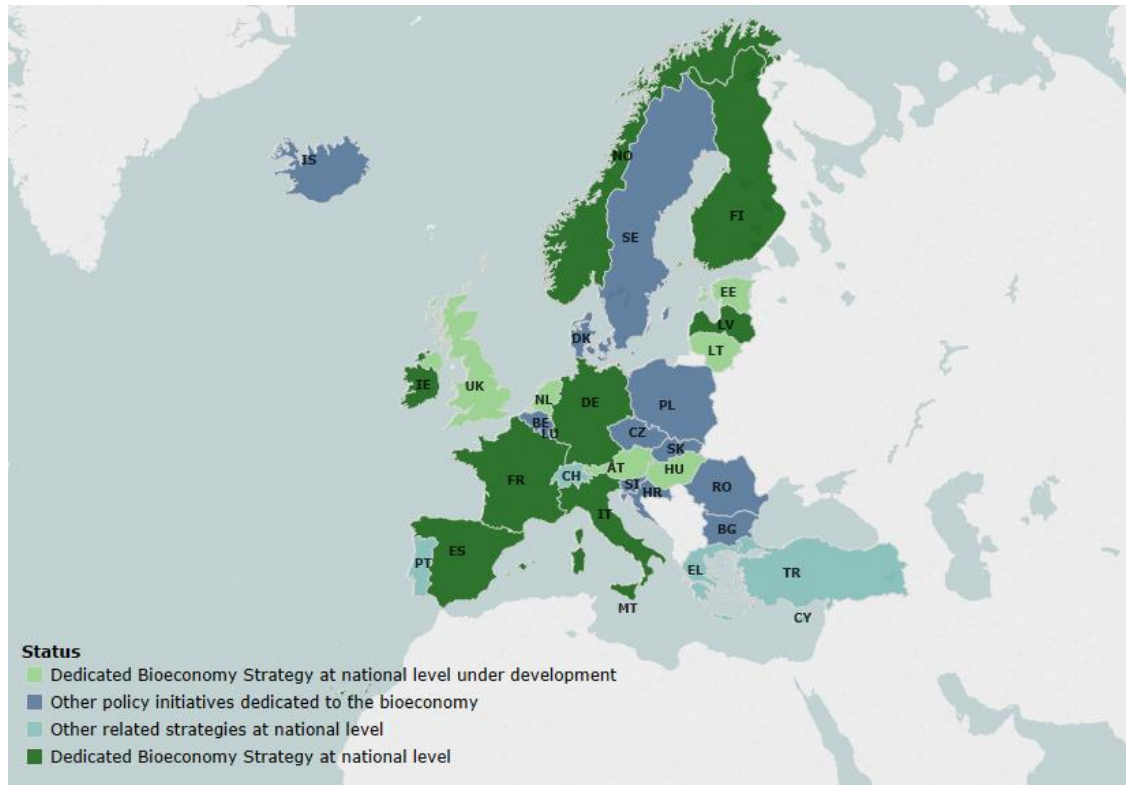


Figure 1.2 – Strategies and other policy initiatives dedicated to the bioeconomy in the Member States of the European Union (status as of March 2018).

In the following sections the outcomes of the survey research on bioeconomy policy developments are schematically summarized for the 28 Member States of the European Union and four H2020 Associated Countries (Iceland, Switzerland, Norway and Turkey).

## Germany

### National institutions involved in the bioeconomy

- Lead Ministry: Federal Ministry of Education and Research; Federal Ministry of Food and Agriculture.
- Other Ministry: Federal Ministry for Economic Affairs and Energy; Federal Ministry for Economic Cooperation and Development; Federal Ministry for Environment, Nature Conservation, Building and Nuclear Safety
- Other Institutions: Federal Office of Agriculture and Food; German Bioeconomy Council; National Contact Point Bioeconomy, Project Management Juelich, Fachagentur Nachwachsende Rohstoffe (FNR).

### National bioeconomy definition

Bioeconomy is the knowledge-based production and utilization of renewable resources in order to provide products, processes and services in all economic sectors, within the framework of an economic system that is viable for the future (National Research Strategy Bioeconomy 2030 [1]; National Policy Strategy on Bioeconomy; German Bioeconomy Council [2]).

### Status of national policies and bioeconomy

According to the bioeconomy progress report [3], German bioeconomy contributed 6% of the overall economic value added in 2010. The bioeconomy grew by 22% between 2002 and 2010, while the economy as a whole grew by 16%. If the weight of the bioeconomy is considered on the basis of the employment ratio, the significance of the bioeconomy is doubled compared to the value added, view National Policy Strategy on Bioeconomy.

### National bioeconomy strategy information

- Goals: 1) Secure supply of high-quality food; 2) Strengthening the transition from a fossil-based economy to an efficient economy based on renewable resources; 3) Sustainable supply of renewable resources while conserving biodiversity and soil fertility; 4) Protection of the climate; 5) Strengthening of Germany's innovative power and international competitiveness in business and research; 6) Securing and creating employment and value added, particularly in rural areas; and 7) Sustainable consumption
- Actions: Funding for Research and Innovation/Public - Private Partnership; Public procurement; and Labelling
- Sectors included: Agriculture; Aquaculture; Biobased chemicals and materials; Biobased textiles; Biofuels; Biotechnology; Fisheries; Food; Forestry; Organic waste; Pulp paper; and Wood, wood products and furniture
- Monitoring framework. Indicators for the monitoring: actions named in the strategies, success of RED projects
- Stakeholders involved: Academia; Consultants; Industry; NGO; and Public institutions, organization

Monitor programme, The Thünen Institut is still in charge to develop the basics for a Germany-wide monitoring system of current and future biomass flows and their evaluation. A comprehensive monitoring approach to measure the contribution of bioeconomy to the overall economy is currently under development through the project Systemic Monitoring and Modelling of the Bioeconomy

(SYMOBIO 10) [4] where one of the goal is the identification of economic key performance indicators to monitor the bioeconomy. The Systemic Monitoring and Modelling of the Bioeconomy (SYMOBIO) [4] project is coordinated by the Centre for Environmental Systems Research (CESR) of Kassel University and runs from March 2017 to February 2020. The main goal of the project is to develop the scientific fundamental for a systemic monitoring and modelling of bioeconomy in Germany.

### **Other national bioeconomy-related strategies**

Climate Action Plan 2050 [5] – Principles and goals of the German government's climate policy; German Resource Efficiency Programme II – Programme for the Sustainable use and conservation of natural resources; German Strategy for Sustainable Development; High-Tech Strategy; and National Strategy on Biological Diversity

### **Regional bioeconomy strategy**

Bavarian Bioeconomy Strategy (<https://www.bestellen.bayern.de>)

### **Other information**

- Bioeconomy funding programmes: Biobased industrial sector; Bioeconomy Research and Innovation; and Infrastructure investments
- Educational programmes on bioeconomy: not known
- National register bio-refineries or bio based industries: No
- National certification schemes for biomass and biobased products: Din-Geprüft (Biobased product); REDcert DE(Biofuel); ISCC DE(Biomass and Bioenergy)
- Incentives for biobased products: No

## France

### National institutions involved in the bioeconomy

- Lead Ministry: Ministry of Agriculture and Food; Ministry of Ecological Development and Development of Solidarity; Ministry of Economy; Ministry of Higher Education, Scientific Research and Innovation; and Ministry of Territorial Cohesion

- Other Ministry: No

- Other Institutions: French network of agricultural institutes; French network of food technology institutes; French Environment & Energy Management Agency; Research consortium for environment; French agriculture and fisheries agency; Higher education and research institutes in food and agriculture area; French bioeconomy cluster; French National Institute for Agricultural Research; National Research Institute of Science and Technology for Environmental and Agriculture; and other clusters (Axelera; Tennerdis; Xylofutur)

### National bioeconomy definition

The bioeconomy encompasses the whole range of activities linked to bioresource production, use and processing. The purpose of bioresources is to provide a sustainable response to the need of food and to part of society's requirements for materials and energy, as well as providing society with ecosystem services. Biobased products are defined as products deriving entirely or partially from bioresources.

### Status of national policies and bioeconomy

Dedicated Bioeconomy Action Plan: Bioeconomy Strategy – Action Plan (2017) [6]

Dedicated Bioeconomy Strategy at national level: National Bioeconomy Strategy (2017) [7]

### National bioeconomy strategy information

- Goals: 1) The bioeconomy strategy defines issues and goals but it doesn't define targets. The action plan will (goals: to guarantee food security and sustainable living standard for current and future generations by conserving natural resources and the ecosystematic functions of habitats); 2) to be efficient, resilient, circular and productive over the long term; 3) to focus on the general public and to be rooted in local regions, contributing to the development of economic value and jobs; and 4) to offer innovative solutions that are effective, affordable and capable of addressing the diversity of human needs

- Actions: Funding for Research and Innovation/Public - Private Partnership; Public procurement (e.g. reviewing article 144 of the Energy Transition, Law on Green Growth – LTECV, which will take also biobased characteristics into account); Labelling; and Other (communication; knowledge of resources; sustainability)

- Sectors included: Agriculture; Aquaculture; Biobased chemicals and materials; Biobased electricity; Biobased textiles; Biofuels; Biotechnology; Fisheries; Food; Forestry; Organic waste; Pulp, paper; Wood, wood products and furniture; and other (Ecosystem services)

- Monitoring framework: No

- Stakeholders involved: Academia; Industry; NGO; Public institutions, organization; and other (Agricultural and forest professions)

**Other national bioeconomy-related strategies**

Agroecology project for France (Plan d'action global pour l'agro-écologie – 2017); Food global conference (États Généraux de l'Alimentation); Forest and wood programme (Programme national de la forêt et du bois – 2016); Low carbon strategy (Stratégie Bas Carbone – 2017); The national strategy for the use of biomass; The national strategy of research.

**Regional bioeconomy strategy**

Not known

**Other information**

- Bioeconomy funding programmes: Biobased industrial sector; Bioeconomy Research and Innovation
- Educational programmes on bioeconomy: Education programme to produce better (Plan d'action "Enseigner à produire autrement"); Bioeconomy is identified by higher education programmes (e.g. AgroPerisTech; Agrocampus Ouest; Montpellier SupAgro; ENGEES; ENSAT; ENSAIA)
- National register bio-refineries or bio based industries: Biofuels; Forest production.
- National certification schemes for biomass and biobased products: No
- Incentives for biobased products: Reduced levy for biofuels; Regulated purchase price for the electricity produced using biogas and biomethane; Obligation of using biobased plastic bags for fruit and vegetables

## Italy

### National institutions involved in the bioeconomy

- Lead Ministry: Ministry of Economic Development; Presidency of the Council of Ministers
- Other Ministry: Ministry of Agricultural, Food and Forestry Policies; Ministry of Education, University and Research; Ministry of the Environment and Protection of Land and Sea
- Other Institutions: Agency for Territorial Cohesion; Association Chimica Verde Bionet; Conference of the Regions and Autonomous Provinces; Council for Agricultural Research and Economics; National Technological Cluster for Agrifood; National Technological Cluster of Green Chemistry

### National bioeconomy definition

The bioeconomy comprises those parts of the economy that use renewable biological resources from land and sea – such as crops, forests, fishes, animals and micro-organisms – to produce food, materials and energy (quoted from Europe's Bioeconomy Strategy, European Commission, 2012) (the National Bioeconomy Strategy) [8]. Thus, it includes primary production sector – such as agriculture, forestry, fisheries and aquaculture – and industrial sectors using and/or processing biological resources, such as the food and pulp and paper industries and parts of the chemical, biotechnological and energy industries. The bioeconomy refers to the set of economic activities relating to the invention, development, production and use of biological products, services and processes across four macro-sectors: 1 – Agrifood; 2 – Forestry; 3 – Biobased industry (bioenergy; biofuels; chemical intermediates); 4 – Marine

### Status of national policies and bioeconomy

Dedicated Bioeconomy Strategy at national level: National Strategy for Bioeconomy [8]

### National bioeconomy strategy information

- Goals: 1) Increasing circular economy; 2) Boosting sustainable locally routed growth; 3) Supporting alignment of EU, national, regional policies and regulations; 4) Reconciling technical progress with environmental conservation and ecosystems resilience; 5) Promoting knowledge-based activities and policy making; 6) Supporting cross-disciplinary education and training for researchers and technicians; 7) Catalyzing learning, education and technology transfer in bioeconomy; 8) Promoting bioeconomy in Mediterranean area; 9) Increase by 20% the current performance of the Italian Bioeconomy by 2030. i.e. from EUR 255 billion to EUR 306 billion of turnover and from 1.7 million to 2 million of jobs
- Actions: Funding for Research and Innovation/Public - Private Partnership; Public procurement (e.g. National Program for Waste Reduction); Labelling; and other (Creating a bioeconomy marketplace to match demand and supply of biomass, technology, and services; Revising education programs for new economic scenarios; Involving local administrations in defining strategies to create organic waste/matter value chains; Promoting and disseminating information on bioeconomy benefits; Valorising sustainable urban biowaste production; Supporting corporate social responsibility by proposing a framework for enterprises to highlight bioeconomy features)
- Sectors included: Agriculture; Aquaculture; Biobased chemicals and materials; Biobased electricity; Biobased textiles; Biofuels; Biotechnology; Fisheries; Food; Forestry; Organic waste; Pulp, paper; Wood, wood products and furniture; and other (Bio-energy; Bio-fertilizers, Bioplastics, Biopharma; Health)

- Monitoring framework. Indicators for the monitoring: 1) Key performance indicators (e.g. Agricultural biomass production; Firms/Employment/R&D; Employment/University courses in bioeconomy sectors; Patent trademark/design applications in bioeconomy sectors; Private/Public R&D expenditure; Import and Export of bioeconomy sectors related goods); 2) Key sustainability indicators (e.g. Change in food price volatility, freshwater availability, land use intensity, greenhouse emissions; Level of water pollution; Final energy consumption; Share of renewable energy; Air pollutants emissions)

- Stakeholders involved: Academia; Consultants; Industry; Public institutions, organization; and other (Farmers' representatives)

### **Other national bioeconomy-related strategies**

Environmental Annex to the Stability Law 2014; Green Public Procurement, National Action Plan; National Action Plan for renewable energy sources; National Biodiversity Strategy; National Marine Strategy; National Plan climate and energy; National Smart Specialization Strategy; Strategic action plan on innovation and research in agriculture, food and forestry sectors; Sustainable Development National Strategy; Towards a Model of Circular Economy for Italy

### **Regional bioeconomy strategy**

Smart specialization Strategies (S3) [9] – including aspects on Bioeconomy - from 21 regions and autonomous provinces.

### **Other information**

- Bioeconomy funding programs: Bioeconomy Research and Innovation

- Educational programs on bioeconomy: Master degree (Laurea magistrale) at the University of Florence; Master degree (Laurea magistrale) at the University of Rome "La Sapienza"; PhD Program at the University of Verona; Master (1<sup>st</sup> level) at the University of Foggia; International Master (2<sup>nd</sup> level) in Bioeconomy in the Circular economy by the Universities of Bologna; Milano "Bicocca", Naples "Federico II" and Turin; Scula@Novamont

- National register bio-refineries or bio based industries: Report on Bioeconomy in Europe, Intesa San Paolo

(<http://assobiotec.federchimica.it/docs/default-source/Event/3-convegno-sulla-bioeconomia-marzo-2017.pdf?sfvrsn=0>)

- National certification schemes for biomass and biobased products: BiomassPlus (for biofuels); ENplus (for pellet)

- Incentives for biobased products: Stability Law 2016. It extend until 2020 the incentives for production of electricity from biomass, biogas and bioliquids established by the Ministry of Economic Development. Decree of 06/07/2012 The regulation has been updated with the Ministry of Economic Development decree of 23/06/2016

## United Kingdom

### National institutions involved in the bioeconomy

Lead Ministry: Department for Business, Energy and Industrial Strategy; Scottish Government (Scotland); The Welsh Government

- Other Ministry: Department for Education; Department for Environment, Food and Rural Affairs; Department for International Trade; Department for Transport

- Other Institutions: Biotechnology and Biological Sciences Research Council; Highland and Islands Enterprise; IBioIC; Innovate UK; James Hutton Institute; Knowledge Transfer Network; Scottish Association for Marine Science; Scottish Enterprise; The Alliance of 5 Industry Councils; York Biovale

### National bioeconomy definition

UK's definition of bioeconomy is being developed as part of the creation of the UK Bioeconomy Strategy [10]. The current definition is: All economic activity derived from biobased products and processes which contribute to the sustainable and resource-efficient solutions to the challenges we face in food, chemicals, materials, energy production, health and environmental protection. The bioeconomy is the production of biomass (organic matter derived from living, or recently living organisms) and the conversion of renewable biological resources into value-added products, such as food, biobased products and bioenergy. In Scotland, it is about using biological resources or bioprocesses to make new products such as food, materials and energy as well as adding value to waste materials. Food waste is a significant source of carbon emissions; and a more circular approach to the beer, whisky and fish sectors alone could lead to potential savings of half a billion pounds per year. Extracting sugars from waste bread and turning into biofuel or beer are to practical examples of the bioeconomy in action. Projects already successfully working in the bioeconomy field in Scotland include CelluComp, a company turning nano fibres from root vegetables into an environmentally friendly thickener for paint; Argent Energy using waste fats and oils to convert into biofuel and Ogilvy Spirits, making vodka from potatoes not suitable for retail. This links in with Scotland's Circular Economy strategy [11] – Making Things Last and new strategy for manufacturing - A Manufacturing Future for Scotland launched by the First Minister in February 2016 [12] - clearly set out the economic opportunities of a more circular approach. From a business perspective, the circular economy agenda is one of innovation, seeking new ways to reduce our call on natural resources and keeping materials flowing through the economy at as high a value as possible for as long as possible. Remanufacturing alone has the potential to create an additional £620 million turnover and 5,700 new jobs by 2020. But it is the choices made by consumers – the public – that will ultimately determine success. At the forefront of my mind is the idea of "Making Things Last", and the potential for the reuse of goods and materials to help protect the environment, and deliver social and economic benefits to our communities.

### Status of national policies and bioeconomy

Dedicated Bioeconomy Strategy at national level under development. The initiative is led by industry and supported by the government.

### National bioeconomy strategy information

- Goals: Not known

- Actions: Not known

- Sectors included: Not known



- Monitoring framework. Not known

- Stakeholders involved: Not known

### **Other national bioeconomy-related strategies**

Industry decarbonisation roadmaps; Sustainable Agricultural Land Management Strategy (this includes Ecosystem Services); UK Synthetic Biology Strategic Plan 2016 [13]

### **Regional bioeconomy strategy**

Biorefining Roadmap [14]; Circular Economy; Draft climate strategy; Draft energy strategy; L&CS Strategy; Science and innovation audit report (North of England); The National Plan for Industrial Biotechnology 2015-2025.

### **Other information**

- Bioeconomy funding programmes: Biobased industrial sector; Bioeconomy Research and Innovation

- Educational programmes on bioeconomy: IBioIC skills programme for PhD studentship, MSc placements products and HND

- National register bio-refineries or bio based industries: No

- National certification schemes for biomass and biobased products: Not known

- Incentives for biobased products: Upcoming ISCF; Specific IUK calls; Renewable Heat Incentive; Waste management plant for England

## Spain

### National institutions involved in the bioeconomy

-Lead Ministry: Ministry of Agriculture, Fisheries, Food and Environment; Ministry of Economy, Industry and Competitiveness

- Other Ministry: Energy, Tourism and Digital Agenda

- Other Institutions: Bioeconomy Observatory; Centre for the Development of Industrial Technology; National Institute of Food and Agricultural Research & Technology; State Research Agency

### National bioeconomy definition

The bioeconomy is the set of economic activities that obtain products and services, generating economic value, making efficient and sustainable use of resources of biological origin as fundamental elements. Its objective is to produce and market food, along with forestry products, bioproducts and bioenergy obtained by physical, chemical, biochemical or biological processing of organic matter not destined for human or animal consumption and involving processes which are respectful of the environment, along with the development of rural areas [15]

### Status of national policies and bioeconomy

Concerning the strategy in 2016, the government also published a first action plan [16]. The research and innovation funding takes resources from European Union funds (H2020), other sources are taken by general state administration funds and regional administration funds. In 2016, the available funds were estimated to add up to EUR 230 million. The strategy document plans assign for bioeconomy a budget of EUR 1.1 billion (around USD 1.4 billion) up to 2020. Spain takes a comprehensive approach to integrate programs in the context of Rural Development, regional level and national bioeconomy, providing around EUR 696 million. Spanish strategy defines a mix of public R&I programs (around USD 860 million). Other actions concern public-private programs funded e.g. under Horizon2020, which provide EUR 570 million (around USD 704 million).

### National bioeconomy strategy information

- Goals: 1) To enhance the competitiveness and internationalization of Spanish companies; 2) To maintain the Spanish bioeconomy as an essential part of the national economic activity; 3) To assist in attaining all the bioeconomy's development potential to 2030 Operational Objectives; 4) To promote development of the bioeconomy; 5) To foster interaction between the public and private Spanish and international science and technology systems and the productive sectors

- Actions: Funding for Research and Innovation/Public - Private Partnership; Public procurement; and other (1 - Assessment and monitoring by the Spanish Bioeconomy Observatory, New indicators, both statistical and on sustainability, may be incorporated. Two types of evaluation index: Commitment and activity: measuring the related public and private investment and the number of activities; Results: evaluation of the economic importance of the sectors linked to biomass-use, and improvements. 2 - Education and public awareness)

- Sectors included: Agriculture; Aquaculture; Biobased chemicals and materials; Biobased electricity; Biobased textiles; Biofuels; Biotechnology; Fisheries; Food; Forestry; Organic waste; Pulp, paper; and Wood, wood products and furniture

- Monitoring framework. Indicators for the monitoring: 1) Final Production; 2) Added Value; 3) Employee numbers; and 4) Exports. However, the nation statistics system does not allow obtaining objective figures to the bioeconomy.

