The bioeconomy and a future biobased food industry and agriculture sector: **How can workers'organisations shape the change?**

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Short report

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Areté Research & Consulting in Economics

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Disclaimer

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Foreword

The **European Federation of food, agriculture and tourism trade unions, EFFAT**, is a single umbrella organisation serving trade unions throughout the food processing chain in Europe, "from field to fork". Our 120 national member organisations bring together over 2.6 million union affiliates and represent workers in all branches of agriculture, in food processing and its allied industries, and in the hotel, restaurant, catering and tourism sector.

EFFAT is committed to **promoting the rights of workers in food production, agriculture and tourism. Safe, high-quality jobs based on safe food, sustainable agriculture and sustainable tourism and decent work conditions are key objectives** of our work.

The agriculture sector and the food industry are changing as they need to respond to environment, human health and world sustainability challenges. Biological resources need to be better used, so there can be food for more people with less environmental and climate impact per unit produced, and renewable biological material enough to produce the replacement for what we currently get from fossil crude oil. New green technologies are of paramount importance for developing a stronger biobased food industry.

This major change is progressively having an impact on jobs and skills as we currently know them, and does raise many questions for the current and future role of trade unions and workers' representatives in the food industry and the agriculture sector.

This report is the outcome of a project to help food and agriculture trade unions across Europe, including candidate countries, to:

- increase their knowledge in **understanding what the bioeconomy means for their industry, sector, jobs and skills**, and
- increase their capacity in **responding to the change towards a bioeconomy, and being part of industry-relevant and sector-led solutions**.

With **financial support from the EU Commission**, EFFAT food and drink, and agriculture sectors have worked with consultants, Areté Research & Consulting in Economics, to allow food and agriculture trade unions to have the **necessary tools to contribute to EU policy making**, in particular in the field of the greening of the economy, job creation and job matching, quality of work, skills and decent work.

We hope that this report will help everyone who is looking for understanding the bioeconomy, information sharing and common approaches to solving shared problems.

Executive summary

The study is based on information and insights collected through a combination of desk research and interviews with key stakeholders, carried out in the framework of a selection of case studies focusing on a wide range of processes aimed at adding value to biomass. The study mainly focused on the **implications of bioeconomy in terms of job creation / required skills of workers in the food industry**, but also considered the linkages with other activities and industries (including those dealing with non-food products and energy generation).

The European Commission defines **bioeconomy** as "the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products as well as bio-energy". In practical terms, the bioeconomy covers all the sectors of the economy that rely on production and processing of biological resources, like agriculture, fisheries, food, forestry, chemicals, materials, soil improvers and bioenergy.

Bioeconomy is a key contributor to economic growth and employment across the EU. According to the European Commission, the total turnover of bioeconomy sectors in the EU was estimated at 2,259 billion Euros in 2015; in the same year, bioeconomy employed around 18 million workers, mostly in agriculture and in the manufacturing of food, beverages and tobacco. Estimates and projections from authoritative sources suggest that **bioeconomy as a whole has a remarkable potential in terms of prospective employment creation**. According to industry estimates cited in the European Commission *Bioeconomy Action Plan 2018*[1], the EU bioeconomy can create up to one million new green jobs by 2030, in particular in rural and coastal areas. The importance of the contribution of agriculture and of the food industry to total employment in the bioeconomy may decrease in the future, even though this general trend may be offset, at least in part, by increases in employment in the forestry and "blue bioeconomy" (biomass from oceans and inland waters). It is likely that most of the growth in employment will take place in non-food sectors (including liquid biofuels and bioenergy), as well as in support services (logistics, equipment and input production, etc.): this implies that **trade unions representing agriculture and food industry workers** should **pay attention to the development of biobased value chains in non-food industries**, should not overlook the **expansion of support services**, and should **enhance their cooperation with the relevant trade unions**.

The study revealed that in many ways **the bioeconomy resembles food processing and the chemical industry**, since these industries make use of highly automated processing equipment, the production is process-oriented, and the industries process biomass into products and materials. The case studies also revealed that **the principles, processes and skills used in the food industry and for processing of biomass are quite transversal**. The study also showed that **besides positive effects in terms of employment creation** (which may be significant), the development of biobased value chains (including non-food ones) can improve the profitability of food companies, and hence **contribute positively to the safeguard of employment levels in the food industry**. The **importance of establishing inter-sectoral linkages** and of **promoting cooperation among diverse groups of stakeholders** as conditions for the development of biobased value chains clearly emerged from the study. These conditions are especially important for developing **large-scale biobased industrial clusters**, which have **significant potential in terms of employment creation**.

[1] European Commission (2018), *Bioeconomy: the European way to use our natural resources – Action plan 2018*, Directorate-General for Research and Innovation - Unit F – Bioeconomy.

The study also revealed that the **development of biobased value chains in the agro-food system** faces a number of **challenges and constraints**: some of these **affect workers**, and have **direct implications for trade unions**:

- With special respect to **job creation**, it should be noted that some biobased processes require substantial capital investments, but relatively limited workforce (capital-intensive processes rather than labour-intensive processes).

- The **sectoral focus of many initiatives for the development of biobased value chains** may prevent them from exploiting inter-sectoral synergies. The biggest potential for job creation, or at least for safeguard of current occupation levels, is offered by an inter-sectoral approach in the development of biobased value chains.

- Finally, there is the issue of the **allocation of value among the various actors** involved in biobased chains, with a special attention for the **share allocated to workers**.

Challenges for **workers** can be addressed by trade unions alone, or through their cooperation/dialogue with other stakeholders (business operators, policymakers, civil society, etc.).

The study showed that **bioeconomy is above all characterised by diversity**. To successfully develop new biobased value chains, such **diversity needs to be taken into account, to be properly understood, and to be adequately dealt with**: failure in doing that can lead to missed opportunities and/or to unaddressed challenges which can put the success of the related initiatives at risk.

The study also highlighted the **critical conditions to be met** to ensure that the potential of bioeconomy in terms of employment creation (or, at least, of safeguard of current employment levels) is fully exploited:

1. The application of the "**cascading approach**"[2] to fully unlock the potential for adding value to biomass without negative environmental side effects.

2. Establishing **inter-sectoral linkages** (between farming and processing; between food and non-food value chains) and **cooperation among different groups of stakeholders** (business operators; research centres and education centres; institutions and policymakers; civil society; etc.) to fully exploit the aforementioned diversity and to implement the "cascading approach".

3. Establishing an **adequate policy / regulatory framework**, in order to:

   a. Minimise regulatory constraints to full exploitation of biomass in value adding processes, **without prejudice to social standards and environment conservation**

   b. Provide financial support and incentives to business operators, research centres and education centres.

The study findings clearly suggest that trade unions should not only **look at the development of the bioeconomy with great attention**, but should **also play a role in shaping that development**. In other words, trade unions should **define a "bioeconomy they want"**, and should **actively contribute to the realisation of a model of bioeconomy which is consistent with their values and goals**.

[2] Cascading involves obtaining the most valuable products in the first stages of biomass processing, and lower-value products only in successive stages; only the residues from biomass processing into biobased products are finally used to generate energy. The cascading approach also allows to minimise waste, with positive implications for the development of an environmentally sustainable bioeconomy.

EFFAT deems that the bioeconomy of the future should be socially, economically and environmentally sustainable.

A SOCIALLY SUSTAINABLE BIOECONOMY

The development of bioeconomy should be an inclusive process: young people and unemployed people should be given a chance to find a job in the bioeconomy. This implies **promoting an adequate educational offer**, including hands-on training in biobased production units.

AN ECONOMICALLY SUSTAINABLE BIOECONOMY

The study revealed that **diversification into non-food biobased value chains** can improve the profitability of the involved food business operators, with **positive implications for the safeguard of current employment levels in the food industry**. This finding reinforces the **importance of an inter-sectoral approach to bioeconomy**. The study also showed that new biobased value chains can be successfully implemented at different scales. Even if the potential for employment creation in large-scale industrial clusters is generally much higher, this development model may be unsuitable for some processes, or unfeasible in certain contexts. The **potential for employment creation of smaller biobased production units should hence not be overlooked**, especially where those units can be built in significant numbers.

AN ENVIRONMENTALLY SUSTAINABLE BIOECONOMY

Last but not least, the development of the bioeconomy should **contribute to enhanced environmental conservation and more effective action against climate change**. To these ends, the development of biobased value chains should: i) be supported by a comprehensive analysis of their environmental/climate change implications; wherever these are negative, adequate **mitigating measures** should be taken; ii) **apply the "cascading approach"**, by virtue of its **waste-minimising effects**.

The study allowed the elaboration of **recommendations** aimed at **promoting the development of a socially, economically and environmentally sustainable bioeconomy**, along the lines defined above. To that end, trade unions and workers' representatives should:

1. Undertake initiatives aimed at **improving their knowledge of the bioeconomy**.
2. **Strengthen trade union solidarity and cooperation across sectors**.
3. Consider the possibility to **invest part of the financial resources available to them** (e.g. those related to workers' retirement funds) **in projects for developing new biobased value chains that are socially, economically, and environmentally sustainable**.

4. Contribute actively to the **adaptation of the existing EU-level and national-level instruments** to promote the development of the bioeconomy, as well as to **the elaboration of new ones**.

5. Contribute actively to the **elaboration of EU-level and national-level initiatives aimed at promoting the development of bioeconomy** (e.g. through research and education, granting of financial incentives, minimisation of regulatory constraints, etc.).

In order to **promote employment creation in the bioeconomy**, and to **ensure that workers have adequate skills for working in the bioeconomy**, trade unions and workers' representatives should:

6. Undertake initiatives aimed at: A) **Improving their knowledge of the implications of the bioeconomy in terms of employment and required skills of workers**. B) **Improving awareness of, and general knowledge about bioeconomy among workers** (e.g. through elaboration of informative material). C) **Helping unemployed workers to access technical education in the field of bioeconomy**, with a view to improving their chances of finding a job in the related sectors.

7. Consider the possibility to **invest part of the financial resources available to them** (e.g. those related to workers' retirement funds) **in initiatives aimed at providing workers with technical education in the field of bioeconomy**, always with a view to improving their chances of finding a job in the related sectors.

Glossary of terms

Biobased industrial cluster: combination of separate plants performing technologically linked *biomass processing* (see) activities: the plants are concentrated in the same industrial site, close to one another.

Biobased products: products obtained from *biomass conversion / processing* (see) in a *biobased value chain* (see). These include *biomaterials* (see) and *biofuels* (see).

Biobased value chain: system for adding value to *biomass* (see) through a sequence of processes. Biobased value chains usually see the involvement of different actors (farmers, processors, traders and distributors, service providers, suppliers of production inputs, etc.), each performing specific functions

Biochemicals: chemical products for a wide range of applications (paints, solvents, etc.) obtained from *biomass conversion / processing* (see).

Bioeconomy / biobased economy: production of renewable biological resources (see "biomass") and the conversion of these resources and waste streams into value added products (see "biobased value chain" and "biomass conversion / processing"), such as food, feed, biobased products (see) as well as bioenergy (see).

Bioenergy: energy (heat, electricity or both) obtained from *biomass conversion / processing* (see).

Biofuels: fuels (for heating, for transportation, for industrial uses, etc.) obtained from *biomass conversion / processing* (see). Biofuels include: biodiesel (mostly obtained from vegetable oils); bioethanol (alcohol obtained from *biomass* (see) containing carbohydrates: sugar cane, sugar beet, cereals, cellulose, wood, etc.); biogas (obtained from digestion of *biomass* (see) by microorganisms in particular conditions.

Biomass: renewable raw materials – residues and side streams from production processes, or biological feedstocks from forestry, agriculture, aquaculture and fisheries - which can be converted into several *biobased products* (see) and into *bioenergy* (see). Details on the different types of biomass used in *biobased value chains* (see) are provided at § 1.4 of the study.

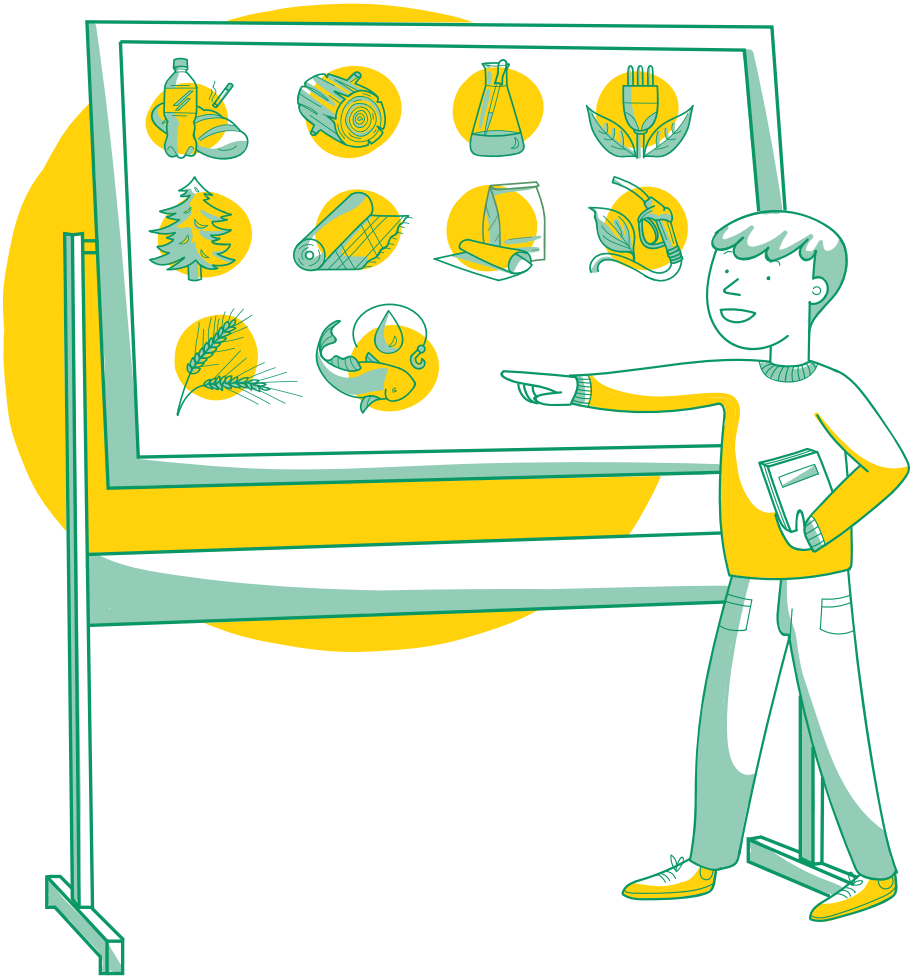
Biomass conversion / processing: combination of activities aimed at obtaining *biobased products* (see) and *bioenergy* (see) from biomass. Biomass conversion can be carried out in a single integrated plant called *biorefinery* (see) or in a combination of technologically linked but separate plants, which may either be concentrated in a *biobased industrial cluster* (see) or located distant from one another.

Biomaterials: materials (for construction, insulation, etc.) obtained from *biomass conversion / processing* (see).

Biorefinery / biorefining: integrated processing plant using *biomass* (see) as raw material. Biorefineries convert biomass into: i) a wide spectrum of *biobased products* (see), such as food and feed, *biomaterials* (see), *biochemicals* (see), *biofuels* (see); *bioenergy* (see). The most advanced types of biorefineries apply the so-called *cascading approach* (see) to unlock the full potential of *biomass conversion* (see). A more detailed explanation of the concept of biorefinery and of its practical applications is provided at § 1.5 of the study.

Cascading approach: the so called cascading approach involves obtaining the most valuable *biobased products* (see) in the first stages of *biomass processing* (see), and lower-value products only in successive stages; only the residues from biomass processing into biobased products are finally used to generate *bioenergy* (see). A more detailed explanation of the concept of cascading approach and of its practical applications is provided at § 1.6 of the study.

1 Understanding the bioeconomy



1.1 Methodological approach

The study is based on information and insights collected through a combination of desk research and interviews with key stakeholders. The study mainly focused on the **implications of bioeconomy in terms of job creation / required skills of workers in the food industry**, but also considered the linkages with other activities and industries (including those dealing with non-food products and energy generation).

Relevant literature was reviewed to explain the basic concepts behind the bioeconomy (§ 1.2 to § 1.6), to provide an overview of its current importance in the EU (§ 2.1) and to outline the key elements of the related policy framework (§ 2.2). It is important to underline that the focus of the study was not the elaboration of original EU-wide estimates of the current and future importance of the bioeconomy in terms of employment creation. Nevertheless, the study provides some insights on the potential of the bioeconomy in that respect by reporting some figures from authoritative sources.

Case studies covering a wide range of concrete applications of biobased technologies in the development of new value chains (§ 3) allowed to investigate on the related organisational solutions, on changes in

production processes stemming from the bioeconomy, on its effects on the use of labour, and on the new skills required to work in the bioeconomy.

The case study findings allowed to draw **conclusions** (§ 4) on the challenges and opportunities of the bioeconomy in the EU agribusiness system, on the application of skills for working in the bioeconomy and on how those skills can be obtained, and on future prospects of working in the bioeconomy.

The knowledge base developed in the study allowed to formulate a number of **operational recommendations** (§ 6) aimed at promoting the development of a **"bioeconomy model"** (§ 5) which is consistent with EFFAT's mission and institutional objectives.