- Stakeholders involved: Academia; Industry; NGO; Public institutions, organizations; and other (Regional administrations and municipalities Technology Platforms and Associations)

### **Other national bioeconomy-related strategies**

Circular Economy (under preparation)

### **Regional bioeconomy strategy**

Andalusian Bioeconomy Strategy [17]; Aragon Bioeconomy Strategy (in preparation); Asturias Bioeconomy Strategy (in preparation); Castile-Leon Bioeconomy Strategy (in preparation); Catalonia Bioeconomy Strategy (pending publishing); Extremadura Bioeconomy Strategy (in preparation); Murcia Bioeconomy Strategy (in preparation); Valencia Bioeconomy Strategy (in preparation).

### **Other information**

- Bioeconomy funding programmes: Biobased industrial sector; Bioeconomy Research and Innovation; Infrastructure investments; and other (funding programmes are bottom-up, no specific target per sector)
- Educational programmes on bioeconomy: Some universities are developing a specific training programme based on Bioeconomy (under preparation)
- National register bio-refineries or bio based industries: Manual of biorefineries in Spain
- National certification schemes for biomass and biobased products: No
- Incentives for biobased products: No

## Poland

### National institutions involved in the bioeconomy

-Lead Ministry: Ministry of Agriculture and Rural Development; Ministry of Entrepreneurship and Technology; Ministry of Investment and Economic Development; Ministry of Science and Higher Education

- Other Ministry: Ministry of Energy, Ministry of Environment; Ministry of Maritime and Inland Waterway Transport

- Other Institutions: AgroBioCluster; Green Chemistry Cluster "West-Pomeranian Bioeconomy Cluster"; Institute of Soil Science and Plant Cultivation – State Research Institute; Klaster Life Science Kraków; Polish Bioeconomy Technological Platform

### National bioeconomy definition

No

### Status of national policies and bioeconomy

Poland participates in BIOEAST, a macro-regional bioeconomy initiative being developed by Central and Eastern European countries. Poland is also developing a Roadmap towards Circular Economy. Other parts focus on sustainable industrial production, sustainable consumption and new business models.

### National bioeconomy strategy information

- Goals: Not known

- Actions: Not known

- Sectors included: Not known

- Monitoring framework: Not known

- Stakeholders involved: Not known

### Other national bioeconomy-related strategies

BIOSTRATEG Strategic and Research program "Environment, Agriculture and Forestry"; Map towards Circular Economy (not approved yet); National Smart Specializations

### Regional bioeconomy strategy

Regional Innovation Strategy of Lubelskie Voivodeship 2020 Bioeconomy as a one of RIS; Regional smart specializations of Łódzkie Elements of Bioeconomy in RIS; Regional smart specializations of Warmińsko-Mazurskie Elements of Bioeconomy in RIS; Regional smart specializations of Wielkopolskie Elements of bioeconomy in RIS; Regional smart specializations of Zachodniopomorskie Bioeconomy as a one of RIS.

### Other information

- Bioeconomy funding programmes: Bioeconomy Research and Innovation

- Educational programmes on bioeconomy: Bioeconomy at the Biotechnology and Food Sciences Faculty at Lodz University of Technology; Bioeconomy – specialization lead in cooperation of three high schools: Warsaw University of Technology, Lodz University of Technology, and Military Technical Academy in Warsew;

Modern bioeconomy – specialization at the University of Life Science in Lublin

- National register bio-refineries or bio based industries: Not known
- National certification schemes for biomass and biobased products: Not known
- Incentives for biobased products: No

## The Netherlands

### National institutions involved in the bioeconomy

- Lead Ministry: Ministry of Agriculture
- Other Ministries: Ministry of Infrastructure and Water, Ministry of Economic Affairs and Climate
- Other Institutions: Bioeconomy Federation; Netherlands Enterprise Agency (RVO); Platform Bio Renewables Business; Wageningen Research

### National bioeconomy definition

In the Netherlands the bioeconomy is defined as in the EU Bioeconomy Strategy 2012. The biobased economy is a part of the bioeconomy particularly working with non-food production. The bioeconomy is the optimized agriculture and forestry for production of biomass for food and other applications in a sustainable way [18].

### Status of national policies and bioeconomy

A dedicated Bioeconomy Strategy at national level is under development. In the Netherlands, a number of strategies closely linked with the Bioeconomy exist. Specific to mention is the Transition Agenda Biomass and Food, within the Circular Economy Programme. A short document to connect these strategies is developed. Other national bioeconomy-related strategies also exist.

There are some funds supporting the Bioeconomy Strategy, Research and Technology, such as: the SME Innovation (MIT) Programme, aiming to strengthen the knowledge-based BBE through R&I, feasibility studies, R&D cooperation projects, innovation and performance contracts, networking and valorisation activities; and the TKI Biobased program, which facilitates the cascaded use of biomass, funding innovation projects on biorefinery and conversion. The Netherlands Enterprise Agency (RVO) supports BBE projects, including pioneering projects in biomass through the Programme for Sustainable Biomass (NPSB).

### National bioeconomy strategy information

- Goals: Not known yet
- Actions: Not known yet
- Sectors included: Not known yet
- Monitoring framework: developed for biobased economy:  
<https://www.rvo.nl/onderwerpen/duurzaam-ondernemen/groene-economie/biobased-economy/monitoring-biobased-economy/>

Stakeholders involved: Not known yet

### Other national bioeconomy-related strategies

Agenda for the food policy; Biomass Vision 2030; Circular Economy; Green Growth: for a strong, sustainable economy; Main line note Biobased Economy; National program on circular economy; The Biobased Economy in the Netherlands [19]

### Regional bioeconomy strategy

Biobased Delta.

**Other information**

- Bioeconomy funding programmes: Biobased industrial sector; Bioeconomy Research and Innovation; and Infrastructure investments
- Educational programmes on bioeconomy: Biobased Economy (Delft University of Technology); Centre of Expertise Biobased Economy at Wageningen University & Research; Materials for schools and universities
- National register biorefineries or bio based industries: Sustainable biomass for co-firing
- National certification schemes for biomass and biobased products: Better Biomass and Biobased Products
- Incentives for biobased products: Bioenergy by SDE+

R&D tax incentives designed to encourage companies to invest in R&D, such as the WBSO (R&D tax credit) scheme (Salaries Tax and Social Insurance Contributions Act [20], widely used for innovation grants, and the RDA subsidy (Research and Tax Deduction), which offers tax deduction from profit before taxes).

## Sweden

### National institutions involved in the bioeconomy

- Lead Ministry: Ministry of Enterprise; Ministry of Environment and Energy; Ministry of Finance
- Other Ministry: No
- Other Institutions: Environmental Protection Agency; Swedish Energy Agency

### National bioeconomy definition

Sustainable production of biomass to enable increased use in a number of social sectors [21]. The aim is to reduce climate impact and the use of fossil raw materials. Increased value added of biomass while minimizing energy consumption and nutrition and energy is taken from the end products. optimizing the value and contribution of ecosystem services to the economy.

### Status of national policies and bioeconomy

Other policy initiatives dedicated to the bioeconomy (Sweden participates in the 'Nordic Bioeconomy', a macro-regional bioeconomy initiative being developed by Nordic countries. A national Forest Programme also exists.).

### National bioeconomy strategy information

- Goals: Not known
- Actions: Not known
- Sectors included: Not known
- Monitoring framework: Not known
- Stakeholders involved: Not known

### Other national bioeconomy-related strategies

Forest program, 2016

### Regional bioeconomy strategy

Not known.

### Other information

- Bioeconomy funding programmes: Biobased industrial sector
- Educational programmes on bioeconomy: Not known
- National register bio-refineries or bio based industries: Not known
- National certification schemes for biomass and biobased products: Not known
- Incentives for biobased products: Reduction quota obligation for petrol and diesel



## **Ireland**

### **National institutions involved in the bioeconomy**

-Lead Ministry: Department of the Taoiseach (Prime Minister)

- Other Ministry: Committee on Finance, Public Expenditure and Reform, and Taoiseach; Department of Agriculture, Food & Marine

- Other Institutions: Bord Iascaigh Mhara; Enterprise Ireland; Environmental Protection Agency; Marine Institute; Science Foundation Ireland; Sustainable Energy Authority of Ireland; Teagasc (Teagasc led BioEIre project developing policy for the Irish bioeconomy); Tipperary County Council (proposed to establish a Bioeconomy Campus and Irish Bioeconomy Association); University College Dublin

### **National bioeconomy definition**

No

### **Status of national policies and bioeconomy**

Dedicated Bioeconomy Strategy at national level [22]

### **National bioeconomy strategy information**

- Goals: 1) Sustainable economy and society - Growing the bioeconomy can put Ireland's economy on a more sustainable footing by encouraging the efficient use and re-use of resources and materials to a much greater extent than hitherto; 2) Decarbonisation of the economy - the bioeconomy can play a part in lowering greenhouse gas emissions through, for example, the development of innovative practices and processes that can improve the efficiency in agriculture and forestry production systems. Bioprocessing and bio-refining can replace high embedded carbon products such as concrete, steel, plastics and chemicals with biobased alternatives and produce new products; 3) Jobs and Competitiveness - the bioeconomy can foster employment as many of the inputs for the bioeconomy are sourced nationally, so its development has a greater impact compared to other areas of the economy that are more reliant on imports. In this context, it is worth noting that as the agri-food and marine sector faces considerable uncertainties due to the prospect of Brexit, growing the bioeconomy represents an opportunity for this sector to diversify and reduce the risks confronting it; 4) Regional Prosperity - one of the advantages of the bioeconomy is that many of the businesses rooted in it are located in rural and coastal areas. Helping the bioeconomy to grow can assist in halting rural decline

- Actions: Funding for Research and Innovation/Public - Private Partnership; Public procurement; Labelling; and other (The Key actions are: 1 - Ensure that there is coherence between all sectoral strategies which impact on the bioeconomy in Ireland; 2 - Establish a network comprised of representatives of commercial entities operating within the bioeconomy and relevant public bodies to inform the future development of the bioeconomy. This network may make additional recommendations to be followed up "this could also include the sharing of best practice regarding applications for BBIJU, SC-2 and H2020 funding"; 3 - Encourage the translation of research into real world applications through promoting collaboration between research institutions "academia" and industry - through the use of pilots/demonstrations at the model demonstrator facilities "Lisheen site, the Marine Research Cluster in Connemara"; 4 - Assess the current legislative definition of waste and recommend whether a redesignation is necessary for residual waste flows to be successfully managed for use in the bioeconomy; 5 - Ensure greater sectoral coherence within the bioeconomy through the development of risk assessment and management protocols regarding the use of by-products which encourages the piloting of opportunities; 6 - Progress the leading value

chain propositions identified in the Bio-Eire project by establishing the conditions required for their commercial viability and how these might be fulfilled; and 7 - Examine how greater primary producer, public and consumer awareness of the bioeconomy and its products could be built up - through knowledge transfer, advisory, sustainable business models, public procurement, consumer awareness campaigns and product labelling initiatives etc.)

- Sectors included: Agriculture; Aquaculture; Biobased chemicals and materials; Biobased electricity; Biobased textiles; Biofuels; Biotechnology; Fisheries; Food; Forestry; Organic waste; Pulp, paper; Wood, wood products and furniture; and other (consultants)

- Monitoring framework: No

- Stakeholders involved: Academia; Industry; NGO; Public institutions, organizations; and other (A high-level Implementation Group - jointly chaired by the Departments of Agriculture, Food and Marine and Communications, Climate Action and Environment - will establish a forum and network to liaise with relevant industry bodies within the bioeconomy. It will also be necessary to liaise closely with other leading stakeholders in the bioeconomy such as state bodies and community groups. The Irish Bioeconomy Foundation has been established as a vehicle to bring together relevant stakeholders with an interest in establishing a National Bioeconomy Hub to be co-located with the Bioeconomy innovation and piloting facility at Lisheen, Co. Tipperary)

### **Other national bioeconomy-related strategies**

Action Plan for Jobs; Action Plan for Rural Development; Food Wise 2025; National Climate Mitigation Plan; National Development Plan – Innovation 2020; National Planning Framework; Sustainable Development

### **Regional bioeconomy strategy**

Ireland's three Regional Spatial and Economic Strategies based on national planning framework (in preparation)

### **Other information**

- Bioeconomy funding programmes: Infrastructure investments; and other (Enterprise Irelands Rural Competitiveness Funds; Science Foundation Irelands Research Centres; Department of Agriculture, Food & Marine R&I funding programmes; EPA R&I funding programmes; SEAI R&I funding programmes)

- Educational programmes on bioeconomy: No

- National register bio-refineries or bio based industries: Carbery Biorefinery West Cork in place since 1979; AgriChemWhey biorefinery Lisheen Co. Tipperary is being built; Pilot biorefineries: Lisheen being built at present; BioMarine Ingredients pilot biorefinery Lough Egish Co. Monaghan

- National certification schemes for biomass and biobased products: Origin Green

- Incentives for biobased products: Draft Bioenergy plan; Renewable Heat Incentive scheme including bioenergy; Biofuels

## Belgium

### National institutions involved in the bioeconomy

- Lead Ministry: Not known
- Other Ministry: Not known
- Other Institutions: AWEX (Coq vert partner); Essenscia Wallonie (Coq vert partner); Flanders, department of Agriculture and Fisheries; Flanders, department of Economy, Science and Innovation; Flanders, department of Environment; Flanders, Interministerial BioEconomy Working Group; Government Walloon. Agriculture; Government Walloon Economy; Government Walloon Energy; GreenWin (Coq vert partner. "Coq vert" is an initiative that was launched in 2013 by a public-private partnership between the GreenWin cluster, the AWEX-Foreign investment and ValBiom, in partnership with Essenscia-Wallonie. Through this project, the partners plan to make a significant contribution to the development of a strong, competitive biobased economy in Wallonia by encouraging new projects that are vital to the growth of the biosourced chemistry industry, and plant chemistry in particular. More information: <http://www.coqvert.be/en>); OEWB (Coq vert partner); and ValBiom (Coq vert partner).

### National bioeconomy definition

Flanders uses the European definition in its official vision and strategy [23]. The bioeconomy includes both the production of renewable biological resources and the use of those resources and residual streams. These are used in (for example environmental/biotechnological) processes and are processed into valuable products such as food, animal feed, (biobased) products and bioenergy. More specifically, the bioeconomy includes, among others, the following sectors: agriculture, forestry, fishing, the food industry, the wood-processing sector, the pulp and paper industry, the environmental technology sector, the construction and infrastructure sector, the energy sector and industrial sectors such as the textile industry, the chemical industry (including the pharmaceutical sector) and the biotechnology sector, and finally the end-user/consumer and the logistics sector (recycling and waste collection). In a nutshell, the bioeconomy therefore includes all activities associated with the production of biomass and the various ways in which this biomass and its residual streams are subsequently used. The biobased economy is not explicitly defined in the European strategy, but following the logic of the abovementioned definition, it is that part of the bioeconomy in which biobased products and materials are made and biomass is used in processes

### Status of national policies and bioeconomy

Other policy initiatives dedicated to the bioeconomy (In Belgium, subnational bioeconomy strategies exist "Flemish region" and being developed "Walloon region". A national strategy on bioenergy/renewable energy also exists)

### National bioeconomy strategy information

- Goals: Not known
- Actions: Not known
- Sectors included: Not known
- Monitoring framework: Not known
- Stakeholders involved: Not known

## **Other national bioeconomy-related strategies**

Bioenergy/renewable energy, 2010

## **Regional bioeconomy strategy**

Bioenergy in Flanders; Biomass to energy; Circular Economy strategy; Memorandum "Stimulating investments in bioeconomy in Wallonie (6MDR) – DRAFT; Stratégie de développement d'une économie biobasée en Wallonie – DRAFT; There are a few independent bioeconomy strategies formulated from research organizations such as VITO, ILVO, UGent

## **Other information**

- Bioeconomy funding programmes: Infrastructure investments; and other (Wallonia: Industries can obtain grants or loans for R&D or investment. There isn't specific regional call for the bioeconomy. Each year, the Walloon Government issues calls for projects to Innovative Clusters, and "Sustainable chemistry" is one of the 3 axis of GreenWin innovation cluster. Flanders: ERDF investment Interreg programme, e.g. development Biobase Europe pilot plant. Flanders does not have specific funding programmes for specific sectors. Projects proposals from different sectors can apply for calls from the research and innovation budget e.g. via Vlaio "innovation and entrepreneurship funding agency")

- Educational programmes on bioeconomy: ULiège-GxABT; UCL; ULB UMONS

- National register bio-refineries or bio based industries: Biobased companies in Wallonia; CEEBIO database "a database containing information on R&D projects, public and private actors/stakeholders in BioEconomy in Flanders

- National certification schemes for biomass and biobased products: Vegaplan; PEFC Belgium

- Incentives for biobased products: Green certificates (for green electricity); Investment subsidy for "energy sustainable use"; R&D cash advance scheme for R&D and pilot plants

## Austria

### National institutions involved in the bioeconomy

-Lead Ministry: Not known

- Other Ministry: Ministry of Sustainable and Tourism; Ministry for Transport, Innovation and Technology; Ministry for Digital and Economic Affairs; Ministry of Labour, Social Affairs, Health and Consumer Protection

- Other Institutions: Austrian Society for Environment and Technology; Bioeconomy Austria – BIOS Science Austria; Environment Agency Austria

### National bioeconomy definition

Step by step fossil resources will be replaced by renewable raw materials in order to provide new products, services and energy. Furthermore, waste matter is used again in the value cycle [24]. In the processes for bioeconomy policies/strategies more comprehensive definitions are discussed.

### Status of national policies and bioeconomy

Dedicated Bioeconomy Strategy at national level under development (In Austria, a dedicated Bioeconomy Strategy at national level is under development. Other national bioeconomy-related strategies also exist)

### National bioeconomy strategy information

- Goals: Not known

- Actions: Not known

- Sectors included: Not known

- Monitoring framework: Not known

- Stakeholders involved: Not known

### Other national bioeconomy-related strategies

Austrian Forest Strategy 2020+; Federal Waste Management Plan; NSTRAT – federal sustainable development strategy; ÖSTRAT – SDS of the province and the federation; Research Agenda Biobased Industry; RESET2020 – Resource Efficiency Initiative; RTI – Strategy for the biobased industry in Austria; Waste Prevention Programme

### Regional bioeconomy strategy

Not known

### Other information

- Bioeconomy funding programmes: Biobased industrial sector; Bioeconomy Research and Innovation and Infrastructure investments

- Educational programmes on bioeconomy: Master's degree programme Biorefinery Engineering at Technical University Graz

- National register bio-refineries or bio based industries: Not known

- National certification schemes for biomass and biobased products: PEFC; Certification of biomass (fuel, waste, etc.)
- Incentives for biobased products: Ökostromgesetz 2012; Rural Development Program – Support for the production of renewable energy, of photovoltaic in agriculture

## Finland

### National institutions involved in the bioeconomy

- Lead Ministry: Ministry of Economic Affairs and Employment; Ministry of Agriculture and Forestry; Ministry of Environment
- Other Ministry: Ministry of Education and Culture; Ministry of Transport and Communications
- Other Institutions: Not known

### National bioeconomy definition

Bioeconomy refers to an economy that relies on renewable natural resources to produce food, energy, products and services. The bioeconomy will reduce our dependence on fossil natural resources, prevent biodiversity loss and create new economic growth and jobs in line with the principles of sustainable development. The bioeconomy is not a new industry; it is a combination of several primary production and refining sectors and end product markets. Typical features of the bioeconomy include the use of renewable, biobased natural resources, environmentally friendly clean technologies and efficient recycling of materials. It is justified to refer to the transition from a fossil economy to a bioeconomy as the new wave of economic development [25]

### Status of national policies and bioeconomy

Dedicated Bioeconomy Strategy at national level [25]

### National bioeconomy strategy information

- Goals: 1) The objective of the Finnish Bioeconomy Strategy is to generate new economic growth and new jobs from an increase in the bioeconomy business and from high added value products and services while securing the operating conditions for the nature's ecosystems; 2) To push our bioeconomy output up to EUR 100 billion by 2025 (from 60 bill. in 2011); 3) To create 100,000 new jobs
- Actions: Funding for Research and Innovation/Public - Private Partnership; and Public procurement
- Sectors included: Agriculture; Aquaculture; Biobased chemicals and materials; Biobased electricity; Biobased textiles; Biofuels; Biotechnology; Fisheries; Food; Forestry; Organic waste; Pulp, paper; and Wood, wood products and furniture
- Monitoring framework. Indicators for the monitoring: 1) Growth of bioeconomy and its significance in the national economy "Bioeconomy output/value added/the number employed and their share in the national economy"; 2) Added value produced for natural resource use "Raw material input/value added to raw material streams"
- Stakeholders involved: Academia; Consultants; Industry; NGO; and Public institutions, organizations

### Other national bioeconomy-related strategies

Business Finland program Bionet

### Regional bioeconomy strategy

Not known

**Other information**

- Bioeconomy funding programmes: Biobased industrial sector; Bioeconomy Research and Innovation
- Educational programmes on bioeconomy: Yes
- National register bio-refineries or bio based industries: Not known
- National certification schemes for biomass and biobased products: Not known
- Incentives for biobased products: Mandatory quota of biocomponent in traffic fuels



## Denmark

### National institutions involved in the bioeconomy

- Lead Ministry: Ministry of Environment and Food
- Other Ministry: Ministry of Energy, Utilities and Climate; Ministry of Higher Education and Science; Ministry of Industry, Business and Financial Affairs
- Other Institutions: Biomasseforum; BioValue; INBIOM; The National Bioeconomy Panel

### National bioeconomy definition

The Danish Government adheres to the definition of bioeconomy outlined by the EU Commission. From the Danish version of the "Government's growth plan for water, bio and environmental solutions" [26]: "Rising food shortages as a result of increasing population growth and pressure on arable land means that we must use our biological resources far more effectively. Therefore the biobased solutions - or the bioeconomy - play a vital part of the green transition Denmark and the rest of the world need. Bioenergy is what most people have heard of. But the potentials of the bioeconomy are broader than that. The potential for biobased solutions are found in areas such as food, energy and the textile sector as well as in the chemical, pharmaceutical and biotech industries". Bioeconomy is also defined as "(societal) economy, where the basic building blocks used for the production of energy, chemicals and materials derive from renewable biological resources from plants and animal residues. The products include, for example, foods (and food ingredients), feed (and feed ingredients), biobased products (biomass-based chemicals, biomaterials, etc.) and bioenergy. Research and development are an important part of developing the bioeconomy value chains".