1.2 What is bioeconomy?

Bioeconomy is at the same time a traditional concept and a new one. In fact, even if the term "bioeconomy" is relatively new, it involves the oldest economic sectors which have been central to the development of the humanity, like agriculture, food production, fuel production and bioenergy (heat and electricity) production by combustion. However, it is also a new sector because it is centred on research, innovation and biotechnologies, with a view to using biological resources better and wasting less. In this light, bioeconomy focuses on new opportunities in both traditional and emerging biobased sectors, including health promoting ingredients, food, feed, textiles, paper and pulp, biofuels, biogas and soil improvers.

A single **definition of bioeconomy** is difficult to establish, given the wide concept which is behind this term. For the European Commission, bioeconomy is "the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products as well as bio-energy". In practical terms, the bioeconomy covers all the sectors of the economy that rely on production and processing of biological resources, like agriculture, fisheries, food, forestry, chemicals, materials, soil improvers and bioenergy.

1.3 Why bioeconomy?

The agro-food system is generally considered as a major responsible for several problems emerged or under discussion in the last decade: climate change (by CO2 and methane emissions), biodiversity loss, use of natural resources (e.g. water), increasing pollution (pesticide residues in drinking water and surplus nutrients ending up in rivers, lakes and coastal shallow waters), and leading to increased occurrence of antibiotic resistance. In addition, other global challenges like the increasing world population and the changing consumption patterns in several areas of the world, contribute to increasing the pressure on natural resources. It is therefore of utmost importance to enable a more efficient use of resources and to minimise waste, unlocking the full potential of biological resources.

Bioeconomy is generally identified as a **potential solution to major global/regional threats**:

- **Feeding the world´s rapidly growing population**[3]

[3] According to the United Nations, the current world population of 7.6 billion is expected to reach 8.6 billion in 2030, 9.8 billion in 2050 and 11.2 billion in 2100.

- **Mitigating climate change**[4]

- **Reduced EU industrial competitiveness and loss of jobs, in particular in rural areas:** according to the European Investment Bank[5] , Europe has experienced a two-decade long decline in competitiveness and productivity growth.

The opportunities stemming from the transition to a biobased economy are immense. **Concrete potential benefits of bioeconomy** include the following:

- **Reduction of greenhouse gas emissions and decrease in dependence on fossil resources:** from a climate change perspective, the key importance of the use of biomass resources in economic sectors beyond food and feed production is to reduce carbon emissions caused by the use of fossil resources.

- **Wiser management of natural resources.**

- **Opportunities for adding value to by-products, waste and residues from food and feed production processes**, which become feedstocks for biobased processes to obtain a wide range of food and non-food products and to generate energy.

- **Opportunities for employment creation** in the different stages of food and non-food biobased value chains and in support activities (logistics, research and development, etc.). As explained in more detail at § 2.1.2, agriculture accounts for 51% of total employment in the EU bioeconomy (9.2 million workers), whereas manufacture of food, beverage and tobacco accounts for 25% (4.5 million workers). The contribution of non-food value chains to total employment in the bioeconomy is bound to increase in the future.

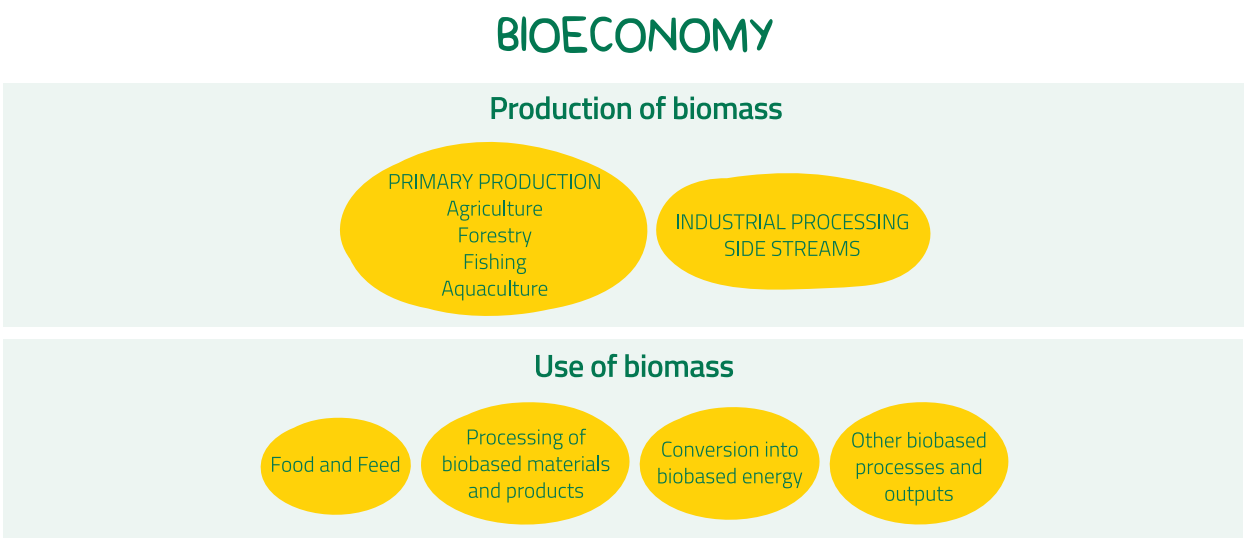
1.4 Biomass, biorefineries, the cascading approach and the value pyramid

Biomass is any renewable raw material - residues, side streams or biological feedstocks - which can be converted into several biobased value added products and into bioenergy.

Figure 1.1 shows a very simplified overview of the **key sources of biomass** and of the main uses of biomass in the bioeconomy.

[4] According to the United Nations, 17 of the 18 warmest years on record have occurred in the twenty-first century.
[5] European Investment Bank (2016), *Restoring EU competitiveness* (updated version).

Figure 1.1 – Key sources and main uses of biomass in the bioeconomy
Source: Areté elaboration on Spatial Foresight, SWECO, ÖIR, t33, Nordregio, Berman Group, Infyde (2017), Bioeconomy development in EU regions. Mapping of EU Member States'/regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy for 2014-2020



A large variety of feedstocks can be processed into biobased products and bioenergy. Some, like food products, are already important factors in the economy. Others, like crop residues, industrial side-streams and bio-waste, already exist but have so far had little economic value. The agriculture, forestry, fishing, aquaculture and waste (industrial and domestic) sectors can provide potential feedstock for the production of biobased products.

In general, the use of biomass is subject to intense discussion, in particular when it is used for energy production. It should be noted that the so-called "first-generation" biofuels were produced from food crops such as maize, sugarcane and palm oil. The production of biofuels from these sources, but more in general the use of these resources in the bioeconomy, is in competition with the production of food: the carrying out of the related activities has several ethical implications, in particular in the current scenario of increasing global population. **The competition between food use and other uses** is a major problem when biomasses are imported from developing countries, in which food production is strategic for ensuring the livelihood of population.

The key technological concept in the bioeconomy is known as "**biorefinery**", which is an **integrated processing plant using biomass as raw material**. In biorefineries, biomass is converted into a wide spectrum of products such as food and feed, biomaterials, biochemicals, biofuels and bioenergy. There were **803 operational biorefineries in the EU in 2018**[6].

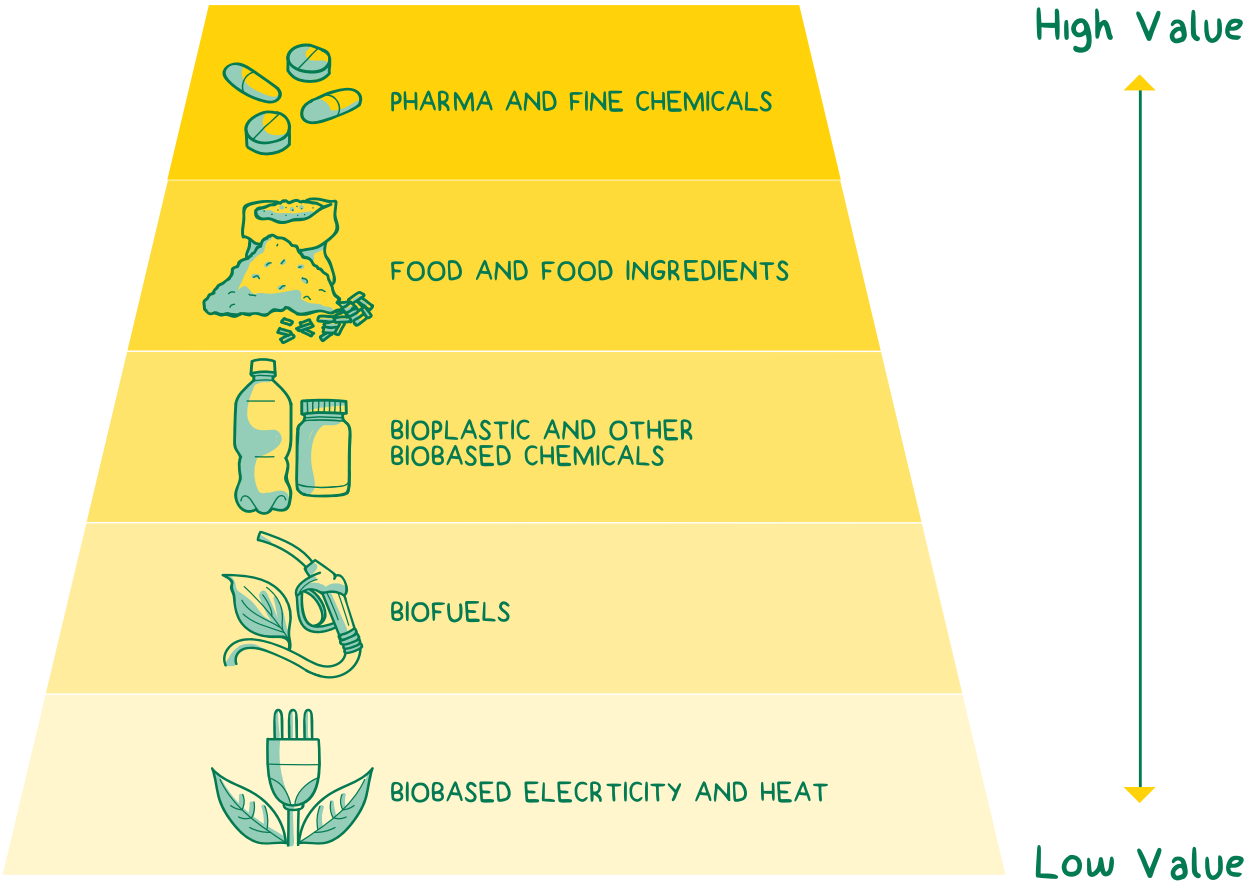
The **biorefinery** and the **principle of cascading use of biomass** are **complementary concepts**. Cascading involves obtaining the most valuable products in the first stages of biomass processing, and lower-value products only in successive stages; only the residues from biomass processing into biobased products are finally used to generate energy. A key factor in the realisation of a successful bio-based economy is the production of a wide range of biobased products in combination with bioenergy, with a view to substituting fossil-derived equivalent products by processing a wide variety of biological feedstocks. With respect to the agro-food system, materials that were previously considered as waste can now be used as feedstocks for production of new added-value products, hence adding value to side streams from agro-industrial production processes. Bioeconomy differs from traditional approaches to the use of natural resources. The traditional approach generally uses natural resources

[6] Parisi, C. (2018), *Research Brief: Biorefineries distribution in the EU*, European Commission - Joint Research Centre.

for one purpose only (e.g. crops for food/feed or wood for energy). By contrast, the **bioeconomy uses natural resources for several purposes, and also minimises waste**.

The **economic value of biomass** is determined by the value added it can generate, i.e. by the difference between the revenue from the various products marketed and the production costs (capital costs and operational costs) of those products. Biomaterials (e.g. polymers) are in general the biobased products with the highest value added, followed by bioechemicals (e.g. flavours, proteins, fine chemicals), biofuels (e.g. bioethanol, biodiesel, biogas) and bioenergy (e.g. wood pellets for direct combustion -> combined heat and power generation). In most of the cases, products with a relatively high market value are associated with high production costs, and vice versa. Furthermore, products with a high market value generally have a relatively small market (e.g. specialty chemicals) and vice versa (e.g. biofuels). Figure 1.2 below shows the **growing added value of products originating from biomass**, that is, the so called "value pyramid". The term value chain (or value added chain) reflects the fact that the processing of biomass implies an increase in the value obtained in each step. It should be noted that the development of new biobased value chains requires cooperation between previously unconnected sectors.

Figure 1.2 - Added value of biobased products
Source: United Federation of Danish Workers 3F (2016), The fundamentals of bioecomomy. The biobased society.



2 The state of the art of bioeconomy in Europe

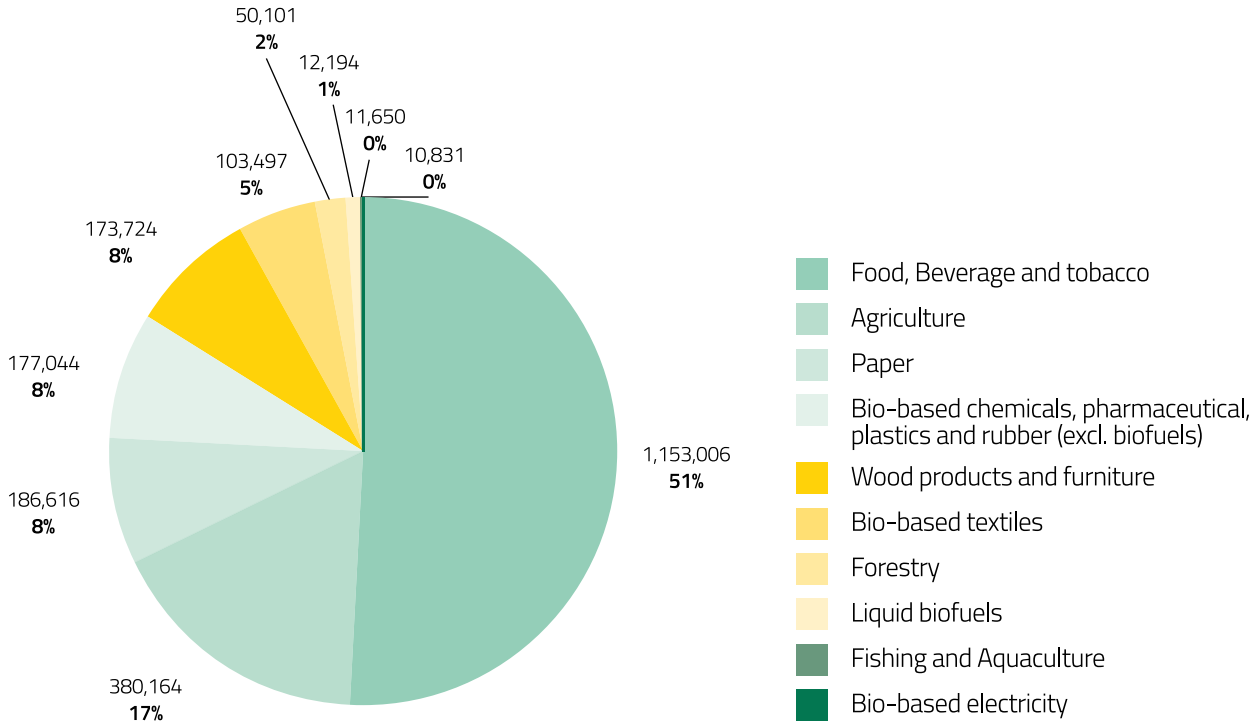
2.1 The state of the art in bioeconomy sectors

2.1.1 TURNOVER OF EU BIOECONOMY

Bioeconomy is a key contributor to economic growth across the EU: in 2015, the total turnover of bioeconomy sectors in the EU was estimated at 2,259 billion Euros.

Figure 2.1 illustrates the turnover of each bioeconomy sector in the EU. Manufacture of food and beverages and the agricultural sector were by far the largest contributors to the EU bioeconomy turnover. Food and beverage (and tobacco) accounted for 51% of the overall turnover, while agriculture accounted for 17%.

Figure 2.1- EU turnover of bioeconomy sectors in 2015 (million Euros)
Source: JRC data portal (https://datam.jrc.ec.europa.eu/datam/mashup/BIOECONOMICS/index.html)



Between 2008 and 2015, the turnover of the EU bioeconomy (Figure 2.2) grew by approximately 169 billion Euros (an 8.1% increase). In absolute terms, the growth is mainly driven by the development of bioeconomy in the manufacture of food, beverages and tobacco products (+114 billion), and to a lesser extent by the development of bioeconomy in agriculture (+23 billion) and in the production of biochemicals, biopharmaceuticals, bioplastics and biorubber (+21 billion). In relative terms, the most impressive growth has been recorded by generation of biobased electricity (+115.6% from 2008 to 2015), forestry (+29.5%) and fishing and aquaculture (+18.3%).