### Status of national policies and bioeconomy

Other policy initiatives dedicated to the bioeconomy (Denmark participates in the 'Nordic Bioeconomy', a macro-regional bioeconomy initiative being developed by Nordic countries. The Danish Government also published a growth plan for water, bio and environmental solutions in March [26]

### National bioeconomy strategy information

- Goals: Not known
- Actions: Not known
- Sectors included: Not known
- Monitoring framework: Not known
- Stakeholders involved: Not known

### Other national bioeconomy-related strategies

Government's plan for growth for water, bio and environmental solutions, 2013; Research 2025

### Regional bioeconomy strategy

Not known

**Other information**

- Bioeconomy funding programmes: Bioeconomy Research and Innovation; Infrastructure investments; and other (Environmental Technology Development and Demonstration Program - MUDP; Energy Technology Development and Demonstration Program - EUDP; Green Development and Demonstration Program - GUDP; BioValue Spir; Bioeconomy programme of Central Denmark Region)
- Educational programmes on bioeconomy: Not known
- National register bio-refineries or bio based industries: No
- National certification schemes for biomass and biobased products: Industry agreement to secure sustainable biomass (wood pellets and wood chips)
- Incentives for biobased products: Environmental Technology Development and Demonstration Program (MUDP); Energy Technology Development and Demonstration Program (EUDP); Green Development and Demonstration Program (GUDP); The Danish Green Investment Fund

## Portugal

### National institutions involved in the bioeconomy

-Lead Ministry: Ministry of Economy; Ministry of Environment

- Other Ministry: Ministry of Agriculture, Forestry and Rural Development; Ministry of Science, Technology & Higher Education; Ministry of Sea

- Other Institutions: Association for the Bioeconomy and Circular Economy; Coalition for Green Growth; ECO.NOMIA portal; Iberoamerican Society for the Development of Biorefineries

### National bioeconomy definition

No

### Status of national policies and bioeconomy

Other relevant strategies at national level

### National bioeconomy strategy information

- Goals: Not known

- Actions: Not known

- Sectors included: Not known

- Monitoring framework: Not known

- Stakeholders involved: Not known

### Other national bioeconomy-related strategies

Agri-food & Forestry R&I Strategy 2014-2020; Circular Economy Action Plan; National Forest Strategy; National Ocean Strategy 2013-2020; Portuguese Strategy for Smart Specialization (RIS3)

### Regional bioeconomy strategy

Not known

### Other information

- Bioeconomy funding programmes: Not known

- Educational programmes on bioeconomy: Bachelor's degree in bio-industry management

- National register bio-refineries or bio based industries: Not known

- National certification schemes for biomass and biobased products: Certification wood pellets

- Incentives for biobased products: Buy from Portugal; Sustainable procurement (some municipalities do have this strategy in place); Biomethane support (an incentive "tax relief or alike" for biomethane is envisaged in the short term)

## Greece

### National institutions involved in the bioeconomy

-Lead Ministry: Not known

- Other Ministry: Hellenic Agricultural Organization (HAO) DIMITER; Center for Renewable Energy; General Secretariat of Research and Innovation (Under the Ministry of Education)

- Other Institutions: Greek Bioeconomy Forum; National Bioeconomy Network; The Bio-energy and Environment Cluster of Western Macedonia (CLuBE)

### National bioeconomy definition

Bioeconomy is considered as a new production system, where the needs for fuel, food and feed are covered by renewable organic sources. Bioeconomy in Greece is supported under different thematic areas within RIS3 (Smart Specialization Strategies), for example in energy, environment and waste management. Regional strategies focusing on bioeconomy are being implemented actively in the region of Western Macedonia, which is one of the biggest energy producing regions in the country. Efforts on bioeconomy development focus primarily on the development of bioenergy from agricultural and forest residues. Specific actions include the adoption of new technology to allow exploitation of biomass resources in co-firing mode in existing large-scale power stations, notably lignite-fired, and the enhanced deployment of interconnected medium and small-scale renewable energy generation facilities including biogas

(<https://www.degruyter.com/downloadpdf/j/ebtj.2018.2.issue-3/ebtj-2018-0018/ebtj-2018-0018.pdf>)

### Status of national policies and bioeconomy

Other relevant strategies at national level

### National bioeconomy strategy information

- Goals: Not known

- Actions: Not known

- Sectors included: Not known

- Monitoring framework: Not known

- Stakeholders involved: Not known

### Other national bioeconomy-related strategies

National Climate Change Adaptation Strategy; National RIS for Smart Specialization (Part 5.4 on Energy; Part 5.5 on Environment and Sustainable Development); National Strategy Framework for Research and Innovation; The Rural Development Programme 2014-2020

### Regional bioeconomy strategy

Not known

**Other information**

- Bioeconomy funding programmes: Not known
- Educational programmes on bioeconomy: MSc Bioeconomics
- National register bio-refineries or bio based industries: Not known
- National certification schemes for biomass and biobased products: No
- Incentives for biobased products: No

## Romania

### National institutions involved in the bioeconomy

- Lead Ministry: Ministry of Agriculture and Rural Development; Ministry of Economy; Ministry of Water and Forests

- Other Ministry: Ministry of Energy; Ministry of Health; Ministry of Research and Development

- Other Institutions: "Bioeconomy" Commissions of the Consultative Body for Research-Development and Innovation (belong to the Ministry of Research and Innovation); Agro Transylvania cluster (food & feed) (2017, Country Report for Romania – DanuBioValNet project – Interreg Danube Transnational Programme); AgroFood Regional Cluster (food & feed) (2017, Country Report for Romania – DanuBioValNet project – Interreg Danube Transnational Programme); BIOGAS INNO cluster (renewable energies) (2017, Country Report for Romania – DanuBioValNet project – Interreg Danube Transnational Programme); Green Energy cluster (renewable energies) (2017, Country Report for Romania – DanuBioValNet project – Interreg Danube Transnational Programme); IND-AGRO-POL cluster (competitiveness pole) – one of addressed sector is bioeconomy (2017, Country Report for Romania – DanuBioValNet project – Interreg Danube Transnational Programme); PROWOOD cluster (primary biomass sector) (2017, Country Report for Romania – DanuBioValNet project – Interreg Danube Transnational Programme); ROSEC cluster (Renewable energies) (2017, Country Report for Romania – DanuBioValNet project – Interreg Danube Transnational Programme)

### National bioeconomy definition

No

### Status of national policies and bioeconomy

Other policy initiatives dedicated to the bioeconomy (Romania participates in BIOEAST, a macro-regional bioeconomy initiative being developed by Central and Eastern European countries)

### National bioeconomy strategy information

- Goals: Not known

- Actions: Not known

- Sectors included: Not known

- Monitoring framework: Not known

- Stakeholders involved: Not known

### Other national bioeconomy-related strategies

Romanian RDI Strategy for 2014-2020; Romanian Strategy for Competitiveness 2014-2020; Smart specialization domains financed by structural funds within Competitiveness Operational Programme 2014-2020; Strategy for the development of the agri-food sector on average and long-term 2020-2030

### Regional bioeconomy strategy

Not known

**Other information**

- Bioeconomy funding programmes: Bioeconomy Research and Innovation; and Infrastructure investments
- Educational programmes on bioeconomy: Master in Biofuels, bio-refineries and related technologies
- National register bio-refineries or bio based industries: Not known
- National certification schemes for biomass and biobased products: "Ecological agriculture" label (synonym to organic or bio)
- Incentives for biobased products: Subsidies for organic food products

## **Czech-Republic**

### **National institutions involved in the bioeconomy**

- Lead Ministry: Ministry of Agriculture and Food
- Other Ministry: Ministry of Industry and Trade; Ministry of the Environment
- Other Institutions: Czech University of Life Sciences Praha; University of South Bohemia – Bioeconomy platform

### **National bioeconomy definition**

No

### **Status of national policies and bioeconomy**

Other policy initiatives dedicated to the bioeconomy (Czech Republic participates in BIOEAST, a macro-regional bioeconomy initiative being developed by Central and Eastern European countries. An overarching strategy on sustainable development also exists)

### **National bioeconomy strategy information**

- Goals: Not known
- Actions: Not known
- Sectors included: Not known
- Monitoring framework: Not known
- Stakeholders involved: Not known

### **Other national bioeconomy-related strategies**

Strategic Framework Czech Republic 2030

### **Regional bioeconomy strategy**

Not known

### **Other information**

- Bioeconomy funding programmes: No
- Educational programmes on bioeconomy: Forestry bioeconomy; Education and Research
- National register bio-refineries or bio based industries: No
- National certification schemes for biomass and biobased products: No
- Incentives for biobased products: Act on Support Energy Source No. 165/2012 Coll. (biomass); Support Woodworker; Supported renewable energy sources Energy Regulatory Office – new decision on financial support for RES as of September 2017



## Hungary

### National institutions involved in the bioeconomy

- Lead Ministry: Ministry of Agriculture
- Other Ministry: Not known
- Other Institutions: Not known

### National bioeconomy definition

No

### Status of national policies and bioeconomy

Dedicated Bioeconomy Strategy at national level under development (In Hungary, a dedicated Bioeconomy Strategy at national level is under development. Hungary also participates in BIOEAST, a macro-regional bioeconomy initiative being developed by Central and Eastern European countries)

### National bioeconomy strategy information

- Goals: Not known
- Actions: Not known
- Sectors included: Not known
- Monitoring framework: Not known
- Stakeholders involved: Not known

### Other national bioeconomy-related strategies

Medium and long-term food industry development strategy 2014-2020

### Regional bioeconomy strategy

Not known

### Other information

- Bioeconomy funding programmes: Infrastructure investments
- Educational programmes on bioeconomy: No
- National register bio-refineries or bio based industries: Not known
- National certification schemes for biomass and biobased products: Not known
- Incentives for biobased products: No

## **Slovakia**

### **National institutions involved in the bioeconomy**

- Lead Ministry: Not known
- Other Ministry: Not known
- Other Institutions: Bioeconomy Cluster (Mainly beneficiary in international projects)

### **National bioeconomy definition**

No formal definition

### **Status of national policies and bioeconomy**

Other policy initiatives dedicated to the bioeconomy (Slovakia participates in BIOEAST, a macro-regional bioeconomy initiative being developed by Central and Eastern European countries)

### **National bioeconomy strategy information**

- Goals: Not known
- Actions: Not known
- Sectors included: Not known
- Monitoring framework: Not known
- Stakeholders involved: Not known

### **Other national bioeconomy-related strategies**

Not known

### **Regional bioeconomy strategy**

Not known

### **Other information**

- Bioeconomy funding programmes: Not known
- Educational programmes on bioeconomy: Not known
- National register bio-refineries or bio based industries: No
- National certification schemes for biomass and biobased products: No
- Incentives for biobased products: No

## Bulgaria

### **National institutions involved in the bioeconomy**

- Lead Ministry: Not known
- Other Ministry: Not known
- Other Institutions: Not known

### **National bioeconomy definition**

No

### **Status of national policies and bioeconomy**

Other policy initiatives dedicated to the bioeconomy (Bulgaria participates in BIOEAST, a macro-regional bioeconomy initiative being developed by Central and Eastern European countries)

### **National bioeconomy strategy information**

- Goals: Not known
- Actions: Not known
- Sectors included: Not known
- Monitoring framework: Not known
- Stakeholders involved: Not known

### **Other national bioeconomy-related strategies**

Not known

### **Regional bioeconomy strategy**

Not known

### **Other information**

- Bioeconomy funding programmes: Not known
- Educational programmes on bioeconomy: Not known
- National register bio-refineries or bio based industries: Not known
- National certification schemes for biomass and biobased products: Not known
- Incentives for biobased products: Not known

## Croatia

### National institutions involved in the bioeconomy

-Lead Ministry: Ministry of Agriculture, Ministry of Economy, Labour and Entrepreneurship; Ministry of Science and Education

- Other Ministry: Ministry of Environment and Energy; Ministry of Regional Development and EU Funds; Ministry of the sea, transport and infrastructure; Ministry of tourism

- Other Institutions: Agency for Investments and Competitiveness; Ruđer Bošković Institute; University of Osijek; University of Zagreb

### National bioeconomy definition

No (Bioeconomy strategy has not yet been created. Based on Croatia's Smart specialization Strategy (2016-2020) [27] the term "bioeconomy" can be defined as economy that comprises primary agriculture, fishery, and aquaculture and other economies that use renewable biological resources from land and sea)

### Status of national policies and bioeconomy

Other policy initiatives dedicated to the bioeconomy (Croatia participates in BIOEAST, a macro-regional bioeconomy initiative being developed by Central and Eastern European countries. Other national bioeconomy-related strategies also exist)

### National bioeconomy strategy information

- Goals: Not known

- Actions: Not known

- Sectors included: Not known

- Monitoring framework: Not known

- Stakeholders involved: Not known

### Other national bioeconomy-related strategies

National Strategic Plan for Aquaculture Development – Draft; Rural Development Programme; Smart Specialization Strategy and Action Plan

### Regional bioeconomy strategy

Not known

**Other information**

- Bioeconomy funding programmes: other (Croatian Science Foundation provides support to scientific, higher education and technological programmes and projects, fosters international cooperation, and helps the realization of scientific programmes of special interest in the field of fundamental, applied and developmental research)
- Educational programmes on bioeconomy: No
- National register bio-refineries or bio based industries: Croatian Chamber of Economy – Register of Business Entities
- National certification schemes for biomass and biobased products: Agency for Investments and Competitiveness
- Incentives for biobased products: No

## Lithuania

### **National institutions involved in the bioeconomy**

-Lead Ministry: Ministry of Agriculture of Republic of Lithuania; Ministry of Economy of Republic of Lithuania, Industry of Education and Science

- Other Ministry: Not known

- Other Institutions: Not known

### **National bioeconomy definition**

No

### **Status of national policies and bioeconomy**

Dedicated Bioeconomy Strategy at national level under development (In Lithuania, a dedicated Bioeconomy Strategy at national level is under development. Lithuania also participates in "Bioeconomy in the Baltic Sea Region", a macro-regional bioeconomy initiative being developed by Baltic sea countries)

### **National bioeconomy strategy information**

- Goals: Not known

- Actions: Not known

- Sectors included: Not known

- Monitoring framework: Not known

- Stakeholders involved: Not known

### **Other national bioeconomy-related strategies**

Not known

### **Regional bioeconomy strategy**

Not known

### **Other information**

- Bioeconomy funding programmes: Not known

- Educational programmes on bioeconomy: No

- National register bio-refineries or bio based industries: No

- National certification schemes for biomass and biobased products: No

- Incentives for biobased products: No

## Latvia

### National institutions involved in the bioeconomy

-Lead Ministry: Ministry of Agriculture of the Republic of Latvia

- Other Ministry: Ministry of Economics of the Republic of Latvia; Ministry of Education and Science of the Republic of Latvia

- Other Institutions: Forest and Wood Products Research and Development Institute (MeKA); Institute of Agriculture Resources and Economics; Institute of Food Safety, Animal Health and Environment "BIOR"; Institute of Horticulture; Latvia University of Life Sciences and Technologies; Latvia Plant Protection Research Centre; Latvia State Forest Research Institute "Silava"; Latvia State Institute of Wood Chemistry

### National bioeconomy definition

Bioeconomy covers those parts of economy where renewable bio-resources (plants, animals, microorganisms etc.) are used in the production of food, feed, industrial products and energy in a sustainable and well-considered way (Source: Bioeconomy is defined in the Latvian Bioeconomy Strategy 2030) [28]. The definition is based on the EU definition provided by the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions "Innovating for Sustainable Growth: A Bioeconomy for Europe"

### Status of national policies and bioeconomy

Dedicated Bioeconomy Strategy at national level (Latvian Bioeconomy Strategy 2030) [28]

### National bioeconomy strategy information

- Goals: 1) Advancement and retention of employment in the bioeconomy sectors for 128 thousand people; 2) Increasing the value added of bioeconomy products to at least EUR 3.8 billion in 2030; 3) Increasing the value of bioeconomy production exports to at least EUR 9 billion in 2030

- Actions: Funding for Research and Innovation/Public - Private Partnership; Public procurement (Wood for construction of public buildings, organically certified products, environmentally-friendly packaging or locally produced products); and other (Achieving the goals of the Bioeconomy Strategy involves five key integrated and complementary lines of action: 1 - Attractive business environment for the entrepreneurship in bioeconomy; 2 - Result-oriented, efficient and sustainable resource management; 3 - Knowledge and innovation development in bioeconomy; 4 - Promotion of production in bioeconomy; 5 - Socially responsible and sustainable development. Nevertheless, it is important to note that the Strategy does not include an action plan)

- Sectors included: Agriculture; Aquaculture; Biobased chemicals and materials; Biobased electricity; Biobased textiles; Biofuels; Biotechnology; Fisheries; Food; Forestry; Organic waste; and Wood, wood products and furniture

- Monitoring framework: No

- Stakeholders involved: Academia; Industry; NGO; and Public institutions, organizations

### Other national bioeconomy-related strategies

Bioeconomy Research Strategy (not published); National Development Plan of Latvia for 2014-2020; Sustainable Development Strategy of Latvia until 2030

**Regional bioeconomy strategy**

Vidzeme Planning Region (in preparation)

**Other information**

- Bioeconomy funding programmes: Infrastructure investments
- Educational programmes on bioeconomy: Joint master's degree programme – Agri-Food Business Management
- National register bio-refineries or bio based industries: No
- National certification schemes for biomass and biobased products: No
- Incentives for biobased products: Differentiation of VAT for food (reduced VAT for fruits and vegetables characteristic for Latvia)



## Slovenia

### National institutions involved in the bioeconomy

- Lead Ministry: Ministry of Agriculture, Forestry and Food; Ministry of Economic Development and Technology; Ministry of Education, Science and Sport
- Other Ministry: Ministry of the environment and spatial planning
- Other Institutions: Not known

### National bioeconomy definition

The term "bioeconomy" is defined according to the Commission's interpretation [29], which means an economy that uses biological resources from land, as well as from waste, sea and raw materials, for food and feed, in industrial production and in the production of energy. It also includes the use of biological processes for sustainable industries

### Status of national policies and bioeconomy

Other policy initiatives dedicated to the bioeconomy (Slovenia participates in BIOEAST, a macro-regional bioeconomy initiative being developed by Central and Eastern European countries. Other national bioeconomy-related strategies also exist)

### National bioeconomy strategy information

- Goals: Not known
- Actions: Not known
- Sectors included: Not known
- Monitoring framework: Not known
- Stakeholders involved: Not known

### Other national bioeconomy-related strategies

Slovenia's Smart Specialization Strategy; Strategy for exploiting biomass from agriculture and health care for energy purposes

### Regional bioeconomy strategy

Not known

### Other information

- Bioeconomy funding programmes: other (BioEconomy related funding programs are part of Smart Specialization strategy)
- Educational programmes on bioeconomy: Bioeconomics (Biotechnical Faculty)
- National register bio-refineries or bio based industries: No
- National certification schemes for biomass and biobased products: Not known
- Incentives for biobased products: No

## Estonia

### National institutions involved in the bioeconomy

-Lead Ministry: Ministry of Economy Affairs and Communications; Ministry of Rural Affairs; Ministry of Environment

- Other Ministry: Ministry of Education and Research

- Other Institutions: Estonia Research Council

### National bioeconomy definition

Bioeconomy covers almost all industrial and economic sectors. Mostly, however, it is based on agriculture, fisheries and forestry, as well as related industries, which produce, manage, or otherwise exploit biological resources (for example, food, feed, fibre, paper, power, chemical, biotechnology industry) [30]. Ministry of Economic Affairs and Communications considers also bioenergy as part of bioeconomy. Most often use terms are: Bioeconomy means the production of sustainable biomass and conversion of biomass into food, feed, energy and other bioproducts; Bioeconomy means adding value to the sustainable utilization of biomass in interrelated economic activities

### Status of national policies and bioeconomy

Dedicated Bioeconomy Strategy at national level under development (In Estonia, a dedicated Bioeconomy Strategy at national level is under development. Other national bioeconomy-related strategies also exist. Estonia also participates in the macro-regional bioeconomy initiatives, BIOEAST and "Bioeconomy in the Baltic Sea Region")

### National bioeconomy strategy information

- Goals: Not known

- Actions: Not known

- Sectors included: Not known

- Monitoring framework: Not known

- Stakeholders involved: Not known

### Other national bioeconomy-related strategies

Climate Change Adaption Development Plan until 2030; Development plan for 2015-2018 of the Ministry of Rural Affairs; Estonian Forestry Development Plan 2011-2020; National Development Plan of the Energy Sector Until 2030 + Research and Development Strategy until 2025 KNOWLEDGE-BASED BIOECONOMY; National Waste Management Plan 2014-2020

### Regional bioeconomy strategy

Not known

**Other information**

- Bioeconomy funding programmes: Not known
- Educational programmes on bioeconomy: Biogas plant operator; Biosystems Engineering
- National register bio-refineries or bio based industries: No
- National certification schemes for biomass and biobased products: No
- Incentives for biobased products: Estonian Biogas Association; Polli Horticultural Research Centre; Bio-Competence Centre of Healthy Dairy Products LLC (BioCC)