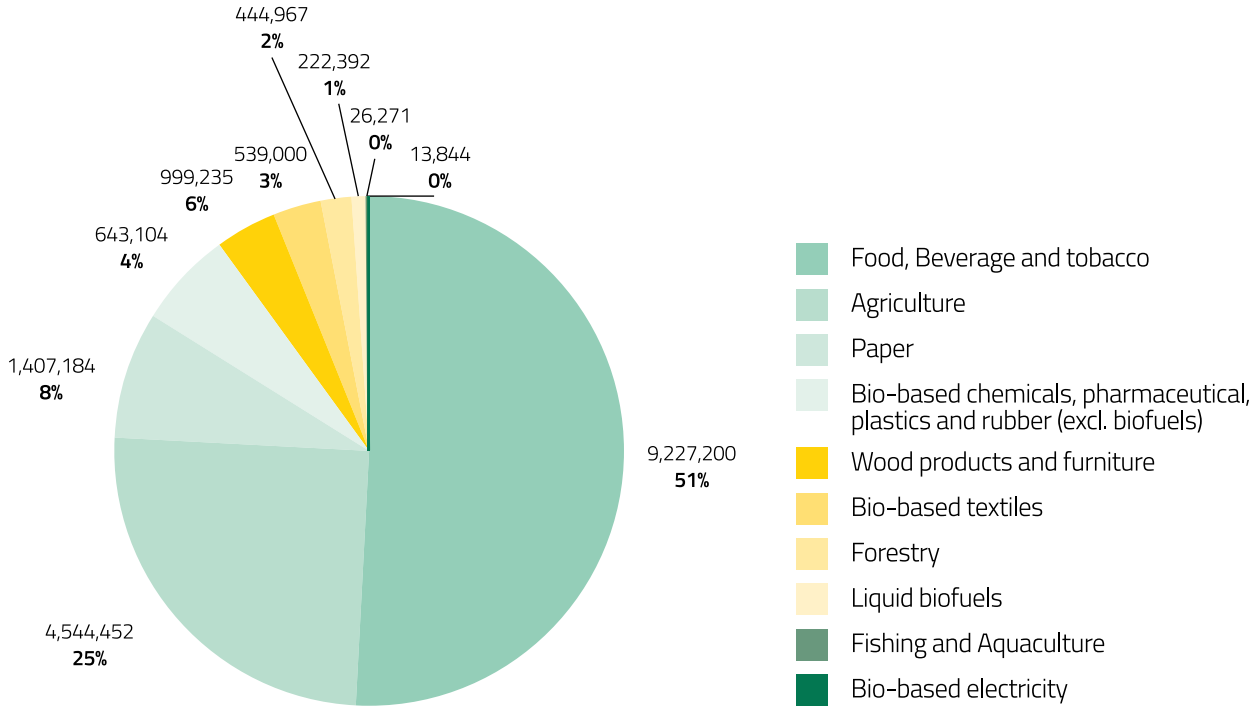
2.1.2 EMPLOYMENT

According to the European Commission (JRC data portal), bioeconomy in the EU28 employed around 18 million workers in 2015. In terms of number of employees, the key sectors are agriculture and the manufacture of food, beverages and tobacco. Nevertheless, it should be noted that the contribution of the primary sector to the bioeconomy is significantly lower in terms of turnover than in terms of the number of persons employed. Agriculture accounts for 51% of total employment in the EU bioeconomy (9.2 million workers); manufacture of food, beverage and tobacco accounts for 25% (4.5 million workers). Figure 2.2 illustrates the employment in each bioeconomy sector in the EU in 2015.

The number of workers in the EU bioeconomy decreased by 12% from 2008 to 2015 (i.e. by approximately 2.5 million units). According to JRC *"this declining trend is mainly driven by the ongoing restructuration of the European agricultural sector, still the main employment sector of the bioeconomy"*[7]. Employment in agriculture experienced a reduction of 1.5 million units (-14.4%). The manufacture of food, beverage and tobacco also saw a reduction of its workforce of 189,000 units, which however amounts to a -4% reduction only in relative terms.

[7] JRC (2017), *Bioeconomy report 2016*, Publications Office of the European Union.

Figure 2.2- EU employment of bioeconomy sectors in 2015
Source: JRC data portal (https://datam.jrc.ec.europa.eu/datam/mashup/BIOECONOMICS/index.html)



Estimates and projections from authoritative sources suggest that **bioeconomy as a whole has a remarkable potential in terms of prospective employment creation**. According to industry estimates cited in the European Commission *Bioeconomy Action Plan 2018*[8], the EU bioeconomy can create up to one million new green jobs by 2030, in particular in rural and coastal areas. A study focusing on the development of bioeconomy in Denmark[9] comes to a similar conclusion: most of the new jobs are likely to be concentrated in rural areas. The results of a study cited by the United States Department of Energy[10] provide comparable estimates for the United States (1.1 million new jobs), and suggest that production of traditional and advanced biofuels, generation of bioenergy (heat and electricity) and manufacturing of advanced bioproducts are likely to account for most of the future employment creation potential. Finally, the results of another recent simulation study[11] suggest that a substantial share of the new jobs created by the development of bioeconomy in the EU will be in supporting services (transportation, storage, contract machinery services, production of equipment and inputs, etc.).

The historical and prospective trends in the development of the bioeconomy illustrated above suggest that **the importance of the contribution of agriculture and of the food industry to total employment in the bioeconomy may decrease in the future, even though this general trend may be offset, at least in part, by increases in employment in the forestry and "blue bioeconomy"**. It is likely that **most of the growth in employment will take place in non-food sectors** (including liquid biofuels and bioenergy), as well as in **support services** (logistics, equipment and input production, etc.).

This implies that **trade unions representing agriculture and food industry workers** should **pay attention to the development of biobased value chains in non-food industries**, should not overlook the **expansion of support services**, and should **enhance their cooperation with the relevant trade unions**. The issue is investigated in more detail at § 3 and 4; recommendations aimed at addressing the issue are provided at § 6.

[8] European Commission (2018), *Bioeconomy: the European way to use our natural resources – Action plan 2018*, Directorate-General for Research and Innovation - Unit F – Bioeconomy.
[9] Copenhagen Economics (2015), *Geographical employment potentials from bioeconomy*, study prepared for the United Federation of Danish Workers.
[10] Rogers J. N., Stokes B., Dunn J., Cai H., Wu M., Haq Z. and Baumes H. (2017), "An Assessment of the Potential Products and Economic and Environmental Impacts Resulting from a Billion Ton Bioeconomy", *Biofuels, Bioproducts, and Biorefining*, 11, No. 1 (2017), pp. 110–128.
[11] Fuentes-Saguar P.D., Mainar-Causapé A.J., Ferrari E. (2017), "The Role of Bioeconomy Sectors and Natural Resources in EU Economies: A Social Accounting Matrix-Based Analysis Approach", *Sustainability*, 9, 2383, MDPI, Basel, Switzerland.

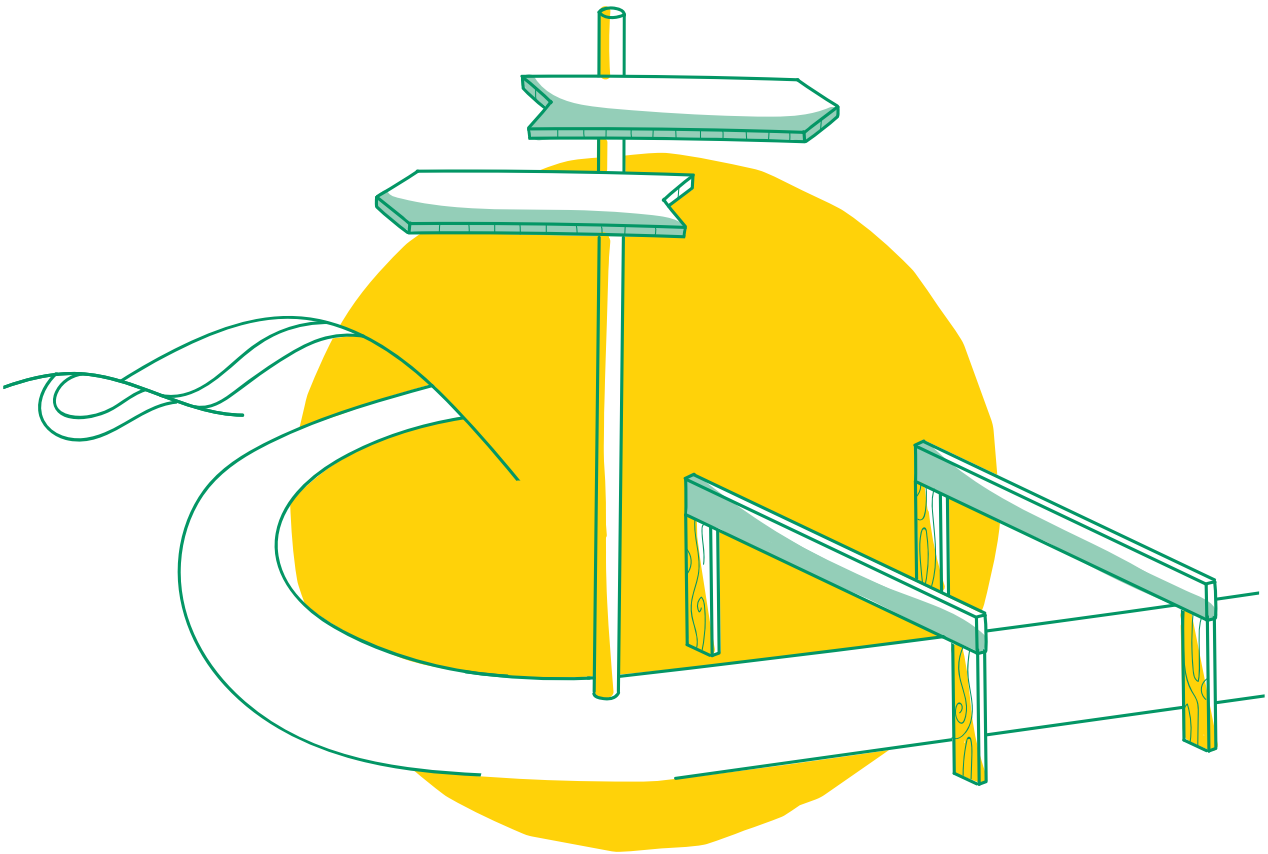
2.2 EU policy framework

The most significant milestone in the evolution of EU policy framework for the bioeconomy is the **Bioeconomy Strategy**, elaborated in 2012.