## Cyprus

### **National institutions involved in the bioeconomy**

- Lead Ministry: Not known
- Other Ministry: Not known
- Other Institutions: Not known

### **National bioeconomy definition**

Not known

### **Status of national policies and bioeconomy**

Other related strategies at national level

### **National bioeconomy strategy information**

- Goals: Not known
- Actions: Not known
- Sectors included: Not known
- Monitoring framework: Not known
- Stakeholders involved: Not known

### **Other national bioeconomy-related strategies**

Multiannual national strategic plan for aquaculture 2014-2020; National Strategy on Adaptation to Climate Change

### **Regional bioeconomy strategy**

Not known

### **Other information**

- Bioeconomy funding programmes: Not known
- Educational programmes on bioeconomy: Not known
- National register bio-refineries or bio based industries: Not known
- National certification schemes for biomass and biobased products: Not known
- Incentives for biobased products: Not known

## **Luxembourg**

### **National institutions involved in the bioeconomy**

-Lead Ministry: Ministry of Agriculture, Viticulture and Consumer Protection; Ministry of Economy; Ministry of Sustainable Development and Infrastructure

- Other Ministry: Not known

- Other Institutions: Biogas association Luxembourg; Luxembourg Institute of Science and Technology; Luxinnovation; University of Luxembourg

### **National bioeconomy definition**

No

### **Status of national policies and bioeconomy**

Other related strategies at national level

### **National bioeconomy strategy information**

- Goals: Not known

- Actions: Not known

- Sectors included: Not known

- Monitoring framework: Not known

- Stakeholders involved: Not known

### **Other national bioeconomy-related strategies**

Cluster economy

### **Regional bioeconomy strategy**

Not known

### **Other information**

- Bioeconomy funding programmes: Biobased industrial sector; Bioeconomy Research and Innovation; and Infrastructure investments

- Educational programmes on bioeconomy: Not known

- National register bio-refineries or bio based industries: Not known

- National certification schemes for biomass and biobased products: Not known

- Incentives for biobased products: Innovation in sustainable construction; biogas – biobased electricity

## Malta

### **National institutions involved in the bioeconomy**

- Lead Ministry: Not known
- Other Ministry: Not known
- Other Institutions: Not known

### **National bioeconomy definition**

Not known

### **Status of national policies and bioeconomy**

Other related strategies at national level

### **National bioeconomy strategy information**

- Goals: Not known
- Actions: Not known
- Sectors included: Not known
- Monitoring framework: Not known
- Stakeholders involved: Not known

### **Other national bioeconomy-related strategies**

Aquaculture strategy for the Maltese islands; National Strategy for Sustainable Development

### **Regional bioeconomy strategy**

Not known

### **Other information**

- Bioeconomy funding programmes: Not known
- Educational programmes on bioeconomy: Not known
- National register bio-refineries or bio based industries: Not known
- National certification schemes for biomass and biobased products: Not known
- Incentives for biobased products: Not known

## Switzerland

### National institutions involved in the bioeconomy

-Lead Ministry: Federal Department of Economic Affairs, Education and Research EAER (Innovation); Federal Department of the Environment, Transport, Energy and Communications DETEC (Energy – SCCER)

- Other Ministry: BLV (Food Safety); Federal Office for Agriculture FOAG; Federal Office of Energy SFOE; Federal Office of the environment FOEN; State Secretariat for Education, Research and Innovation SERI

- Other Institutions: Commission for Technology and Innovation; National Thematic Network (NTN) Swiss Biotech; Swiss Competence Centre for Bioenergy Research (SCCER BIOSWEET); Swiss Industrial Biocatalysis Consortium (SIBC); Swiss Wood Innovation Network

### National bioeconomy definition

Switzerland uses the definition of the Organisation for Economic Co-operation and Development (OECD): From a broad economic perspective, the bioeconomy refers to the set of economic activities relating to the invention, development, production and use of biological products and processes [31].

### Status of national policies and bioeconomy

Other related strategies at national level

### National bioeconomy strategy information

- Goals: Not known
- Actions: Not known
- Sectors included: Not known
- Monitoring framework: Not known
- Stakeholders involved: Not known

### Other national bioeconomy-related strategies

Green Economy; SCCER biosweet; SCCER efficiency of industrial processes; Swiss food research

### Regional bioeconomy strategy

Not known

**Other information**

- Bioeconomy funding programmes: Biobased industrial sector; Bioeconomy Research and Innovation; and other (No specific bioeconomy funding programmes, but competitive funding programmes on R&I, Infrastructure, etc. not specifically related to bioeconomy)
- Educational programmes on bioeconomy: Not known
- National register bio-refineries or bio based industries: No
- National certification schemes for biomass and biobased products: Not known
- Incentives for biobased products: No



## Norway

### National institutions involved in the bioeconomy

-Lead Ministry: Ministry of Agriculture and Food; Ministry of Education and Research; Ministry of Trade, Industry and Fisheries

- Other Ministry: Ministry of Climate and Environment; Ministry of Foreign Affairs; Ministry of Petroleum and Energy; Ministry of Transport and Communications

- Other Institutions: Not known

### National bioeconomy definition

The Government's bioeconomy policy targets sustainable, effective and profitable production, extraction and use of renewable, biological resources into food, feed, ingredients, health products, energy, materials, chemicals, paper, textiles and numerous other products. The use of enabling technologies like biotechnology, nanotechnology and ICT are in addition to conventional disciplines like chemistry essential for the development of a modern bioeconomy (Source: National bioeconomy strategy) [32]

### Status of national policies and bioeconomy

Dedicated Bioeconomy Strategy at national level (The Government's Bioeconomy Strategy 2016) [32]

### National bioeconomy strategy information

- Goals: 1) The national effort should underlie all sectors in accordance with four priority areas (Cooperation across sectors, industries and thematic areas); 2) Markets for renewable biobased products; 3) Efficient use and profitable processing of renewable, biological resources; 4) Sustainable production and extraction of renewable biological resources

- Actions: Funding for Research and Innovation/Public - Private Partnership; Public procurement

- Sectors included: Agriculture; Aquaculture; Biobased chemicals and materials; Biobased electricity; Biobased textiles; Biofuels; Biotechnology; Fisheries; Food; Forestry; Organic waste; Pulp, paper; and Wood, wood products and furniture

- Monitoring framework: No

- Stakeholders involved: Academia; Consultants; Industry; NGO; Public institutions, organizations

### Other national bioeconomy-related strategies

National Strategy for Biotechnology

### Regional bioeconomy strategy

Not known

**Other information**

- Bioeconomy funding programmes: Biobased industrial sector; Bioeconomy Research and Innovation
- Educational programmes on bioeconomy: Not known
- National register bio-refineries or bio based industries: No
- National certification schemes for biomass and biobased products: Not known
- Incentives for biobased products: No

## **Iceland**

### **National institutions involved in the bioeconomy**

- Lead Ministry: Not known
- Other Ministry: Not known
- Other Institutions: Not known

### **National bioeconomy definition**

Not known

### **Status of national policies and bioeconomy**

Other policy initiatives dedicated to the bioeconomy (Iceland participates in the 'Nordic Bioeconomy', a macro-regional bioeconomy initiative being developed by Nordic countries)

### **National bioeconomy strategy information**

- Goals: Not known
- Actions: Not known
- Sectors included: Not known
- Monitoring framework: Not known
- Stakeholders involved: Not known

### **Other national bioeconomy-related strategies**

Not known

### **Regional bioeconomy strategy**

Not known

### **Other information**

- Bioeconomy funding programmes: Not known
- Educational programmes on bioeconomy: Not known
- National register bio-refineries or bio based industries: Not known
- National certification schemes for biomass and biobased products: Not known
- Incentives for biobased products: Not known

## Turkey

### National institutions involved in the bioeconomy

-Lead Ministry: Republic of Turkey, Ministry of Food Agricultural and Livestock; Republic of Turkey, Ministry of Environment and Urbanization; Republic of Turkey, Ministry of Science, Industry and Technology

- Other Ministry: Republic of Turkey, Ministry of Energy and Natural Resources; Republic of Turkey, Ministry of Interior

- Other Institutions: Not known

### National bioeconomy definition

In Turkey, bioeconomy is defined as the contribution of biotechnical applications on economy aimed the producing of goods which are sensitive to the environment and health and also aimed sustainable utilization of renewable biological resources

(<https://www.rvo.nl/sites/default/files/2015/10/Renewable%20Energy%20Turkey.pdf>)

### Status of national policies and bioeconomy

Other related strategies at national level

### National bioeconomy strategy information

- Goals: Not known

- Actions: Not known

- Sectors included: Not known

- Monitoring framework: Not known

- Stakeholders involved: Not known

### Other national bioeconomy-related strategies

National Biotechnology Strategy and Action Plan; National Rural Development Strategy

### Regional bioeconomy strategy

Not known

### Other information

- Bioeconomy funding programmes: Not known

- Educational programmes on bioeconomy: No

- National register bio-refineries or bio based industries: Not known

- National certification schemes for biomass and biobased products: Not known

- Incentives for biobased products: Republic of Turkey, Ministry of Energy and Natural Resources, General Directorate of Renewable Energy

## 1.2. EUROPEAN ECONOMIC INDICATORS BIOECONOMY DEPLOYMENT

Bioeconomy indicators in the Member States of the European Union during the time period 2008 – 2015 are available on the website of the Bioeconomy Knowledge Centre, as web-based interactive dashboards in the [economy tab](#) “Country” page or in the [economy](#) “Topic” page (figure 1.1).

In particular, the indicators selected are turnover, value added, and employment.

Turnover represents the value of sales from a given sector. The turnover of the whole bioeconomy includes all the sales from the different activity sectors that compose the bioeconomy, including the sales of products from one sector to a downstream sector of the bioeconomy. It thus leads to occasional double counting throughout the value chain.

Value added (factor costs) is the gross income from operating activities after adjusting for operating subsidies and indirect taxes. Value adjustments (such as depreciation) are not subtracted.

Employment is the number of persons employed by country, year and sector of the bioeconomy.

In [economy tab](#) “Country” page (figure 1.3) there are two drop-down menus that interact with each other (figure 1.4). The first one allows the users to select the year in the period 2008-2015, whereas the second one allows users to select one or all the biobased activities (agriculture; biobased electricity; biobased textiles; fishing and aquaculture; food, beverage and tobacco; forestry; liquid biofuels; paper; wood products and furniture; and biobased chemical, pharmaceuticals, plastics and rubber (excl. biofuels)). Graphs and figures can be expanded to full screen mode, downloaded and shared using the buttons that appears in the bottom right corner of the page.

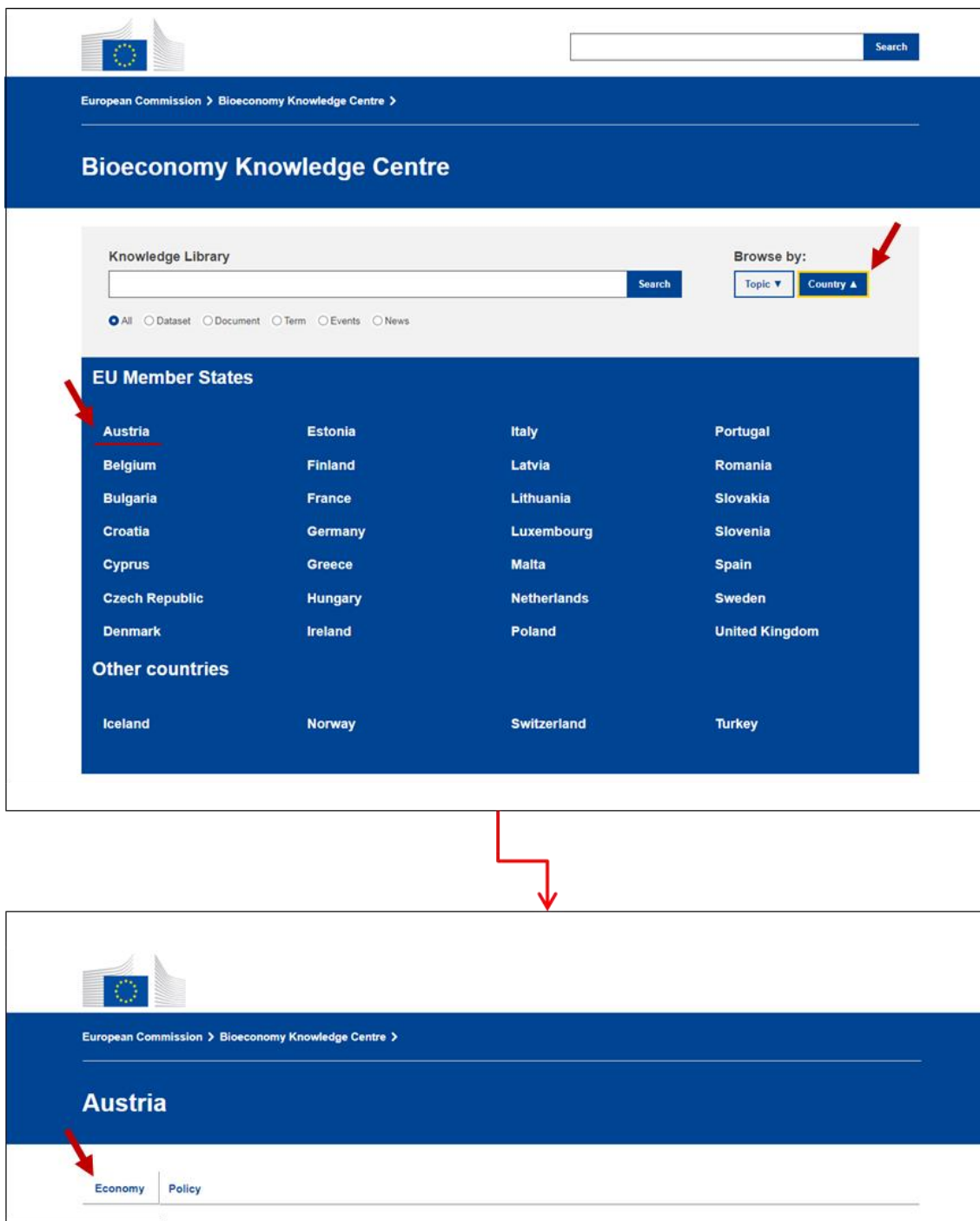


Figure 1.3 – Bioeconomy Knowledge Centre online dashboard with highlighted the economy tab in country page.

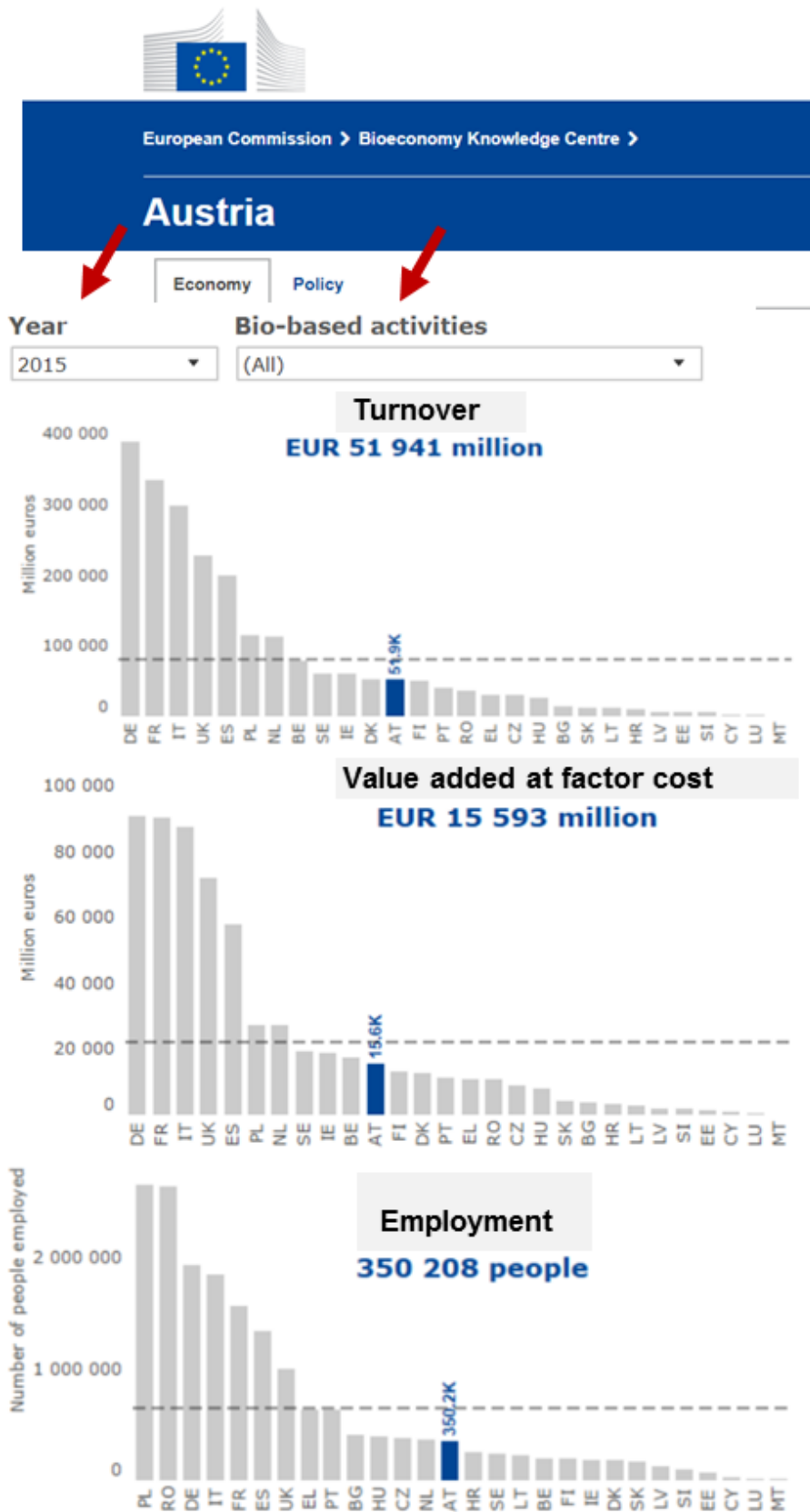


Figure 1.4 – Bioeconomy Knowledge Centre online dashboard with highlighted the two drop-down menus (year and biobased activities) in economy tab.

In economy tab "Topic" page it is possible to customize your graphs, charts, maps and data tables. In particular, the user can make different selections on each page or tab:

Country - one or more of the 28 Member States of the European Union.

Year - only a single year between 2008 and 2015 can be selected.

Sector - one or more sectors can be selected.

A specific selection impacts all charts contained in a page or tab.

Considering that the bioeconomy is still an area of research, the estimations of the indicators (e.g. turnover, value added, and employment) are to evolve according to future advances in research.

According with EC- Data portal of agro-economics research – DataM, in 2015 the EU bioeconomy employed around 18.1 million people and generated approximately EUR 2.3 trillion of turnover or EUR 621 billion of value added. This means that the bioeconomy represented around 8.2% of the EU-28 labour force and generated 4.2% of the EU-28 gross domestic product. Agriculture and food, beverages and tobacco activities accounted for about two thirds of the value added and turnover of the bioeconomy and three quarters of bioeconomy employment. These sectors generated EUR 174 billion and EUR 233 billion of value added respectively in 2015. Over the post crisis years (2009-2015) a slight increase in turnover of all activities of the biobased economy in the Member States of the European Union (from 2.1 million Euro to 2.3 million Euro) is concomitant to a decrease in employment (from 20.5 to 18.1 million people) mostly related to agriculture sector (figure 1.5 and 1.6).



## EMPLOYMENT

(number of people employed)

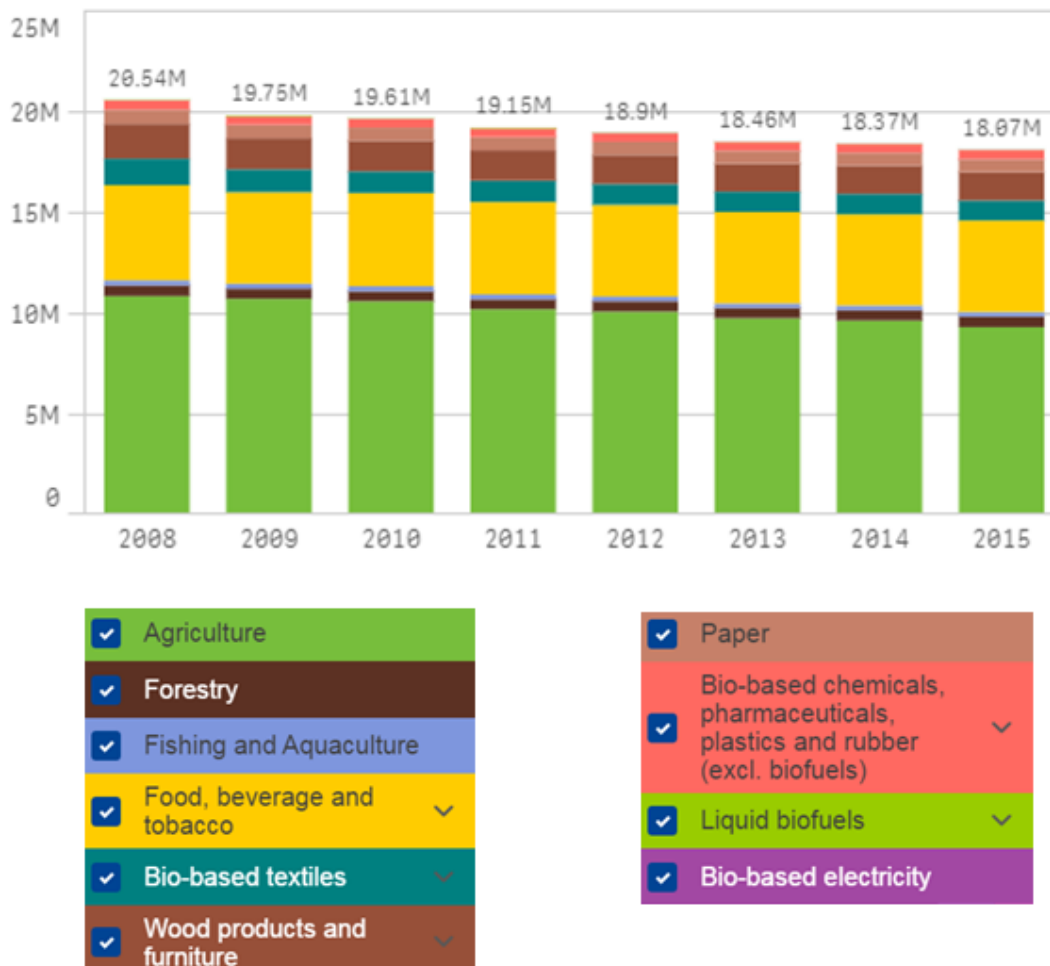


Figure 1.5 – Development of the employment by sectors of the bioeconomy in the 28 Member States of the European Union during the time period 2008 – 2015 (source: EC- Data portal of agro-economics research – DataM).

## TURNOVER

(million €)

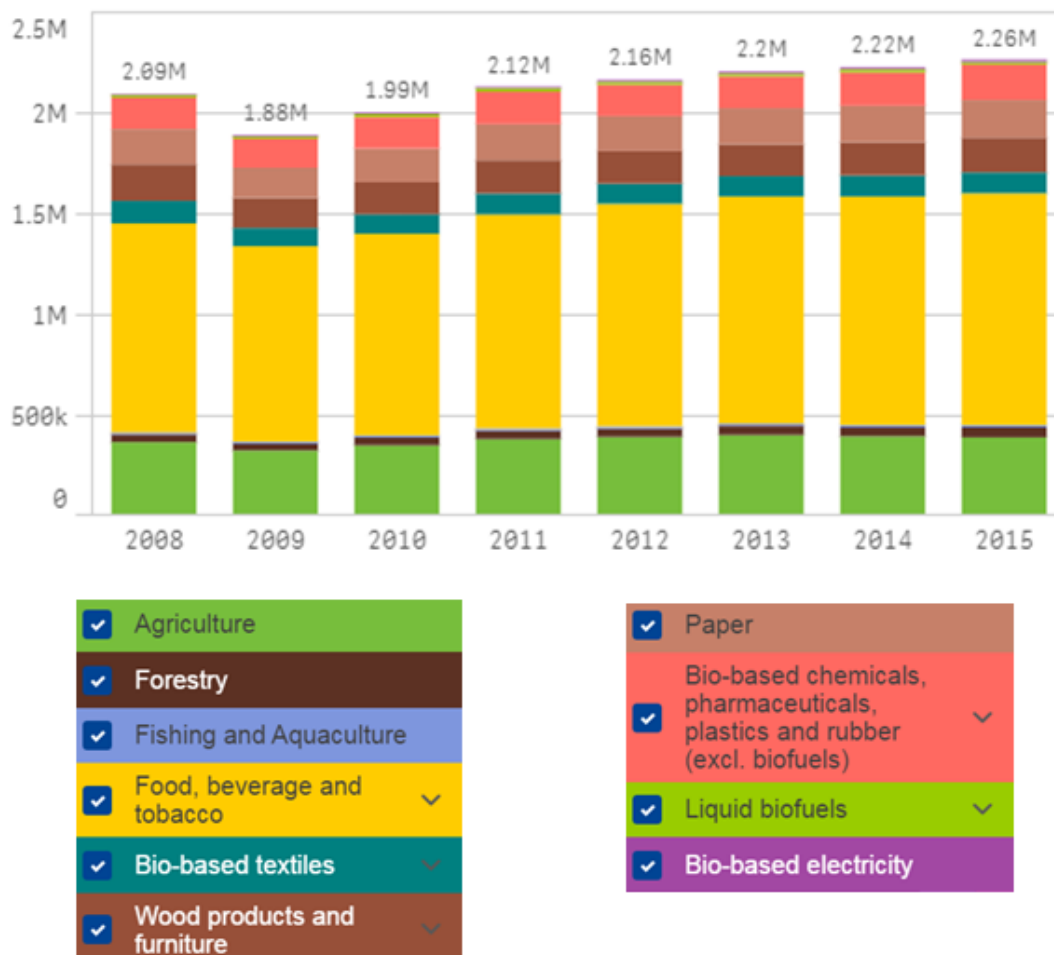


Figure 1.6 – Development of the turnover by sectors of the bioeconomy in the 28 Member States of the European Union during the time period 2008 – 2015 (source EC- Data portal of agro-economics research – DataM).

Figure 1.7 shows the turnover per person employed in all sectors of the bioeconomy for the years 2008, 2011 and 2015 (a sharp differences among the countries is highlighted with higher values in BE, DK, NL, IE).

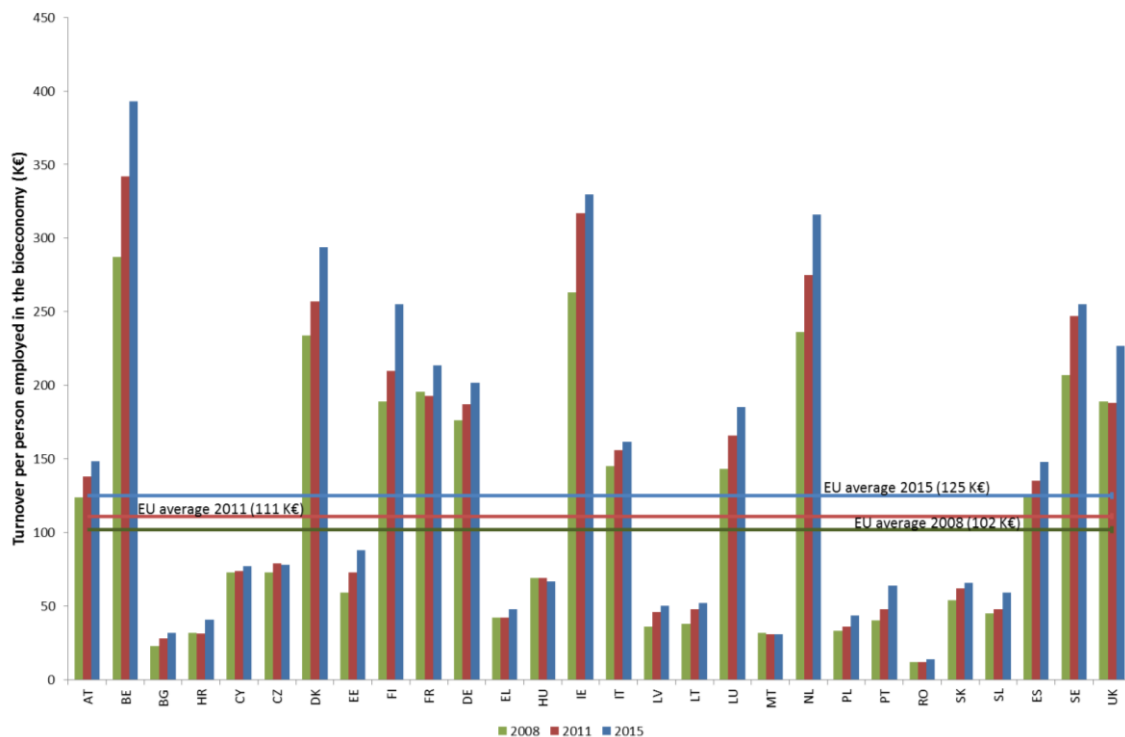


Figure 1.7 – Turnover per person employed in all sectors of the bioeconomy for the years 2008, 2011 and 2015, data elaboration on – DataM source.

In the period 2008-2015 the value added generated by the bioeconomy has increased by EUR 45 billion and the apparent labour productivity has also improved from EUR 28000 of value added per person employed in 2008 to EUR 34000 in 2015 (figure 1.8 and 1.9).

## VALUE ADDED

(million €)

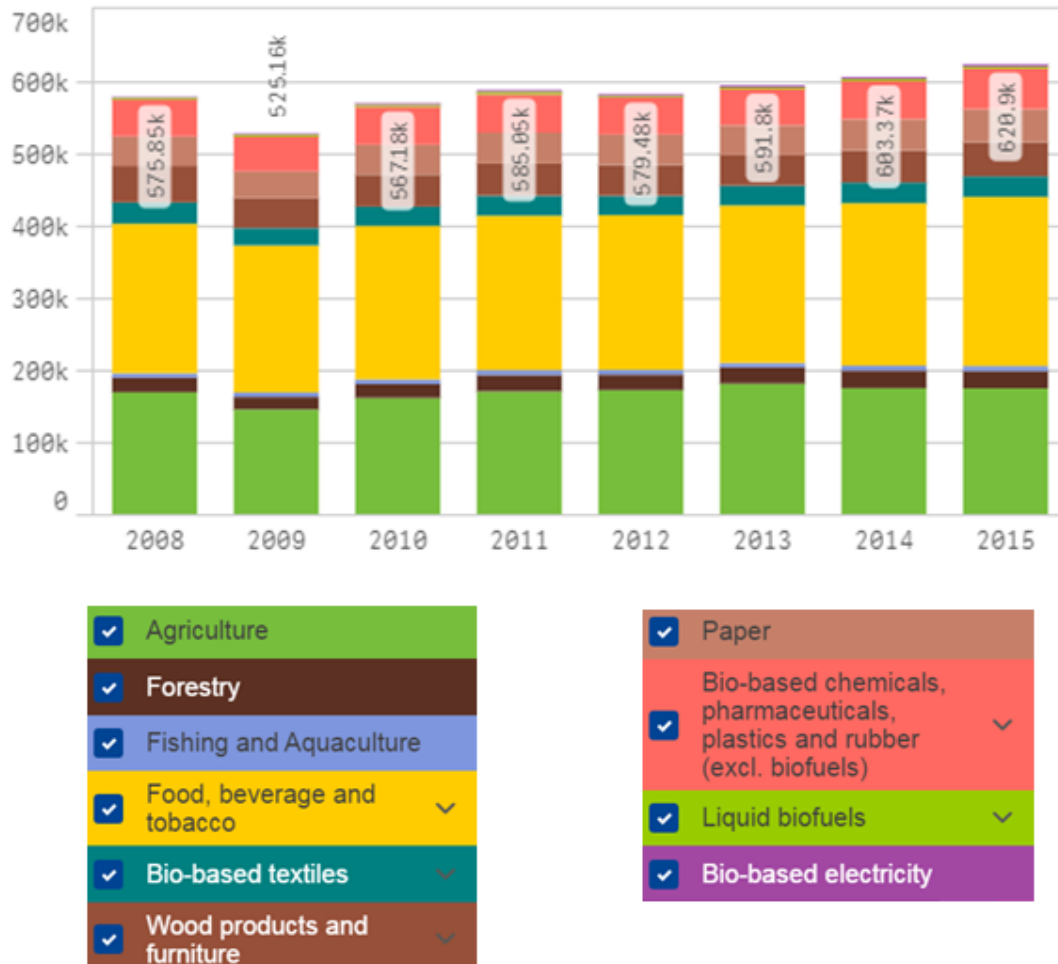


Figure 1.8 – Development of the value added by sectors of the bioeconomy in the 28 Member States of the European Union during the time period 2008 – 2015 (source: EC- Data portal of agro-economics research – DataM).

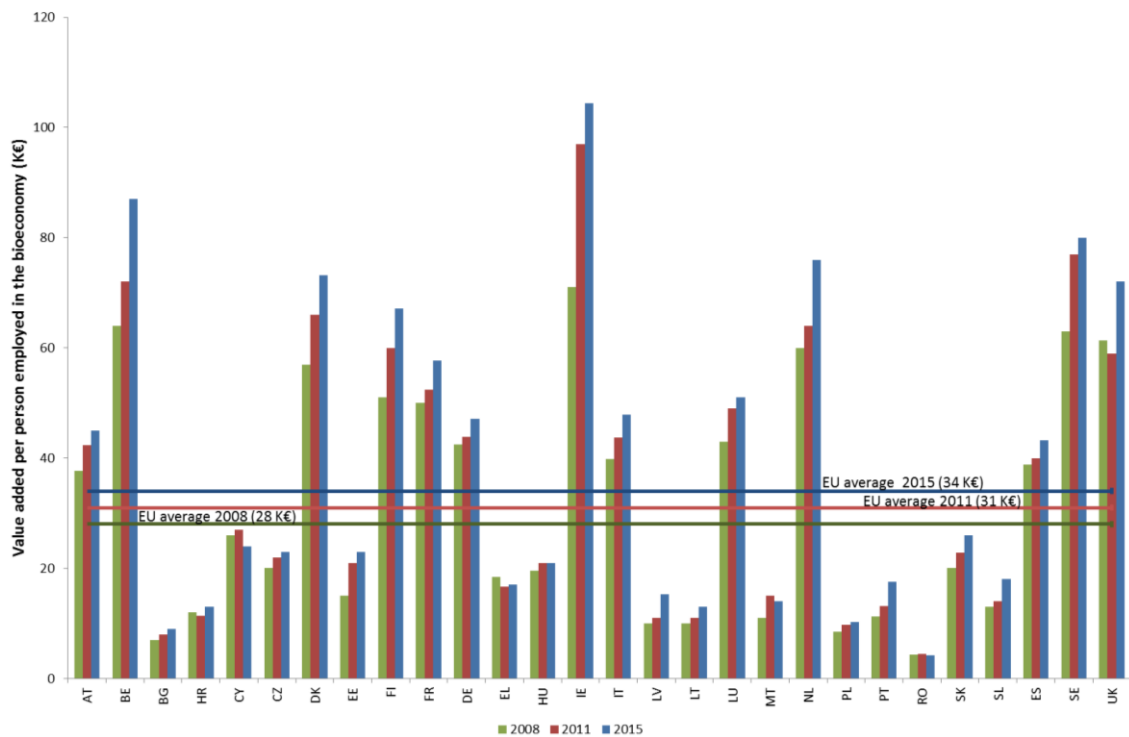


Figure 1.9 – Value added per person employed in all sectors of the bioeconomy for the years 2008, 2011 and 2015 (data elaboration on – DataM source).

The indicators (turnover, value added, and employment) show considerable heterogeneity among the Member States of the European Union. The (figure 1.10) compares the turnover, value added, and employment of the biobased economy for each Member State of the European Union in 2015. Western and Northern European countries generate much higher turnover and value added compared to the employment generated.

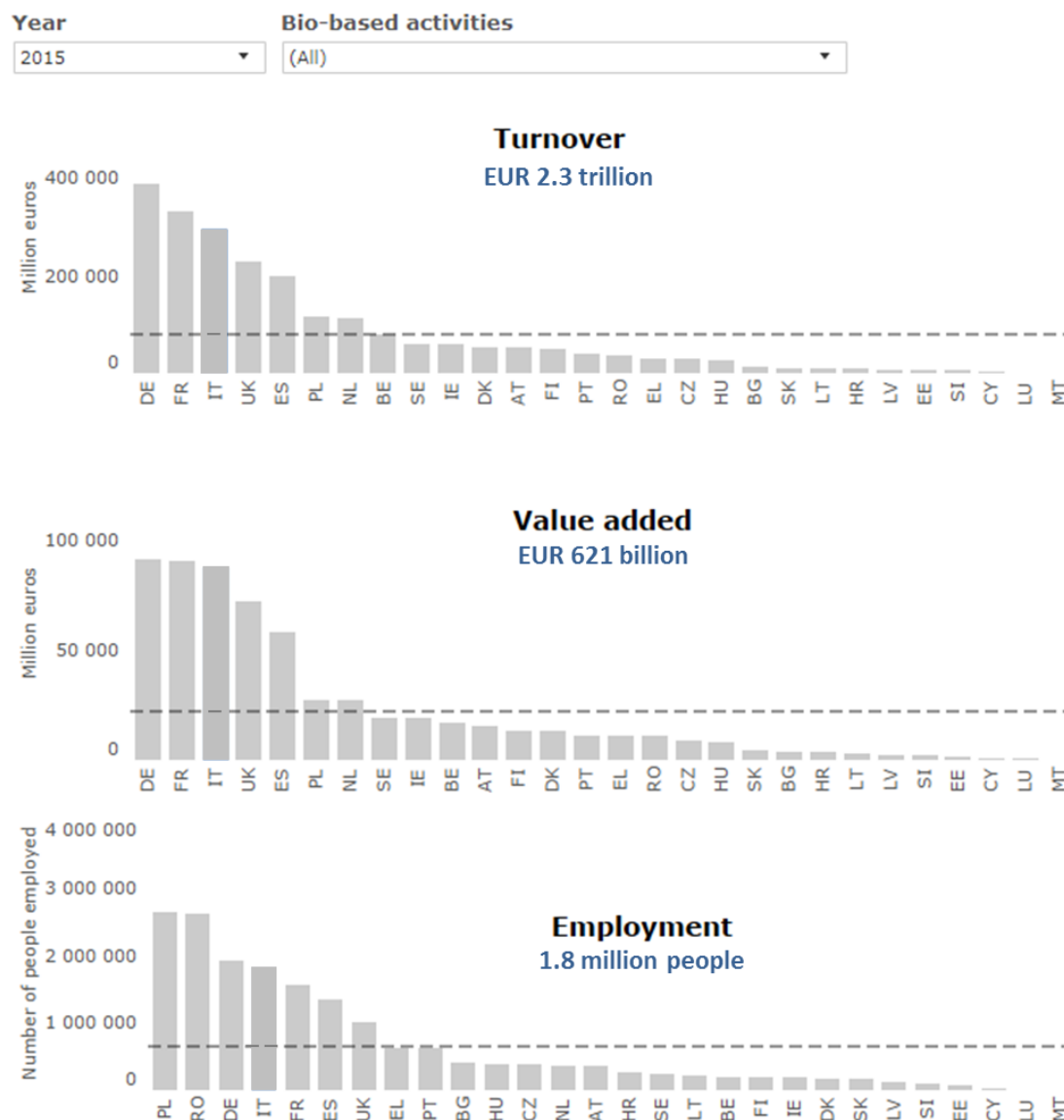


Figure 1.10 – Employment, turnover and value added by all sectors of the bioeconomy per the 28 Member States of the European Union in 2015 (source: Bioeconomy Knowledge Centre online dashboard).

In order to have quantitative comparisons, the linear correlations between turnover and employment (figure 1.11) and between value added and employment (figure 1.12) were analyzed. As a whole, excluding RO and PL from the analysis, strong correlations between turnover and employment (coefficient of determination, denoted  $R^2 > 0.86$ ) and between value added and employment (coefficient of determination, denoted  $R^2 > 0.87$ ) are obtained. In particular, in the RO and PL labour market the proportion of persons employed in bioeconomy sectors is nearly three-four times higher than the proportion of bioeconomy workers on the 28 Member States of the European Union labour market.

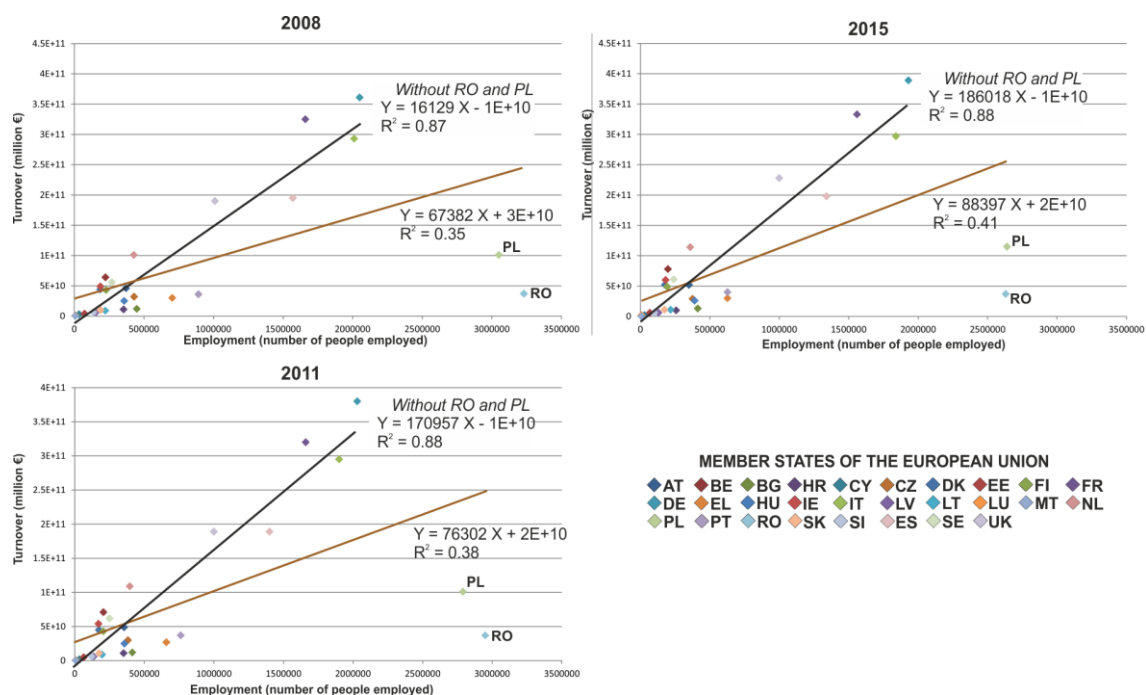


Figure 1.11 – Linear regression model graphs between turnover and employment by all sectors of the bioeconomy for the years 2008, 2011 and 2015.