The EU strategy puts the bioeconomy in a broader context: bioeconomy is described as an opportunity to address several challenges, such as food security, natural resource scarcity, fossil resource dependence and climate change, with emphasis on the sustainable use of natural resources, competitiveness, socioeconomic and environmental issues[12]. Launched and adopted on February 13, 2012, the **Strategy and Action Plan "Innovating for Sustainable Growth: A Bioeconomy for Europe"** is structured around three pillars: 1) investments in research, innovation and skills; 2) reinforced policy interaction and stakeholder engagement; 3) enhancement of market set and competitiveness. The strategy aims at paving the way "to a more innovative, resource efficient and competitive society that reconciles food security with the sustainable use of renewable resources for industrial purposes". The strategy proposes a comprehensive approach to address five societal challenges through the introduction of bioeconomy: 1) ensuring food security; 2) managing natural resources sustainably; 3) reducing dependence on non-renewable resources; 4) mitigating and adapting to climate change; 5) creating jobs and maintaining EU competitiveness. The strategy was updated in 2018 with a view to accelerating the deployment of a sustainable European bioeconomy, in order to maximise its contribution towards the 2030 Agenda and its Sustainable Development Goals (SDGs), as well as the Paris Agreement on climate change.

[12] Scarlat, N., Dallemand, J. F., Monforti-Ferrario, F., & Nita, V. (2015), "The role of biomass and bioenergy in a future bioeconomy: Policies and facts", *Environmental Development*, 15, 3-34.

3 Opportunities and challenges stemming from the introduction of bioeconomy for workers in the agricultural and food sectors



A wide range of concrete applications of biobased technologies in the development of new value chains were investigated through a number of case studies, covering:

- the development of an industrial cluster focusing on the production of biofuels, bioproducts and bioenergy in Ghent (Belgium);
- value adding to forest biomass through combined generation of heat and power in Croatia;
- the development of biobased value chains from processing of organic clover grass and starfish in Denmark;
- the development of biobased value chains starting from traditional processing of sugar beet into sugar, ethanol, yeast and by-products (molasses, beet pulps) in France;
- the success story of an Italian company which developed a wide range of biobased value chains, also in partnership with other stakeholders;
- pilot initiatives aimed at developing biobased value chains in the tomato processing sector in Italy.

The findings of the case studies allowed to identify the main **challenges and opportunities** stemming from the introduction of bioeconomy **for workers in the agricultural and food sectors**.

The case studies suggested that bioeconomy in the EU is developing rapidly, and this opens up opportunities for creating new jobs and offering workers new possibilities.

The case studies revealed that in many ways **the bioeconomy resembles food processing and the chemical industry**, since these industries make use of highly automated processing equipment, the production is process-oriented, and the industries process biomass into products and materials. The case studies also revealed that **the principles, processes and skills used in the food industry and for processing of biomass are quite transversal**. This is an important aspect to keep in mind when looking at the opportunities or challenges for work in the bioeconomy.

The case studies on Denmark showed that technologies for harvesting or cleaning new types of biomass may have a strong impact on the quality of the biomass itself, and require skilled specialist workers to operate the needed machinery and equipment.

The case of Ghent biobased industrial cluster (Belgium) revealed that knowledge about biomass processing can support the development of biobased processes producing a diverse range of products, including biochemicals and nutraceuticals.

The case study on Croatia showed that the country is building bioeconomy on its forestry sector, and that there is a close focus on ensuring a sustainable development of bioeconomy. In this context, woodland protection and management become important aspects for ensuring a sustainable resource base. The case study on Croatia has demonstrated how sustainable forestry management may impact the future skills requirements for jobs across the forestry sector.

The French and Italian case studies showed that **besides positive effects in terms of employment creation** (which may be significant, as also demonstrated by the Ghent case), the development of biobased value chains (including non-food ones) can improve the profitability of food companies, and hence **contribute positively to the safeguard of employment levels in the food industry**.

One of the Italian case studies also showed an interesting approach to the development of biobased value chains, based on:

1. Re-conversion of non-operational plants into biorefineries integrated in the local economy, to revitalise deindustrialised areas and to promote new job opportunities.
2. Promotion of a circular economy: renewable raw materials are processed into renewable products, which can be again recycled into renewable raw materials at the end of their life.
3. Promotion of inter-sectoral linkages between farming and processing, and between food and non-food value chains.

The **importance of establishing inter-sectoral linkages** and of **promoting cooperation among diverse groups of stakeholders** as conditions for the development of biobased value chains clearly emerged from all case studies. These conditions are especially important for developing **large-scale biobased industrial clusters** (like the ones studied in Belgium and France), which have **significant potential in terms of employment creation**.

Opportunities from processing of new types of biomass such as green leaves or marine materials

(which were investigated in the Danish case studies) were also found to result in **significant opportunities for employment creation**. Those are emerging segments in the bioeconomy, yet they are already providing employment. The opportunities for employment creation can be further increased by the scalability of many biobased processes: a process implemented in a small-scale plant with relatively few workers can be successfully applied also in larger plants, with more significant opportunities for employment creation.

However, case studies (especially the ones carried out in Denmark, France and Italy) also revealed that **the development of biobased value chains in the agro-food system** faces a number of **challenges and constraints**. These can be classified as follows (indications on possible approaches to address those challenges are also provided).

CHALLENGES FOR WORKERS: THESE HAVE DIRECT IMPLICATIONS FOR TRADE UNIONS

- With special respect to **job creation**, the fact that some biobased processes require substantial capital investments, but relatively limited workforce (capital-intensive processes rather than labour-intensive processes).
- The **sectoral focus of many initiatives for the development of biobased value chains**, which prevents them from exploiting inter-sectoral synergies. The biggest potential for job creation, or at least for safeguard of current occupation levels, is offered by an inter-sectoral approach in the development of biobased value chains.
- The issue of the **allocation of value among the various actors** involved in biobased chains, with a special attention for the **share allocated to workers**.

Challenges for **workers** can be addressed by trade unions alone, or through their cooperation/dialogue with other stakeholders (business operators, policymakers, civil society, etc.).

CHALLENGES FOR BUSINESS OPERATORS WISHING TO DEVELOP BIOBASED VALUE CHAINS

- Availability of cheaper alternative biomass sources for the new biobased processes.
- Limited size of the (potential) market for certain biobased products.
- The substantial investments which the development of certain biobased value chains require. Those investments are clearly unaffordable for small-scale start-ups in the lack of external support (see below "challenges from context factors").
- Scarce synergies between research clusters focusing on biobased technologies and the food industry. There are many promising innovations, but very few of them see commercial exploitation.

Challenges for business operators wishing to develop biobased value chains may have **direct or indirect implications for workers**: trade unions can usually address those implications through cooperation/dialogue with business operators and/or other stakeholders (including policymakers).

CHALLENGES FROM CONTEXT FACTORS (BUSINESS CULTURE, INSTITUTIONAL SETTINGS, POLICY FRAMEWORK, ETC.)

- Risk propensity/aversion by entrepreneurs, which may be inversely proportional to the availability of financial resources.
- Promoting cooperation among diverse stakeholders (which may have partly conflicting goals): businesses, trade unions, institutions, research centres, civil society organisations, etc.
- The strong debate on the ethical, social, environmental implications of food versus non-food uses of biomass.
- Inadequate legislative framework. Significant limitations to the development of biobased value chains may derive from the prohibition to use specific typologies of biomass – e.g. because they are categorised as "waste" by legislation - for the production of food or feed.

Challenges from context factors are usually addressed through policy measures and/or dialogue among stakeholders. Those challenges **may also have indirect implications for workers**, which can usually be addressed by trade unions through cooperation/dialogue with policymakers and/or other stakeholders.

CHALLENGES FROM EXTERNAL FACTORS

- Instability of fossil fuel prices, which can have an influence on the profitability of some biobased value chains.

Challenges from external factors are usually addressed through policy measures. Those challenges **may also have indirect implications for workers**, which can usually be addressed by trade unions through cooperation/dialogue with policymakers.