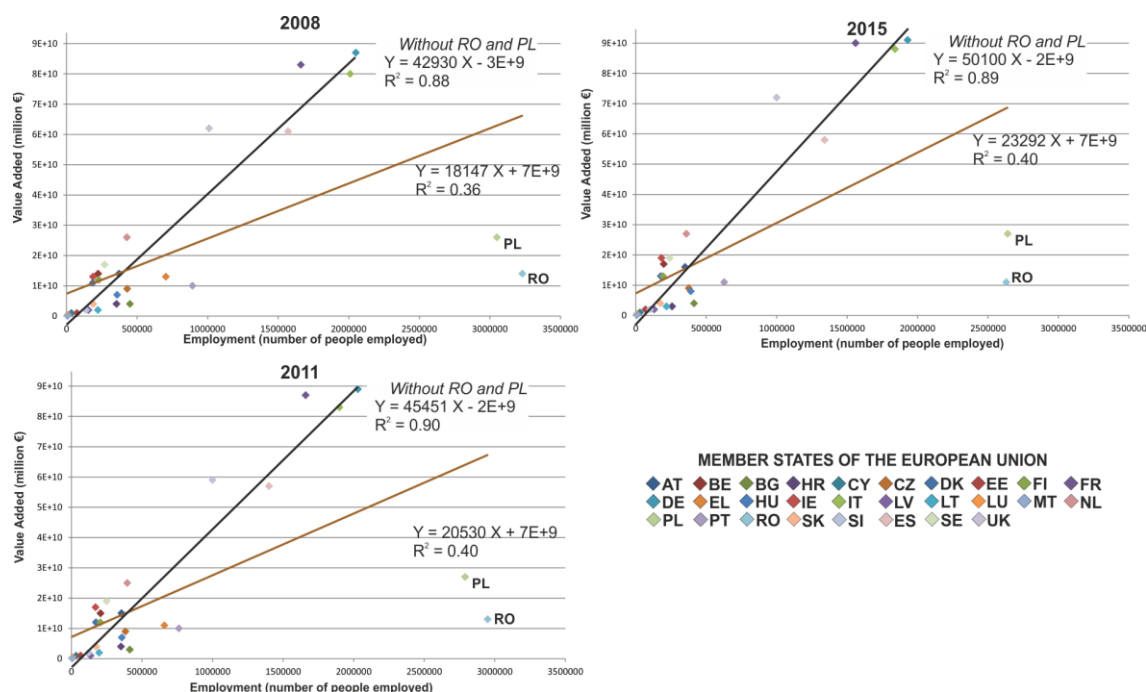


Figure 1.12 – Linear regression model graphs between value added and employment by all sectors of the bioeconomy for the years 2008, 2011 and 2015.

### 1.3. OTHER COUNTRIES

In the following paragraphs, some descriptions of the bioeconomy status in Australia, United States and Canada is separately provided. These countries did not respond to the bioeconomy online survey, but as IEA NTL (National Team Leader) provided online accessible sources for desktop research.

#### 1.3.1 Australia

The Australian Government generally defines the bioeconomy as “the sustainable production and conversion of biomass for a range of food, health, fibre and other industrial products as well as energy” (Department of Industry, 2018) [33]. For the Australian Department of Industry, Innovation and Science, the bioeconomy encompasses “all industries and sectors producing, managing or otherwise making use of biological resources (including organic waste), such as agriculture, forestry, and fisheries. The bioeconomy is intended as combination of knowledge and innovation in biosciences, with other technology sectors such as chemistry, engineering, computer science and nanotechnologies” (Department of Industry, 2018) [33]. Australia does not have currently a bioeconomy strategy, but a set of measures, mostly R&D, that foster bioeconomy related to sectors such as: biobased chemical (including bioplastic packaging); biofuels and bioenergy; agriculture; fisheries; food and beverage industry; forestry and pharmaceuticals industry. In 2013, the Australian government defined fifteen strategic research priorities for the future, which also included typical bioeconomy sectors, for instance bioenergy, ecosystem monitoring and management, optimized food and health (Bioekonomierat, 2015) [34]. In Australia, the concept of bioeconomy is often linked to biotechnology policy and strategies. For example, the Department of Agriculture, Fisheries and Forestry commissioned a report in 2008 entitled “Biotechnology and Australian Agriculture: Toward the Development of a Vision and Strategy for the Application of Biotechnology to Australian Agriculture” (ACIL Tasman, 2008) [35]. This report focus on bioeconomy as a concept linked to agro-biotechnology. Additionally, in 2011 the Australian Government released two biorefinery scoping studies assessing the potential of tropical and temperate biomass value chains. Bioeconomy research is supported by the Australian Government through the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Rural Industries Research and Development Corporations (RIRDC), and Cooperative Research Centres (CRC). For instance, the RIRDC, a national agency, prepared the bioenergy innovation strategy (“Opportunities for primary industries in the bioenergy sector – national RD&E strategy”) and the linked workplan, as a result of consultation among Australian government and regional agencies, industry and other stakeholders (Bioekonomierat, 2015) [34].

In 2015, the Minister for Industry and Science launched also the “National Marine Science Plan 2015–2025”, focused on the “blue economy” focus on Australia’s oceans and marine resources protection (Bioekonomierat, 2015) [34]. Some state and local governments also support bioeconomy, for example, South Australia has a regional bioeconomy strategy “Building a Bioeconomy in South Australia 2011–2015” mostly dedicated to biosciences, in June 2016 Queensland State Government has published its Biofutures 10-year Roadmap and Action Plan to promote the industrial biotechnology and bioproducts sector development through a AUD \$5 million (about USD 3.8 million) using the Biofutures Industry Development Fund (Department of State Development, 2017) [36].

The Australian bioeconomy aims to increase food security; mitigate the environmental impact of agriculture and fisheries sectors. The bioeconomy will also help the transition away from fossil fuels energy and material production. In particular, industrial biotechnology is seen as central aspect for bioeconomy, as it enables commodities being produced from biomass, rather than non-renewable petrochemical feedstocks (Department of Industry, 2018) [33]. The Department of Agriculture and Water Resources manages various programs and policies related to the bioeconomy, including in



rural R&D, farmer support, biosecurity and natural resource management. For instance, the national Bioenergy RD&E Strategy has four priority areas for innovation: feedstock identification and availability, supply logistics, sustainability and integrated supply chains and industry development, with a special focus on regional applications (RIRDC, 2018) [37].

Since Australia does not have currently a specific bioeconomy strategy, no comprehensive approach to measure the contribution of bioeconomy to the overall economy has been developed yet. The Australian Government programmes are not including specific criteria on bioeconomy, in the sense that even we have evaluation on set of indicators like employment, economic, productivity, environmental and social performance, the Bioeconomy aspects are not evaluated in a distinct way. Bioeconomy activities are occurring and are supported in programs in numerous Australian Government portfolios, such as Department of Environment and Energy, Department of Jobs and Small Business, Department of Agriculture and Water Resources and Department of Infrastructure and Regional Development. Responsibility, for instance, the Department of Environment and Energy has responsibility for renewable energy projects, including projects that divert biomass waste, convert that waste into energy and then use the energy in its operations, it means that the bioenergy sector is considered like a branch of energy, and no explicit indicators of bioeconomy are specifically measured.

Until a specific bioeconomy strategy officially in place, appears difficult implement a system to measure and monitor systematically the bioeconomy contribution to the Australian economy. Most bioeconomy-related policies are actually R&D strategies and focus on biotechnology and innovation, bioeconomy is implicitly incorporated into overall measurement criteria.

Even though the Australian Government has not yet developed a holistic national bioeconomy strategy, it provides support for bioeconomy-related when research finance sectors like food production, fishing and technology advanced used also in the biotechnology as well.

At the regional level, In 2015, to mention an initiative launched by the Federal State of Queensland that adopted the AUD 1 billion (around USD 780 million) "Queensland Biofutures 10-Year-Roadmap and Action Plan", as part of regional "Advance Queensland" initiative under which the Department of State Development is commissioned to develop roadmaps for emerging and promising industries, such as advanced manufacturing, including biomaterials, as way to pursue in future the diversification of forestry and algae feedstock, and also biogenic waste

As part of the AUD 518 million (around USD 399 million) "Advance Queensland" initiative, the Biofutures Roadmap "concentrates mainly on policy interventions supporting innovation and commercialization in the bioindustry, including demand-side measures. With regard to support for innovation and commercialization in the bio-industry", the fund invests AUD 20 million (almost USD 15 million) in four key measures: AUD 5 million (around USD 4 million) will be provided for the Biofutures Industry Development Fund, mainly for early stage funding for industrial biotechnology-focused projects and for financing a Research Chair of Advanced Biofuels. An additional AUD 3 million (around USD 3 million) will be invested in the Biofutures Acceleration Program for the development of new commercial-scale biorefinery projects in Queensland. With the AUD 5 million (around USD 4 million) Biofutures Commercialization Program, the Government of Queensland aims to promote pilot and demonstration projects for improved technologies and processes.

### 1.3.2 United States of America

The Strategic Plan for a Thriving and Sustainable Bioeconomy (2016) [38] follows the newer direction of U.S. bioeconomy development and reflects a vision of a future clean energy economy rather than one of a holistic bioeconomy. The bioeconomy is defined as “sustainable use of domestically produced renewable biomass for fuels, products, and power”. The Federal Activities Report (2016) [39] describes it as “global industrial transition of sustainably utilizing renewable aquatic and terrestrial biomass resources in energy, intermediate, and final products for economic, environmental, social, and national security benefits”.

The United States Department of Agriculture (USDA) defines biobased products industry: “Any industry engaged in the processing and manufacturing goods from biological products, renewable resources, domestic or agricultural or forestry material”. The seven major sectors chosen to represent the biobased products industry’s contribution to the US economy are: agriculture and forestry; biorefining; biobased chemicals; enzymes; bioplastic bottles and packaging; forest products and textiles. The USDA’s definition of biobased products excludes the energy, livestock, food, feed, and pharmaceutical industries (USDA, 2015) [40].

In 2012, the U.S. Administration announced the National Bioeconomy Blueprint (The White House, 2012) [41], describing how the agencies would drive the progress in bioeconomy. In the United States, the bioeconomy is defined as “the global industrial transition of sustainably utilizing renewable aquatic and terrestrial biomass resources in energy, intermediate, and final products for economic, environmental, social, and national security benefits” (Biomass R&D Board, 2016) [39].

The Blueprint states, the development of the bioeconomy in the USA in 2012 was due mainly to the three technologies (genetic engineering, DNA sequencing, and automated high-throughput manipulations of biomolecules), (The White House, 2012) [41]. The Bioeconomy Blueprint considered also emerging trends in other sectors like health, biobased energy production, agriculture, bio-manufacturing, and environmental clean-up, with goals could be resumed as:

1. Supporting R&D investments to provide the foundation for the U.S. bioeconomy.
2. Facilitating the transition of bio-inventions from research lab to market, including an increased focus on translational and regulatory sciences.
3. Developing and reforming regulations to reduce barriers, increase the speed and predictability of regulatory processes, and reduce costs while protecting human and environmental health.
4. Updating training programmers and aligning academic institution incentives with student training for national workforce needs: improve science, technology, engineering, and mathematics (STEM) education, and increase the number and diversity of STEM students.
5. Identifying and supporting opportunities for the development of public-private partnerships and precompetitive collaborations, where competitors pool resources, knowledge, and expertise to learn from successes and failures.

Since 2013, the Biomass R&D Board members have been planning acts to promote the expansion of the bioeconomy (Biomass R&D Board, 2016) [39]. The Board is co-chaired by senior officials from the U.S. Departments of Energy (DOE) and Agriculture (USDA) and currently consists of senior decision makers from the DOE, USDA, U.S. Department of Transportation (DOT), U.S. Department of the Interior (DOI), U.S. Department of Defense (DoD), U.S. Environmental Protection Agency (EPA), National Science Foundation (NSF), and the Office of Science and Technology Policy (OSTP)

within the Executive Office of the President (Biomass R&D Board, 2016) [39].

The Biomass Research and Development (R&D) Board was created through the enactment of the Biomass Research and Development Act of 2000 “to coordinate programs within and among departments and agencies of the federal government for the purpose of promoting the use of biobased industrial products by:

1. maximizing the benefits deriving from federal grants and assistance;
2. bringing coherence to federal strategic planning.”

In 2015, the U.S. government renewed the federal “Strategy for American Innovation”, deriving reports named “Billion-ton Report” (2005, 2011, 2016) [42]; an inter-agency vision to sustainably produce one billion tons of biomass by 2030 with the goal of implementing innovative approaches to remove barriers and promote sustainable use of domestic biomass resources, while maximizing economic, social, and environmental outcomes (Biomass R&D Board, 2016) [39]. The implementation of this billion-ton strategy is documented in the “Federal Activities Report on the Bioeconomy” which was published in February 2016 which provides an overview of publicly funded bioeconomy activities. In 2016, the government adopted the “Strategic Plan for a Thriving and Sustainable Bioeconomy” [38] The policy strategy intends to provide a framework for biomass-derived product development in the United States.

The DOE project 1 billion tons of biomass to be sustainably produced and collectable annually by 2030 (DOE, 2016) [38]. The Board and the Biomass R&D Technical Advisory Committee (TAC) point to coordinated multi-department vision focused on developing plans for utilizing the available biomass, decrease reliance on foreign oil, create market-driven demand for bioenergy and bioproducts, create jobs, reduce GHG impacts, and enhance national security (Biomass R&D Board, 2016) [39].

The Agricultural Act of 2014 (the 2014 Farm Bill) [43] reauthorized and expanded the 2002 Farm Bill which established the so-called BioPreferred program, managed by the U.S. Department of Agriculture, with the goal of increasing the purchase and use of biobased products. The programmer’s purpose is to spur economic development, create new jobs and provide new markets for farm commodities, while reducing reliance on oil, increasing the use of renewable agricultural resources, and diminishing adverse environmental and health impacts (USDA, 2018) [44]. The two main components of the Bio Preferred program are mandatory purchasing requirements for federal agencies and their contractors; and a voluntary labelling initiative for biobased products.

The USDA report, An Economic Impact Analysis of the U.S. Biobased Product Industry: 2016 Update (USDA, 2016) [45], examines and quantifies the effect of the biobased products industry from an economics and jobs perspective at the state level. It was anticipated by a report analyzing the effect at national level (USDA, 2015) [40] and by a report (Golden & Handfield, 2014) [46] which resume some available information on the bioeconomy in the country and a platform highlighting some effort to measure the bioeconomy in the future.

The 2014 report [46], commissioned by the USDA BioPreferred Program, evidenced some lack of understanding and quantification of benefits related to bioeconomy, with focus on sectors outside the biofuel. The report provided detailed information on the contributions of the biobased products industry in the United States, in particular The USDA 2016 report [45] models the bioeconomy at the national level using IMPLAN’s 2013 and 2014 national databases, on the basis of the supply/demand pooling method. A particular multiplier (the Type Social Accounting Matrix (SAM) multiplier), considering portions of value added to be both endogenous and exogenous to the target

region, outcomes are the overall monetary contribution (value added) or jobs (employment) supported by the bioeconomy (USDA, 2016) [45].

The economic impacts calculated show that the biobased industry in 2014 contributed to a total of about USD 400 billion value added to the U.S. economy; involved a total of 4.2 million jobs through direct, indirect and induced contributions; and generated 1.76 jobs in other sectors of the economy for every biobased job. Additionally, the indirect jobs in satellite activities are estimated to be around 1.53 million jobs, while induced jobs (produced from the purchase of goods and services generated by the direct and indirect jobs directly supported the biobased product industry) resulted in 2.7 million spillover jobs. The report also estimates that the biobased industry generated USD 127 billion in direct sales and USD 266 billion in spillover sales (USDA, 2016) [45].

In terms of environment impact the report estimates that biobased products displaces about 6.8 million barrels of oil a year and have the potential to reduce GHG emissions by 10 million metric tons of CO<sub>2</sub>eq/year (USDA, 2016) [45].

Concerning the Biobased Product Economic Indicators to mention a report (USDA, 2011) [47] showing the methodology and the results of an analysis of indicators elaborated with Iowa State University. The various indicators were grouped in the broad categories of inputs, investments and outputs. Inputs were mainly basic resources like physical goods or nonindustrial inputs such. Investments include for instance tax and trade policies, direct and indirect public spending, public and private R&D. Outputs include above others: commodity flows, prices, value added, patents, environmental and social outcomes.

In 2018, the USDA also released a report on Indicators of the U.S. Biobased Economy (Golden J. S., et al., 2018) [44] to further understand and analyze trends in the biobased economy, making a comparison between 2011 and 2016 report data on agriculture, bioenergy, renewable chemicals and biobased products, and policy. The report develops the following indicators and analysed their trends in the period 2011-2016:

Agriculture indicators:

1. land use;
2. production;
3. consumption;
4. economics (prices and economic value).

It takes into account all the various organic inputs into biofuels, renewable chemicals, and biobased products: starches, lipids and cellulosic feedstocks. Bioenergy indicators for ethanol, biodiesel, wood pellets, waste-to-energy and biogas:

1. physical: number of States with bioenergy plants; total number of existing bioenergy plants; and number of plants under construction from years 2010 to 2016;
2. production: amount of ethanol/biodiesel/biogas produced; amount of ethanol/biodiesel imported, exported, and total ethanol/biodiesel consumed within the transportation and non-transportation sector; consumption in British thermal units (BTU) of wood used for energy from 1970 to 2010; amount of wood pellets produced in the United States and worldwide; amount of energy produced from waste and breakdown on how much energy is used within the commercial and utilities sector; information on the methane potential

produced from landfills, wastewater, animal manure, and organic waste; amount of kWh energy generated by biogas from year 2010 to 2016, and the methane emissions reductions of each year;

3. economics: price per gallon of ethanol/biodiesel from 2010 to 2016, direct and indirect jobs created from the bioenergy industries; ethanol/biodiesel/waste-to-energy industries' influence on GDP; revenue generated from the waste-to-energy sector; household average income influence from the bioenergy industry; tax revenue generated from the ethanol industry; and a theoretical economic analysis of the potential market value of the biogas industry and an estimate on job creation from constructing new biogas systems. . Renewable chemicals and biobased products: number of biobased product companies; number of categories for mandatory Federal Purchasing (FP) and voluntary labelling categories; number of certified products in the USDA BioPreferred Program.

Economics and Investment indicators are: number of direct, indirect or induced, and total jobs contributed to the United States economy through the biobased products industry; biotech revenues; venture capital investments and academic research and development expenditures on bioscience. in particular, the analysis focuses on:

- a) Bioplastics: United States bioplastic manufacturing data on imports, exports, and industry value added; global and United States bioplastic production; revenues from the United States bioplastic manufacturing; plastic bottle manufacturing gross output in the United States;
- b) Renewable Chemicals: value added by United States renewable chemical products; revenues from the United States chemical industry; global chemicals market value with bio-derived chemicals market value;
- c) Forest Products, Apparel, and Textiles: wood and paper products, textile, apparel, leather, and allied products' value added to the United States economy (based on North American Industry Classification System (NAICS) classification).

According to the USDA 2018 report, the renewable chemicals and biobased product sectors contributed 4.2 million jobs to the U.S. economy in 2014, with a value-added contribution of USD 393 billion. Under the USDA BioPreferred Program, the number of renewable chemicals and biobased products that are USDA-certified has increased from 1 800 in 2014 to 2 900 in 2016. The report also found that ethanol production in the United States generates 270000 jobs (Golden J. S., et al., 2018) [44].

In 2017, also the Department of Energy (DOE) [48] provided some figures about the size of the bioeconomy in terms of:

- number of products that have been certified to display the USDA Certified Biobased Product label;
- companies that either manufacture or distribute biobased products;
- gallons of cellulosic biofuel produced;
- airlines that are part of the Farm to Fly initiative to accelerate the availability and viability of a sustainable aviation biofuel industry;
- revenues and jobs generated by biobased activities;

- patents and licenses secured by laboratories working with the DOE's Bioenergy Technologies Office (in the last seven years).

To date, more than 2,500 products have been certified to display the USDA Certified Biobased Product label More than 3,000 companies in the USA either manufacture or distribute biobased products 19.3 million l of cellulosic biofuel were produced in the USA in 2017 Nine major airlines are part of the Farm to Fly initiative to help accelerate the availability of a commercially viable and sustainable aviation biofuel industry in the USA Biobased activities in the current economy are estimated to have directly generated more than USD 48 billion in revenue and 285,000 jobs In the last seven years, national laboratories working with the U.S. Department of Energy's Bioenergy Technologies Office have secured 246 patents and 32 licenses for bioenergy-focused technologies [48].

According to the DOE figures, biobased activities in 2014 have directly generated more than USD 48 billion in revenue and 285 thousand jobs. These estimates are significantly lower than those reported by the USDA 2016 report. The difference is due to the different sectors included in the estimation. The DOE estimates are taken from a paper considering direct employment and revenues from biomass resources fed into a number of end-uses and products including heat and power generation, biobased chemicals and products (including wood pellets), and biofuels and coproducts (Rogers, et al., 2016). Most of these sectors were instead excluded from the USDA 2016 report, which considered as bioeconomy industries:

- agriculture and forestry;
- biorefining;
- biobased chemicals;
- enzymes;
- bioplastic bottles and packaging;
- forest products;
- textiles.

There are training programs for professionals and technical students and pledges support for career path information for high school students. Furthermore, career awards, ranging from USD 300,000–400,000 for 3 years, are intended to support early careers and tenure-track positions in the area of sustainable energy, biochemical engineering, process and reaction engineering etc.

BETO's Strategic Plan (2016) [38] proposes several demand-side instruments. Public awareness of bioeconomy should be raised by a communication strategy and by establishing an expert stakeholder network to hold workshops and conferences. It also discusses pricing measures for fuels and sustainability requirements. BETO's policy plan and the Federal Activities Report (2016) seek to improve the business conditions for biobased products. They propose a review of the regulatory framework with a view to developing and using new biobased products as well as alternative biogenic resources, such as waste and CO<sub>2</sub>.