Examples of biobased production sites

*Aerial view of the Port of Ghent and of the Syngas Biorefinery Cluster**
Photo from Huffington Post, retrieved from https://www.sustaineurope.com/growing-the-bioeconomy-in-flanders--12042017.htm

** the view shows the fermentation plants where the gas is made and then transferred by pipelines from storage facilities to distribution centres and to power plants, where it is burned to generate electricity*

Arial view of the Bio Base Europe Plant
Source: http://www.bbeu.org/

Aerial view of the Glina cogeneration plant
Source: adapted from http://sherif.hr/

View of the Danish Marine Protein's factory in Skive (Denmark)
Source: Niels Joergen Madsen, Danish Marine Protein

4 Workers' skills and bioeconomy

4.1 Application of skills for working in the bioeconomy

Companies operating in the bioeconomy depend on **many of the same skills** as companies operating in the **food and food ingredients industry, the chemical industry and materials processing industry**. Interviews with companies operating across a wide range of bioeconomy subsectors in a number of EU Member States[13] allowed to identify the most important skills needed for working in the bioeconomy (Table 4.1). Overall, among the most important skills needed are the ability to think and take an initiative; identify and implement solutions; and to monitor and steer a technical process.

Table 4.1 - Required skills for working in the bioeconomy
Source: interviews, workshops and case studies

Stage of the biobased value chain	Function of the worker	Skills required
Biomass production	Harvesting / collecting biomass	Skills for handling harvesting equipment Insights to the parameters determining quality of the biomass
Biomass handling and processing	Operating processing equipment and process monitoring	Skills for operating processing equipment including automated production systems Understanding of batch production and continuous production Insights into ICT and digitalised systems for production control, quality and traceability including interpretation of data Experience in quality assurance work Experience in cleaning of processing equipment and maintenance
Biomass packing and storing	Operation of equipment for filling and packing of products	Skills for operating processing equipment including automated production systems Insights into ICT and digitalised systems for production control, quality and traceability, and interpretation of data Experience in quality assurance work Experience in cleaning of processing equipment and maintenance
Biomass and logistics	Transport of biomass and finished products	Insights into ICT and digitalised systems for production control, quality and traceability Truck certificate Driver's license

For industrial-scale production, the bioeconomy makes use of technologies and systems that integrate digital interfaces for monitoring and control as well as automated technologies for processing of the biomass. This is a very similar set-up to the system used in the food industry. **Workers holding experience from the food industry could have the opportunity of finding a job in biobased manufacturing**. Bioeconomy could also be an option for older workers, as the production in the biobased economy is often not dependent on hard physical work.

4.2 Obtaining skills for working in the bioeconomy

The case studies demonstrated that the **transferability of skills between the food industry and biobased manufacturing**, as well as **across the sub-sectors of biobased manufacturing**, is **very high**. These industries need skills such as technological insights, skills for using ICT, and understanding of the materials processed and the production processes. Therefore, **skills for working in the bioeconomy** could in principle be **obtained within the present system of education targeted at different job profiles in the food industry**.

The case studies revealed that in addition to well-known skills from the food industry the **understanding of the idea of "biobased manufacturing"** is considered as very valuable by companies

operating in the biobased industries. This is due to the fact that this understanding frames such worker competencies as:

- Ability to understand the biomass processed.
- Understanding of the product.
- A general understanding of biobased manufacturing.

There is a **growing interest among farmers** to apply a **circular approach to agricultural production**[14], and this is **reflected in agricultural colleges**. More students are interested in learning about circular production systems and opportunities for growing new crops and adding value to them. An example is the cultivation of industrial crops such as elephant grass, which is used for making building and insulation materials. Developing the biobased economy builds on ingenuity and technical competences, and "farmers-to-be" could represent an important segment to target by including technology development into curricula. Further down this line, it is obvious that **agricultural and technical colleges** could play a **key role for providing education of employees for the biobased industries**.

4.3 Prospects of working in the bioeconomy

Biobased manufacturing is a highly diverse industry, since many different types of biomass are processed into a wide variety of products, materials and substances.

It could be argued that the bioeconomy builds on **three transversal dimensions** that can be **applied across the many sub-sectors and value chains of the bio-based manufacturing**, and which are **relevant for work and skills**. This is because skills for working in the bioeconomy are centred around experience in processing of biomaterials (with adjoining functions that are adapted to the specific context of the company), the type of biomass and the status of the bioeconomy. The three dimensions are discussed in the following sections.

THE COMPANY AND BUSINESS IDEA

Case studies showed that the bioeconomy spans from small-scale start-up companies to large-scale industrial manufacturing (biobased industrial clusters involving multiple companies and plants). The production technology and organisation of production will relate to the company and factory lay-out, but experience in operating processing equipment is fundamental. The case study on France revealed that workers who were formerly employed in the sugar industry could transfer their skills to hold a job in a large-scale biorefining plant.

THE TYPE OF BIOMASS

The types of biomass processed in biobased value chains can be sourced from many different environments: agriculture and forestry, marine environment, side streams from industries, and more. Some types of biomass have been used for many years (e.g. straw and wood) and others are new (e.g. starfish). The bioeconomy provides a frame for using known types of biomass in a new context, as demonstrated by the Italian case study (use of tomato skins for making bio-based lacquer).

[14] The circular approach is based on reuse of / value-adding to residues of agricultural production, which are used as production inputs (e.g. as feed, as fertilisers etc.) and/or as feedstock for new processes (e.g. production of biomaterials, generation of bioenergy, etc.).

The **type of biomass to process defines the technology to be used and points to the end-products for the market and re-circulation**. For example, skills related to monitoring and adjusting automated processing equipment is equally relevant for any processing industry, irrespective of the type of biomass it is processing. Ability to combine insights about technological opportunities with coordination of activities and human resources are valued skills and are needed across many functions, irrespective of company size or typology of production process.

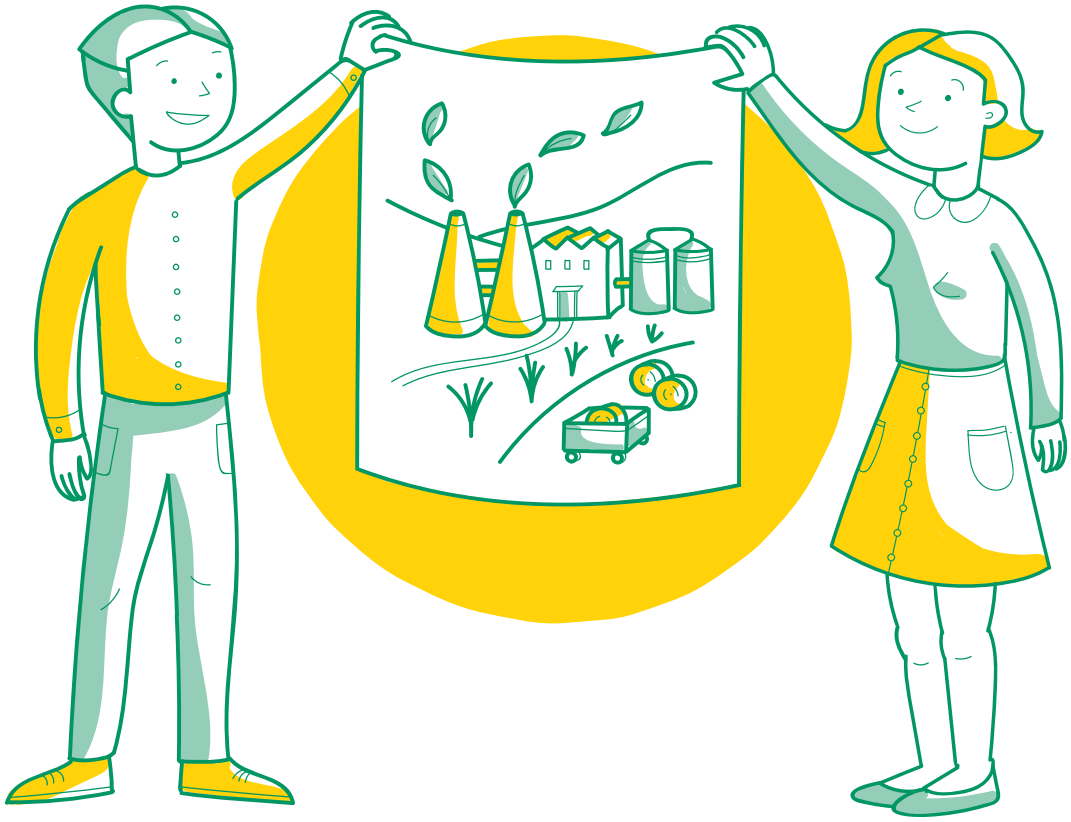
THE BIOECONOMY AND ITS POTENTIAL SPIN-OFF EFFECTS

Bioeconomy is in principle already integrated in the use of resources today, as many resources are **re-circulated to improve the overall exploitation** of natural resources. Wood is a good example in that respect. As more attention is devoted to ensuring sustainable sourcing of raw materials and to paying attention to possibilities for re-use of waste and side streams, new perspectives open up. The case study on Croatia, for instance, revealed that the forestry sector has emphasised its role as contributor to sustainable resource management and nature conservation programs. This approach is an add-on to a biobased value chain and could motivate to obtaining new skills within, for instance, sustainable resource management or sustainable processing technologies.