Good Governance should be promoted by monitoring and measuring activities, including sustainability indicators and standards for feedstock valuation. Other measures highlighted by the innovation strategy (2015) [42] are the exploration of ethical, legal and social implications of emerging technologies and the development of standards. With a view to policy coherence and

capacity building, BETO's Strategy Plan (2016) [38] supports jointly funded intra- and interagency working groups, personnel exchanges and memoranda of understanding between government authorities. The Federal Activities Report (2016) [39] also emphasizes increased inter-agency collaboration to fully leverage governmental expertise. In this respect, for example, it highlights a Bioeconomy Federal Strategy Workshop which was organized by the Biomass R&D Board and was aimed at sharing information on existing agency programs and activities, identifying processes for working together and building a national federal government coalition to coordinate agency efforts.

International collaboration in the bioeconomy should be further enhanced through the U.S.' active membership in the Global Alliance for Climate-smart Agriculture (GACSA), a partnership of countries and international organizations committed to mitigating greenhouse gases in agricultural systems. It focuses on providing support for research and monitoring, data standardization and outreach activities. Also the U.S.' engagement in the Global Bioenergy Initiative should be fostered by jointly developing international sustainability criteria and indicators.

#### Key points Policy measures Concrete implementation

- Promoting innovation Public R&D Plants Engineered to Replace Oil (PETRO) Program Transportation Energy Resources from Renewable
- Agriculture (TERRA) Program Physical Biosciences and Photosynthetic Systems programs
- National Laboratories and competitive grants to academic institutions Biomass Research and Development Initiatives
- Clean Water State Revolving Fund (CWSRF): funding for projects that produce biofuels and biopower from treatment of municipal wastewater Plant Genome Research Project Technology development e.g. Advanced Research Projects Agency-Energy (ARPA-E) awards (funding and technical assistance for energy researchers)
- Stimulating private sector R&D e.g. industry-led consortia, public-private partnerships Open innovation Hackathons, accelerators & online innovation marketplaces Supporting Establishing next-generation digital infrastructure & infrastructure capacity building Grants for increasing the number of Biofuels Infrastructure Partnership renewable fuel pumps Cluster development Multi-user facilities Integrated scale-up and demonstration facilities Training and educational programs Support for career path information e.g. career awards Supporting Market development for biofuels and e.g. feasibility testing of biofuels in locomotives commercialization bioproducts Domestic and international marketing incl. market reports, economic analysis, outreach, etc..

There are programs for U.S. producers of food, fiber and specialty crops Commercial-scale biorefineries and Biorefinery, Renewable Chemical, and Biobased manufacturing facilities for biobased Product Manufacturing Assistance Program (incl. loan products guarantees):

- Repowering Assistance Program;
- Advanced Biofuel Payment Program;
- Mandatory biobased product purchasing requirement for federal government agencies;
- Voluntary bioproduct certification and labeling;
- Reviewing the regulatory framework;

- National standards to address carbon pollution from existing fossil-fuel fired power plants;
- Monitoring and measuring activities;
- Intra- and interagency collaboration;
- Impact analysis on national bioeconomy policies;
- International monitoring.



### 1.3.3. Canada

The Canadian government has not yet developed a dedicated national bioeconomy strategy [49]. There are present some bioeconomy regional approaches [50], Like the provinces of Sarnia and Ontario have focused on the development of biobased chemicals, instead in Drayton Valley and Alberta are more focused on woody biomass production, and Winnipeg and Manitoba pay more attention on biocomposite promotion [51]. The first federal policy approach in the framework of bioeconomy development was launched in 2017, with the adoption of a strategy paper named "A Forest Bioeconomy Framework for Canada" [52].

The Forest Bioeconomy Framework developed by the Canadian Council of Forest Ministers (CCFM), started as a public engagement campaign which is composed established the forum of Canadian bioeconomy. The campaign encompassed for promoting cooperation across the forest sector, involving more than 350 stakeholders from public bodies, business, academia, indigenous groups. The strategy particularly focus on converting forest-based resources into traditional forest products (such as pulp, paper and lumber) and into new high value products and services (including biofuels, biochemicals and advanced building materials), highlighting concepts like the circular, competitive and innovative character of the bioeconomy, the sustainable production and utilization of bioresources. In the same year, the Ministry of Environment and Climate Change further published a regulatory framework aimed to promote clean-tech economy and the development of lower carbon fuels.

In the strategy is proposed the establishment of a bioeconomy hub, as way to bring together various stakeholders, with the aim of ensuring continuous learning from best practices, moreover guarantee the access to bioeconomy-related networks and laboratories as well as the development of technology-driven business clusters. The federal innovation budget also includes substantial support for innovative business clusters and networks, in this contest the Forest Products Association of Canada (FPAC) and its partners submitted a bioeconomy supercluster proposal, the cluster is named the "BioDesign Super Cluster" and its focus is the circular approach to maximizing the value of biomass feedstock, this could be reached through connection nationwide the industrial players and other stakeholders facilitating the knowledge transfer, other ideas are the further supports for building green infrastructure and green spaces (so-called urban forests) to foster low-carbon and healthy communities [53].

Capacity building is primarily supported by training programs in engineering, biobased technology, the placement of more bioeconomy graduates in the forest sector. Trade is also supported by access to capital for biobased companies, including debt and equity financing. Tax incentives (such as accelerated capital cost allowances, etc.). The government also intends to support market development with the help of demand-side instruments, such as standards and certification schemes for sustainably produced bioproducts (e.g. lignin, pellets, and cellulose nanocrystals). For the demand side biobased products should be further stimulated by outreach and marketing activities, including science-based communication and information campaigns, and the introduction of procurement strategies and programs. There also the plan on improving policy coherence among existing initiatives, monitoring activities, which include life-cycle analysis and biomass data collection. In connection with this, the strategy also provides a first set of indicators for monitoring the progress made towards achieving a low-carbon forest bioeconomy in Canada. Some examples are indicators for measuring the contribution of biobased products and forest-based activities to the Canadian economy, indicators for quantifying the value of forest ecosystem goods and services, indicators measuring the forest bioeconomy's contribution to the reduction of greenhouse gas emissions.

## 1.4. SUMMARY

The Bioeconomy includes many productive sectors:

- agriculture;
- food (including feed), beverage and tobacco industry;
- wood products and furniture;
- biobased textiles;
- manufacture of paper and paper products;
- forestry;
- biobased chemicals;
- pharmaceuticals and plastics;
- fisheries and aquaculture;
- biofuels;
- biobased electricity.

Jobs and turnover in the European Union bioeconomy sectors of the Member States represent indexes of the bioeconomy development.

The governments in France, Italy, Austria, Latvia, Norway, Spain, Finland, Ireland have issued documents including bioeconomy strategy issues. Of particular relevance appear some initiatives. In Denmark, the Ministry of Environment and Food has set up a new Bioeconomy Council in 2017. Since 2017 in the Netherlands there is the "Bioeconomy Federation" (FBN) supporting the creation of a Scientific Council in charge to assess sustainability issues and stakeholders co-operation. On the whole, the survey indicates that the global upward trend in developing bioeconomy policies has rapidly increased in the last years. However, relevant differences appear among the Member States. In each country bioeconomy initiatives are stimulated by different national drivers, i.e.:

- climate change;
- energy security;
- fossil fuel reduction;
- relaunch of industrial sectors in crisis;
- employment;
- food security.

While clear targets are available in most countries for biofuels and bioenergy, a roadmap towards a higher biobased portfolio is still not fully consolidated. As a result implementation programmes are mostly missing and clear targets for replacement of fossil resources/products with renewable products are not available.

There is no agreed methodology to measure the realization of the targets that were set. There are differences among countries in the selection of the proper indexes to assess the bioeconomy contribution to the national economy. In Germany, a bioeconomy research strategy was financed by the Ministry of Education and Research (BMBF) in 2016. In late 2016, the Ministry of Food and Agriculture (BMEL) released a progress report monitoring the implementation of the German bioeconomy strategy. In order to develop a sound monitoring system for the bioeconomy, three research projects were funded by the government, addressing the main components of monitoring system, such as economic statistics data, the biomass resource base and sustainability, and a systematic modelling approach for bioeconomy. Monitoring results are expected by 2019. Bioeconomy monitoring systems are under development in many other countries, in terms of indicators under assessment as part of regional and national programs in countries as, France, Italy, Latvia, Spain, the UK, Australia, Canada, and USA.

In EU there are several financial opportunities to promote initiatives in the framework of bioeconomy. In particular, the European Structural Investment Funds (ESIF) makes available part of the overall EUR 450 billion budget (around USD 550 billion) for the period 2014-2020 to promote the bioeconomy development. The Central and Eastern European Bioregions Forum promotes the participation of stakeholders from business, academia and civil society and have prepared a declaration boosting the bioeconomy development in local "biocommunities", including bio-villages, biocities and bioregions. The Central-Eastern European Initiative for Knowledge-based Agriculture, Aquaculture and Forestry in the Bioeconomy (BIOEAST) is further promoting a strategic vision for bioeconomy development in Eastern Europe (Czech Republic, Hungary, Poland, Slovakia and Estonia), expanding the initiative to South Eastern Europe to countries like Bulgaria, Romania, Slovenia and Croatia. Similarly, Nordic Countries (including Denmark, Finland, Norway, Sweden, the Faroe Islands, Greenland and Iceland) are currently developing a common Nordic bioeconomy strategy. The experience built with these first macro regional programs will be used in promoting further cooperation on bioeconomy in all the Nordic countries. Baltic Sea Region macro-regional bioeconomy cooperation is for instance under development. In Europe, the BioBased Industries Joint Undertaking (BBI JU), with EUR 3.7 billion-backed public-private partnership (around USD 4.5 billion), is another important vehicle to promote bioeconomy development, fostering sustainable biomass production and use, its efficient conversion into high-value biobased products. The Biobased Industries Consortium (BIC) published the overview on biobased industrial opportunities in Europe.

## 2. Biorefineries mapping EU Member States and beyond

The IEA Bioenergy Task 42 “Biorefining” prepared the following definition on biorefinery: “Biorefining is the sustainable processing of biomass into a spectrum of biobased products (food, feed, chemicals, materials) and bioenergy (biofuels, power and/or heat) [59].

Mapping of biorefineries is an important way, for policy makers and stakeholders, to monitor the development of the emerging Bioeconomy Sector, and to help them to make decisions in order to maximise the benefits, what are not only economics, but also include social and environmental aspects.

Obtaining regular analysis and data is fundamental. Quantifying and benchmarking relevant sectors as biobased industries often faces challenges, i.e.: different classifications and definitions of biomass feedstocks, different schemes and classification for relevant biobased products, it is difficult to quantify the share of biobased products where they are output of hybrid processes (fossil/bio based).

Existing databases, like EUROSTAT and PRODCOM, have limited possibilities for gathering data on the biobased industry, as they are designed for a wider range of materials, where biomass-derived products are often a fraction of the data in the database. In general due to a lack of wide biomaterials standardization we miss a link between information on the origin of the raw materials and the amount of industrial biobased products as output.

In this chapter, starting with existing experiences carried out by US government, the European Biobased Industries Consortium (BIC) within the EU BBI JTI Programme, JRC Bioeconomy, and IEA Bioenergy, we test a collection system with the aim to put in place the foundation for building an harmonized biorefineries dataset with qualitative and quantitative data, with worldwide geographically covering.

The products included in the survey are: Biobased chemicals, including: platform chemicals, solvents, polymers, paints, coatings, inks, surfactants, cosmetics, adhesives, lubricants, plasticisers, stabilisers, enzymes and agrochemicals; Liquid biofuels, including: bioethanol, biodiesel and biobased jet fuel; Biobased composites and fibres, including: wood-plastic composites, natural fibres composites and different types of fabrics; Bioenergy and Bio-heat.

The chapter presents the biorefineries survey result, taken from the structured questionnaire already mentioned in this report, i.e. section G of the survey, that was targeted to a group of IEA Bioenergy NTLs involved, in a validation process towards the possible future harmonized and interoperable worldwide biorefineries database. Because of this testing process, the result is a validated sample of existing biorefineries, and consequently does not represent the full picture of global biorefineries market deployment.

## 2.1. METHODOLOGY

The IEA section G of the survey has targeted a group of IEA Bioenergy NTLs with the aim to have, from their representative countries, an overview of commercial, flagship, demo/pilot, R&D projects, and also of stakeholders involved in biorefineries deployment. The survey research, that was opened in September 2017, by inviting them to fill in the online survey, ended on January 2018.

The biorefineries were divided in three main categories Commercial, Flagship, and Demo-Pilot, according to different Technology Readiness Level (TRL) for the collection of info data according to the scheme in table 2.1. Overall, it was possible to develop a preliminary database of biorefineries producing biobased chemicals, biofuels, and biobased composites and fibres. Specific data are not shown since the distinction between the biorefineries products was not always feasible based on the available information.

	Name	Category	Country/ location	Owner	Capacity	Raw materials	Type of refining technology	Portfolio of products	Investments (private/public)	Weblink	Main contact
Biorefinery 1											
Biorefinery 2											
Biorefinery 3											
Biorefinery 4											
Biorefinery 5											

Table 2.1 – Biorefineries questionnaire, online survey section G.

For the data analysis the issues of assessment were: geographical information, capacity of the biorefineries, raw materials use, and portfolio of products produced. The first step was data acquisition from the survey on-line tool. The DB was converted to excel format, with the aim to facilitate data completeness and inconsistencies analysis. R-Cran script and programming was used. R is a high level programming language and environment for statistical computing and graphics. The source code for the R software environment is written primarily in C, Fortran, the data set obtained was analysed in order to harmonise the database and avoiding double counting.

For the Geographical information "biorefineries site", location in the survey was reported as nation or region, the DB was refined reporting town or geographical coordinates, producing the biorefineries mapping representation in GIS (Geographical Information System) environment. The raw data, exported from the online tool data collection system, were also compared with the existing dataset, using desktop research, starting the preliminary assessment on completeness and consistencies.

**2.2. COMMERCIAL BIOREFINERIES FROM SURVEY SAMPLE TEST**

The term Commercial is referred to “actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies” TRL (Technology Readiness Level) 9. On the base of the section G survey result, 32 commercial biorefineries were identified (figure 2.1).

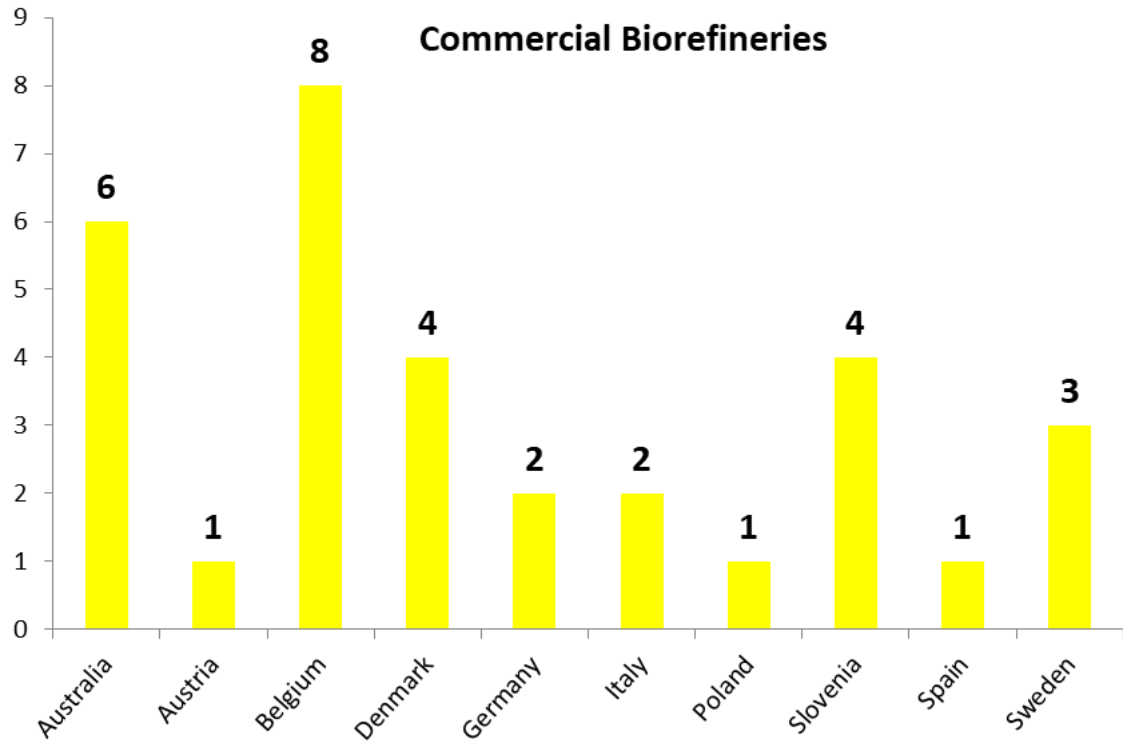


Figure 2.1 - Commercial biorefineries for each country that answered to the section G of the survey.

Figure 2.2 shows the location of the 26 (out of the 32 identified) commercial biorefineries in the Member States of the European Union that produce biobased chemicals, biofuels, and composites and fibres.



2.3. FLAGSHIP BIOREFINERIES FROM SURVEY SAMPLE TEST

The term flagship biorefinery plants is referring to units covering a value chain with a TRL 8 (system complete and qualified), operating at an economically viable scale. Flagships support the first application/deployment in the market of an innovation that has already been demonstrated but not yet applied/deployed in the market. 'First' means new at least to Europe or new at least to the application sector in question. Flagships deploy the (optimised) technologies and business models for biomass conversion into competitive added value products, i.e. intermediate products (materials, chemicals) or biobased 'consumer' products, and demonstrate cost and performance improvements to levels that are competitive with fossil-based alternatives or other non-renewable resources. Flagship plants are large-scale production facilities; they may be new installations, substantially remodelled existing facilities or reconverted old or abandoned industrial facilities. On the base of the section G survey result, 6 flagship biorefineries were identified (figure 2.3).

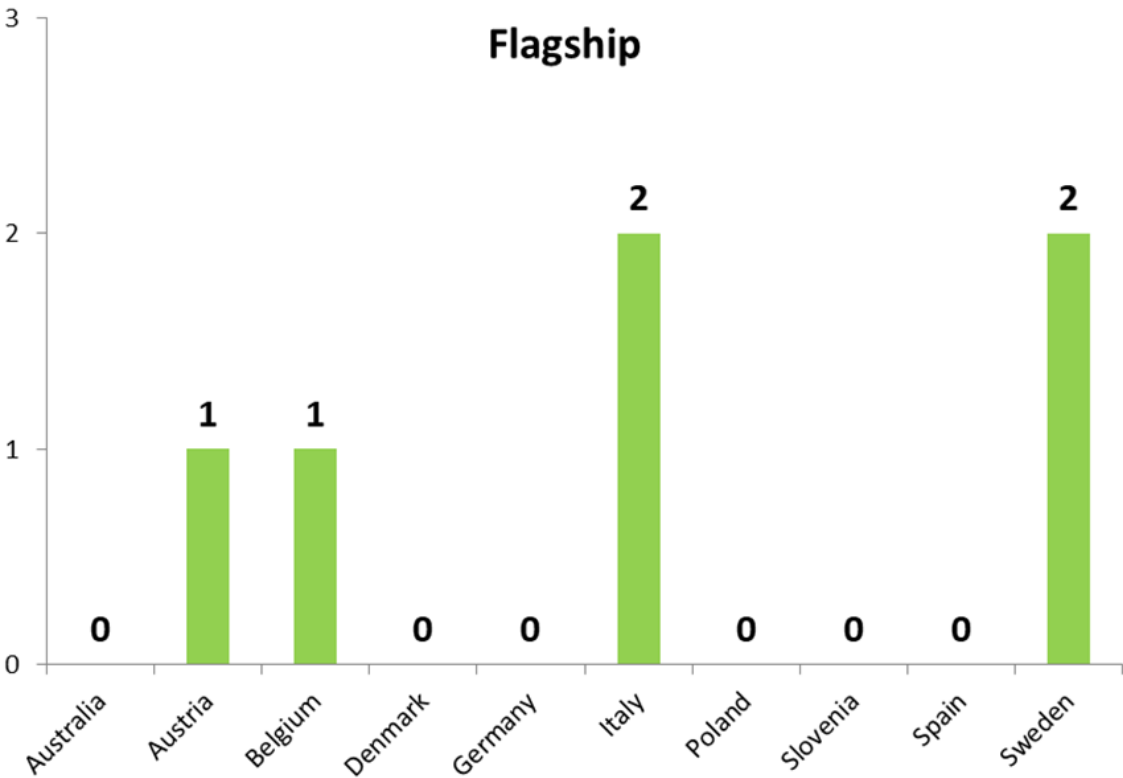


Figure 2.3 - Number of flagship biorefineries for each country that answered to the section G of the survey.

The figure 2.4 shows the location of the 6 flagship biorefineries that produce biobased chemicals, biofuels, and composites and fibres.



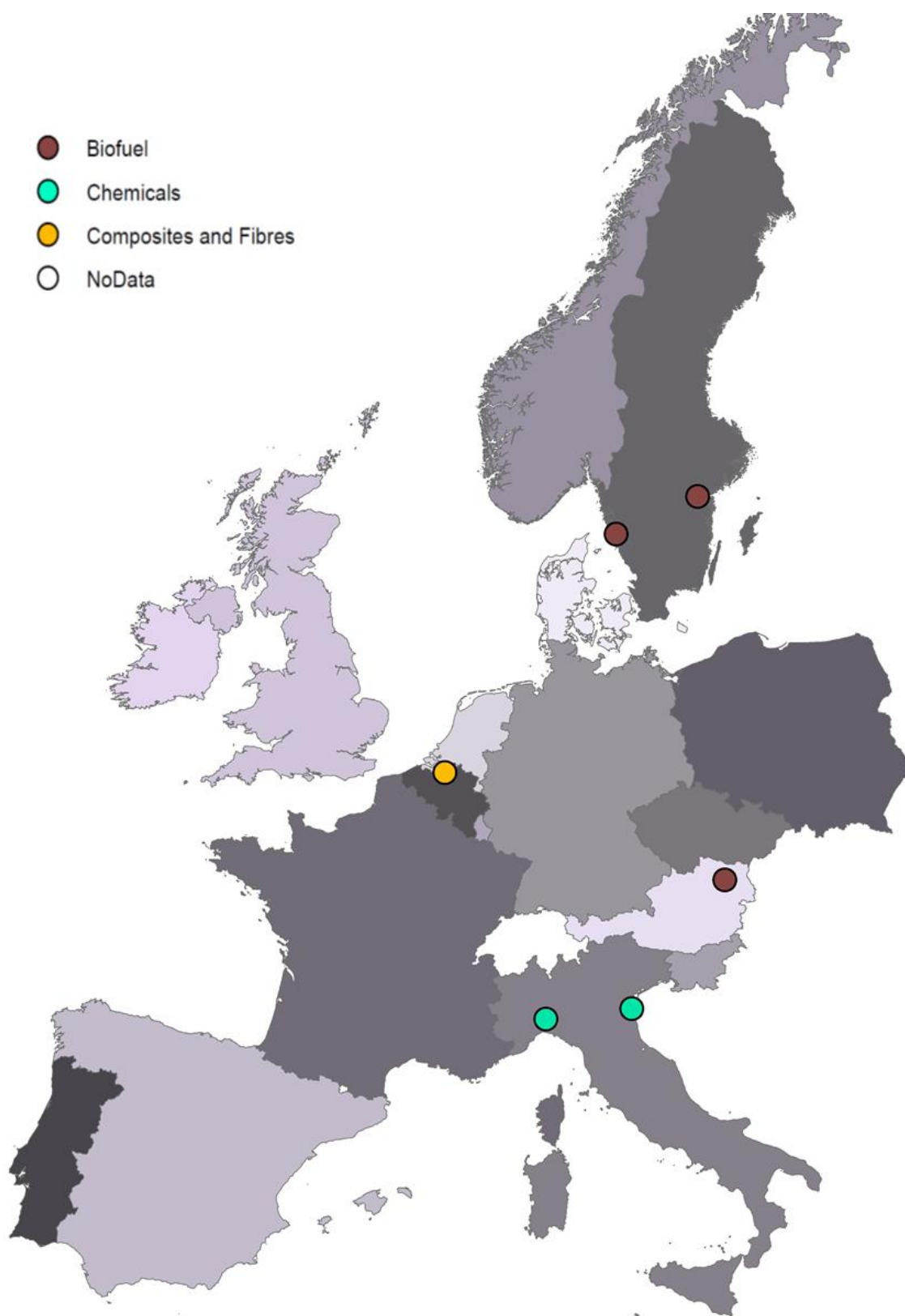


Figure 2.4 – Map of the 6 flagship biorefineries that produce biobased chemicals, biofuels, composites and fibres, sample test from survey data.

## 2.4. DEMO AND PILOT BIOREFINERIES FROM SURVEY SAMPLE TEST

The term Demo and Pilot is referred to “technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies) TRL 5, the technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies TRL 6 and – system prototype demonstration in operational environment TRL 7. On the base of the section G survey result, 24 Demo-Pilot biorefineries were identified (figure 2.5).

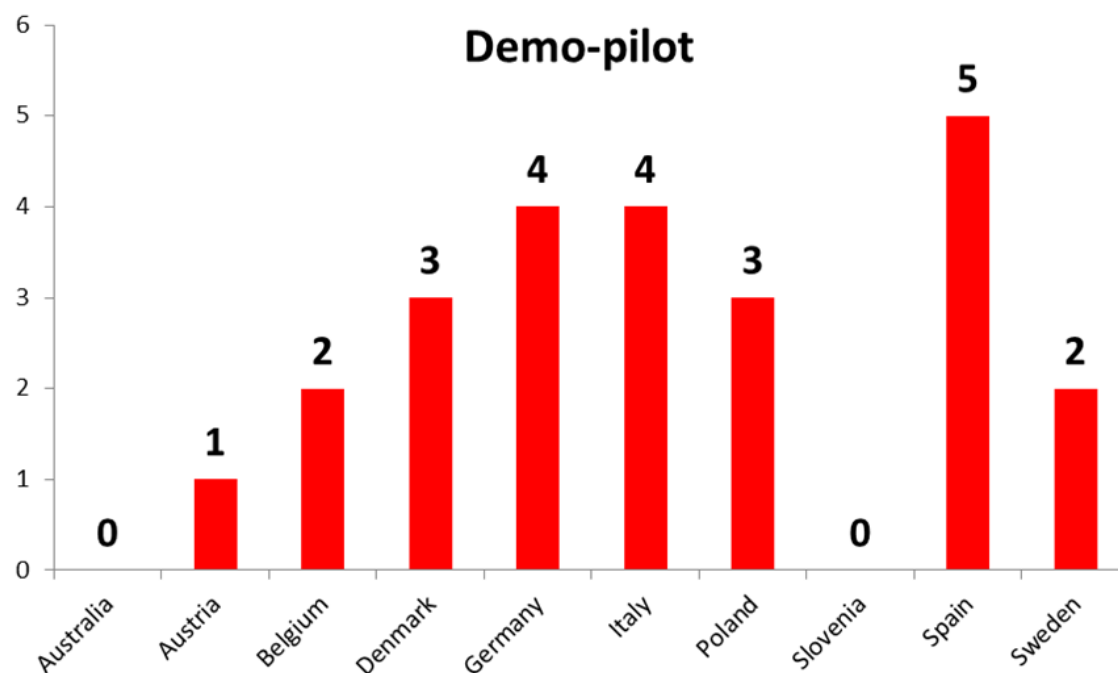


Figure 2.5 - Number of Demo-Pilot biorefineries for each country that answered to the section G of the survey.

The figure 2.6 shows the location of the 24 Demo-Pilot biorefineries that produce biobased chemicals, biofuels, and composites and fibres.

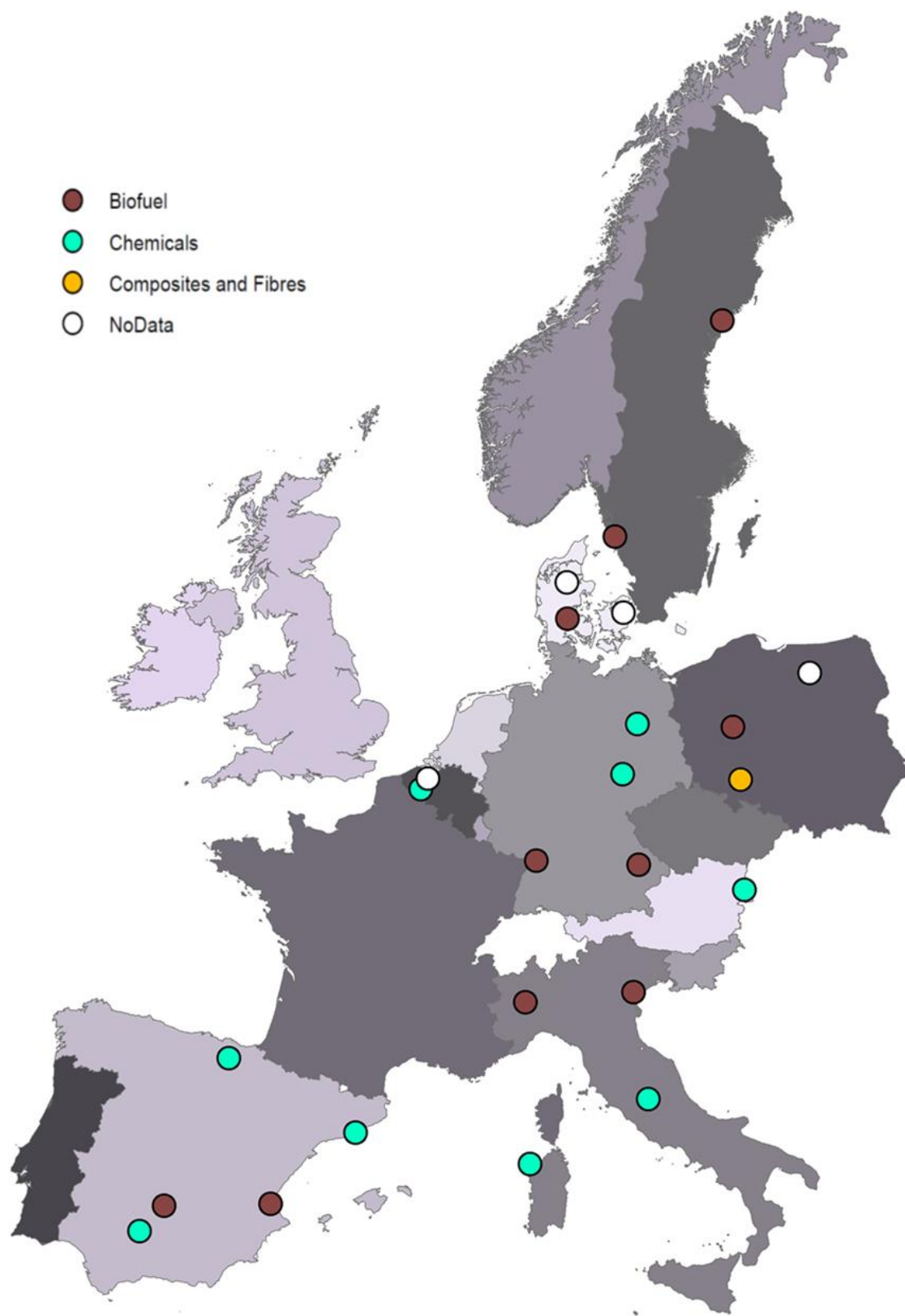


Figure 2.6 – Map of the 24 Demo-Pilot biorefineries that produce biobased chemicals, biofuels, and composites and fibres, sample test from survey data.

## 2.5. BIOREFINERIES GEOLOCATION

With the aim to support decision makers in assessing current biorefineries status and plan future development, the biorefineries in the database (DB) are geo-located (figure 2.7 and 2.8). The position is important as it influences logistical costs and related implications. There could be some advantages when bio-materials facilities installations occur near chemical industrial sites, as being located near other chemical companies enables easier access to specialised suppliers and service providers, it advantages integrated operations, sharing infrastructure. Further advantages could be linking the location of current biobased facilities with the specific kinds of locally available biomass, in future optimal locations of new biorefineries for the best exploitation of local resources (natural and industrial).

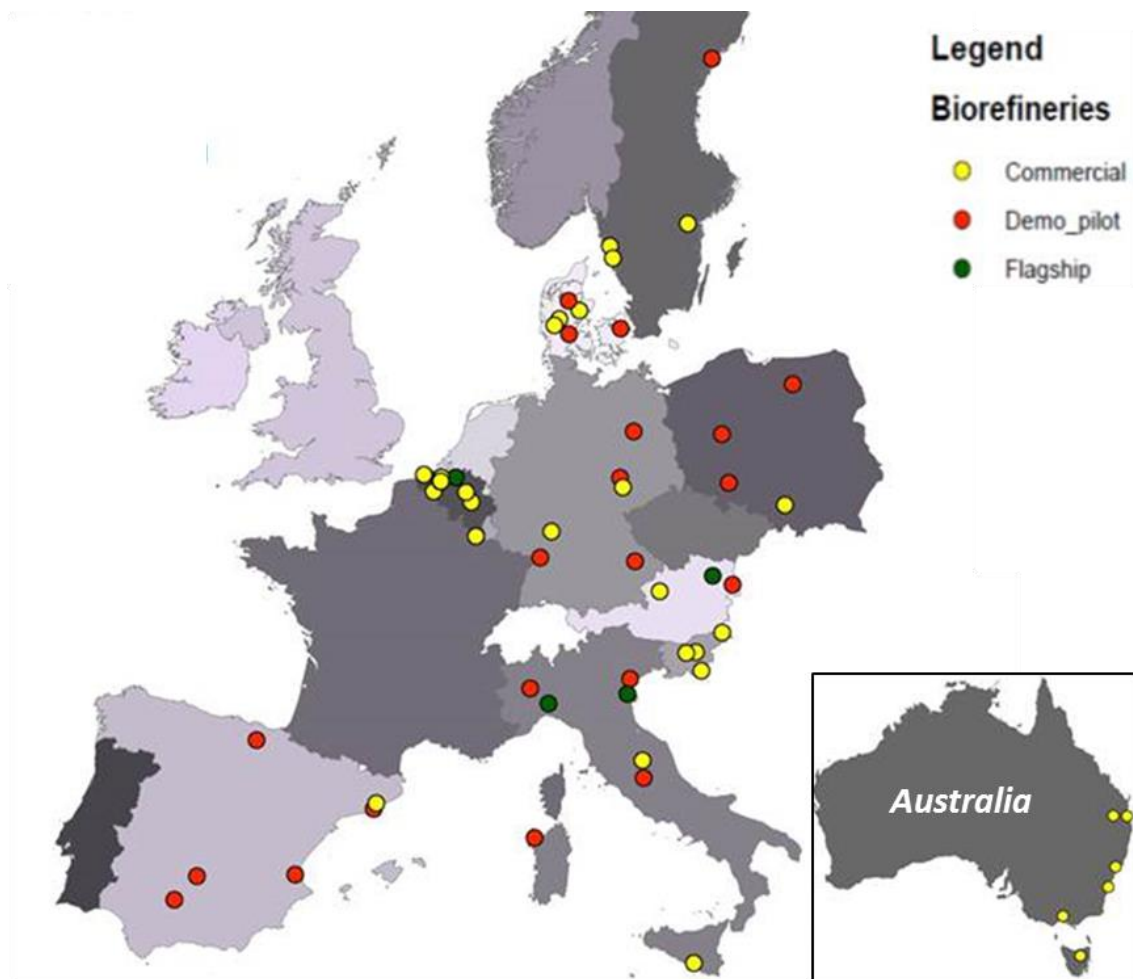


Figure 2.7 – Map of the 62 biorefineries with highlighted the three main categories (commercial, flagship, and demo-pilot), sample test from survey data.

Towards a process on biorefinery data base harmonization, the first assessment of existing databases produced by IEA Bioenergy, EC BIC/BBi and EC JRC has been made and mapped in figure 2.8. The validation process (qualitative and quantitative) will be part of the IEA Bioenergy Task 42 activities in triennium 2019-2021.

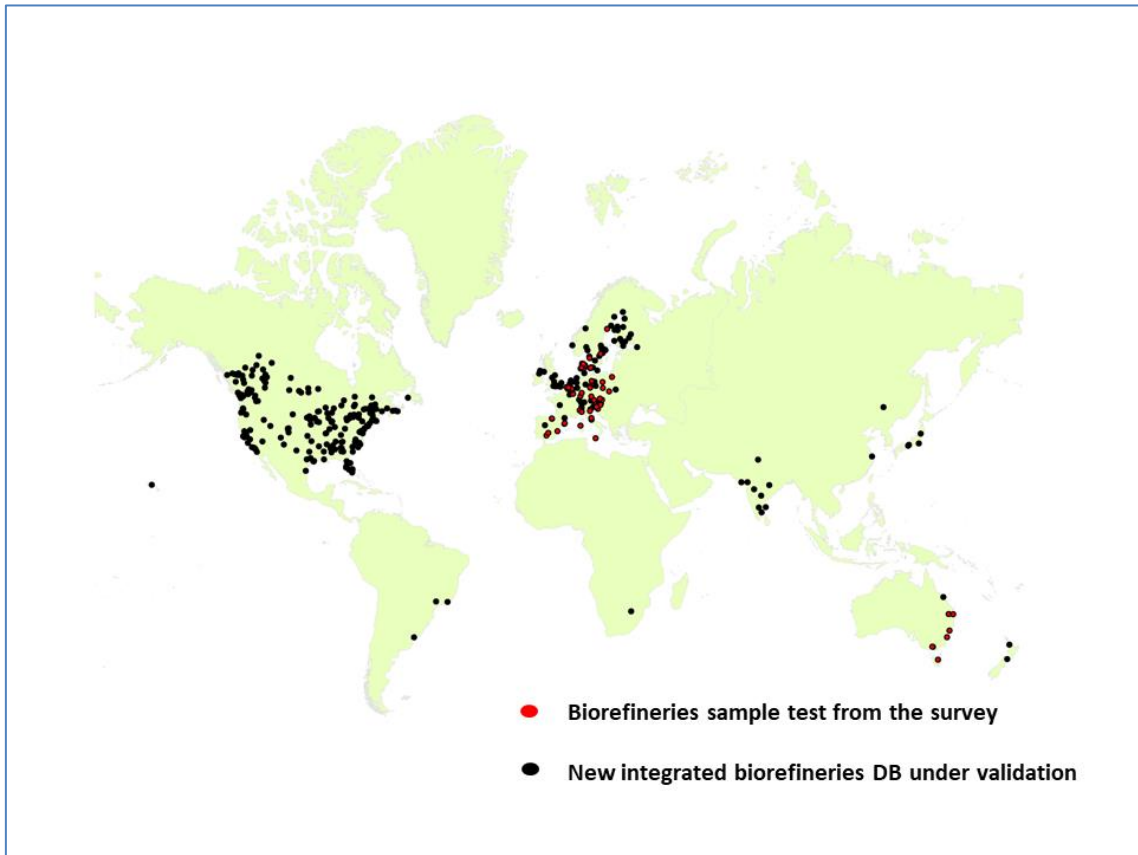


Figure 2.8 – Map of the biorefineries from the survey versus new integrated biorefineries data base under validation.

## 2.6. SUMMARY

Monitoring and mapping biorefineries is an important way, for policy makers and stakeholders, to monitor the development of this emerging economic sector, help them making decisions in order to maximise economics, social and environmental benefits. Several definitions of biorefinery have been elaborated in the last decades. According to the IEA Bioenergy task42, a biorefinery is intended as “Biorefining is the sustainable processing of biomass into a spectrum of biobased products (food, feed, chemicals, and materials) and bioenergy (biofuels, power and/or heat) [59].

The general objective of the biorefineries mapping task is to check a process to collect, analyse and map the current status of the biobased industry, with a preliminary picture representing countries participating the IEA Task 42. The results shown are based on the contribution of NTLs who fill in the online survey, section G “biorefineries”. On the base of the TRL classification, commercial, flagship, and demo & pilot facilities were included in the survey. Only Australia, Austria, Belgium, Denmark, Germany, Italy, Poland, Slovenia, Spain and Sweden answered to the section G of the survey. Overall, 62 biorefineries were identified of which 32 commercial, 6 flagships, and 24 demo-pilot facilities. Of these biorefineries, 14 produce biobased chemicals, 28 biofuels and 5 biobased composites and fibres. Specific data (15 biorefineries) are not shown since the distinction between the biorefineries products was not always feasible based on the available information.

The harmonization, standardization, interoperability of existing biorefinery databases, including a process of data gathering for the coming years is planned as follow up of testing process evaluated in this chapter.

### 3. Discussion, conclusions and follow-up

The lack of dedicated classification systems widely shared, and a systematic data collection approach, generates difficulties in comparing Bioeconomy and biorefinery deployment status among EU Member States and beyond.

There are many classifications of economic activities: International Standard Industrial Classification (ISIC), North American Industry Classification System (NAICS), Classification of Economic Activities in the European Community (NACE); Nomenclature for External Trade (NET); Classifier per Category (CPC); System of National Accounts (SNA). In general these systems do not incorporate measurement and monitoring of the Bioeconomy. They are based on the traditional industrial activities and are not conceived to classify the biobased industry. For this reason they are not appropriate for the heterogeneous nature and variety of biobased products. Their classifying criteria make no distinction into bio or other (fossil) inputs. This can lead to under or overestimation of the size of the Bioeconomy. This is in agreement with some recent analysis in the literature (Wierny, Coremberg, Costa, Trigo, & Regunaga, 2015) [55]. In facts, the high number of biobased products, heterogeneity of inputs and products, and the large amount of data that need to be collected, make it difficult to provide a fully quantitative picture of the status and evolution of the Bioeconomy (Nattrass, Biggs, Bauen, Parisi, & Gómez-Barbero, 2016) [56]. These surveys represented a starting point to map the Bioeconomy progress status. There were difficulties in preparing a proper and understandable questionnaire, and on the other side difficulties for the respondents to assemble the data requested, which probably generated incomplete responses.

Currently there is no homogenous definition of a Bioeconomy across the countries under screening, any straightforward comparison about the relevance of Bioeconomy in the different economies are not directly feasible. In general the Bioeconomy country's strategy mostly reflects national priorities that could be linked to availability of natural resources and prevalent national traditional industries. Some ongoing efforts aim to harmonize the definition and measurement of the Bioeconomy, for instance across EU macro-regions are in place. These efforts will allow to have structured and comparable measurement and monitoring of the trends in the Bioeconomy, at least for some sets of countries (EC, 2018) [57].

Concerning the size of the Biobased Economy (BBE), many challenges emerge. There are many different products and intermediates (particularly in the chemical sector), therefore biobased materials can be difficult to quantify. It is not clear how much biobased raw material is actually used in particular in the chemical sector. Unlike fuels, chemicals and materials are often intermediates for the production of several final products. They can be moved over along to the production chain, and this could potentially generate double counting. Raw materials for green chemistry often come from the agriculture and this could be in competition with food and feed sector.

In order to facilitate the measurement and monitoring of the Bioeconomy, the governments are trying to connect different domestic agencies, try to start protocols for sharing data, and fund clusters stimulating cooperation between stakeholders. FAO is already coordinating international efforts towards the development of an international Bioeconomy also providing a guideline (FAO 2106) [58].

The harmonization, standardization, interoperability of existing biorefinery databases, including a process of data gathering for the coming years, is planned as follow up of the testing process evaluated in this report.

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