The case study on processing of clover grass in Denmark demonstrated that **biobased value chains can spur the development of new job functions**. The quality of the grass harvested is essential for obtaining a sufficient yield from the biorefing process, and therefore the development of new and improved technologies for grass harvesting has led to creation of new job functions in Denmark.

It is important to underline that the development of new biobased value chains may create jobs **not only in the processing stage**, but also (and in some cases especially) **in the upstream stages** (biomass production; production of equipment, machinery, etc.) and **in support activities** (especially logistics, i.e. storage and transportation of both biomass and biobased products, but also in research and consulting).

5 The bioeconomy we want



The study showed that **bioeconomy is above all characterised by diversity**. A great variety of biomass types, biobased processes and related outputs, and approaches to the development of biobased value chains emerged from the analysis. Such diversity translates into a wide range of opportunities, but also in different challenges to address. The study highlighted that there is no "one fits all" approach to the development of biobased value chains. Successful, or at least promising examples of biobased value chains investigated in the study differ in many respects, including:

- the conditions to be ensured for a successful development of the initiatives;
- the needs in terms of workers' skills;
- the potential for employment creation.

To successfully develop new biobased value chains, such **diversity needs to be taken into account, to be properly understood, and to be adequately dealt with**: failure in doing that can lead to missed opportunities and/or to unaddressed challenges which can put the success of the related initiatives at risk.

The study highlighted a number of **critical conditions to be met** to ensure that the potential of bioeconomy in terms of employment creation (or, at least, of safeguard of current employment levels) is

fully exploited. These conditions are of technical, economic, organisational and political nature, and include:

1. The application of the **cascading approach** to fully unlock the potential for adding value to biomass. Cascading involves obtaining the most valuable products in the first stages of biomass processing, and lower-value products only in successive stages; only the residues from biomass processing into biobased products are finally used to generate energy. The cascading approach also allows to minimise waste, with **positive implications for the development of an environmentally sustainable bioeconomy**.

2. Establishing **inter-sectoral linkages** (between farming and processing; between food and non-food value chains) and **cooperation among different groups of stakeholders** (business operators; research centres and education centres; institutions and policymakers; civil society; etc.) to fully exploit the aforementioned diversity and to implement the cascading approach.

3. Establishing an **adequate policy / regulatory framework**, in order to:
   a. Minimise regulatory constraints to full exploitation of biomass in value adding processes, **without prejudice to social standards and environment conservation**.
   b. Provide financial support and incentives to business operators, research centres and education centres.

Most importantly from EFFAT's standpoint, the study showed that the development of biobased value chains has **significant potential in term of job creation** as well as **safeguard of current employment levels,** and can have substantial direct **implications for workers** in terms of **required skills and career paths.** The study also showed that besides opportunities, the development of biobased value chains also presents challenges, which can turn into positive or negative implications for workers.

The study findings illustrated above clearly suggest that **trade unions** should not only **look at the development of the bioeconomy with great attention**, but should **also play a role in shaping that development**. In other words, trade unions should **define a "bioeconomy they want"**, and should **actively contribute to the realisation of a model of bioeconomy which is consistent with their values and goals.**

EFFAT deems that the **bioeconomy of the future** should be **socially, economically and environmentally sustainable**.

A SOCIALLY SUSTAINABLE BIOECONOMY

The development of bioeconomy should be an inclusive process. This means that:

- **Young people and unemployed people should be given a chance to find a job in the bioeconomy**. This implies **promoting an adequate educational offer**, including hands-on training in biobased production units.

- Innovation- and risk-oriented entrepreneurs lacking the needed resources and/or technological know-how to implement biobased productions processes should be supported through provision of incentives and/or counselling.

AN ECONOMICALLY SUSTAINABLE BIOECONOMY

Most of the successful examples of development of biobased value chains analysed in the report concern non-food biobased products and/or generation of bioenergy. However, the study revealed that **diversification into non-food biobased value chains** can improve the profitability of the involved food business operators, with **positive implications for the safeguard of current employment levels in the food industry**. These positive implications also derive from another finding of the study, which revealed that the skills needed for working in biobased production processes are often similar to the skills of food industry workers. This finding further reinforces the **importance of an inter-sectoral approach to bioeconomy**.

The study also showed that new biobased value chains can be successfully implemented at different scales: from small-scale pilot plants to large-scale industrial clusters. Even if the potential for employment creation in large-scale industrial clusters is generally much higher (even if several biobased processes are capital-intensive rather than labour-intensive), this development model may be unsuitable for some processes, or unfeasible in certain contexts. The **potential for employment creation of smaller biobased production units should not be overlooked**, especially where those units can be built in significant numbers.

AN ENVIRONMENTALLY SUSTAINABLE BIOECONOMY

Last but not least, the development of the bioeconomy should **contribute to enhanced environmental conservation and more effective action against climate change**. To these ends, the development of biobased value chains should:

1. be supported by a comprehensive analysis of their environmental/climate change implications; wherever these are negative, adequate **mitigating measures** should be taken;

2. **apply the cascading approach**, by virtue of its **waste-minimising effects**.

6 Recommendations

The recommendations in this section are aimed at promoting the development of the bioeconomy in the EU along the lines defined at § 5.

Recommendations are targeted at trade unions and workers' representatives, which can promote the "bioeconomy they want" in two ways:

1. Through direct initiatives.
2. Through dialogue/cooperation with, as well as sensitisation of, the other key stakeholders: business operators and their associations, national governments, EU institutions.

The recommendations propose **concrete actions to be implemented**, and move from the key findings of the study.

6.1 What should trade unions do...

6.1.1 ... TO PROMOTE THE DEVELOPMENT OF THE BIOECONOMY?

Trade unions and workers' representatives should:

1. Undertake initiatives aimed at **improving their knowledge of the bioeconomy**. This study represents a significant step forward in the right direction, but more can be done.

2. **Strengthen trade union solidarity and cooperation across sectors.** The study has clearly showed the importance of inter-sectoral dialogue and cooperation for the development of socially, economically and environmentally sustainable biobased value chains.

3. Consider the possibility to **invest part of the financial resources available to them** (e.g. those related to workers' retirement funds) **in projects for developing new biobased value chains** which meet the conditions set out at § 5, i.e. that are **socially, economically and environmentally sustainable**. Funds managed by trade unions could be invested in sustainable biomass production and processing, marketing of biobased products, logistical/support activities.

4. Contribute actively to the **adaptation of the existing EU-level and national-level instruments** to promote the development of the bioeconomy, as well as to **the elaboration of new ones**, to ensure that national, regional and **especially sectoral specificities are taken into account** wherever opportune. This can be done also in cooperation with business stakeholders (see § 6.2.1).

5. Contribute actively to the **elaboration of EU-level and national-level initiatives aimed at promoting the development of bioeconomy** (e.g. through research and education, granting of financial incentives, minimisation of regulatory constraints, etc.). This can be done also in cooperation with business stakeholders (see § 6.2.1).

6.1.2 ... TO PROMOTE EMPLOYMENT CREATION IN THE BIOECONOMY, AND TO ENSURE THAT WORKERS HAVE ADEQUATE SKILLS FOR WORKING IN THE BIOECONOMY?

Trade unions and workers' representatives should:

6. Undertake initiatives aimed at:

   a. **Improving their knowledge of the implications of the bioeconomy in terms of employment and required skills of workers.** As already underlined at point 1, this study represents a significant step forward in the right direction, but more can be done.

   b. **Improving awareness of, and general knowledge about bioeconomy,** within their membership base, i.e. **among workers** (e.g. through elaboration of informative material).

   c. **Helping unemployed workers to access technical education in the field of bioeconomy,** with a view to improving their chances of finding a job in the related sectors.

7. Consider the possibility to invest part of the financial resources available to them (e.g. those related to workers' retirement funds) in initiatives aimed at providing workers with technical education in the field of bioeconomy, always with a view to improving their chances of finding a job in the related sectors.

6.2 What should trade unions ask...

6.2.1 ... TO BUSINESS STAKEHOLDERS?

Trade unions and workers' representatives should:

8. **Discuss** with business stakeholders about the **fair allocation of value deriving from the development of new biobased value chains** among the involved stakeholders, focusing on the **share allocated to workers.**

9. **Discuss** with business stakeholders about the **working conditions in new biobased value chains,** with a special focus on the **safety and quality of jobs.**

10. **Sensitise business operators** which are about to develop biobased production processes on the critical importance of:

    a. **considering all the available options** in terms of: type(s) of biomass to be used as feedstock; type(s) of process to be activated; type(s) of biobased products to be obtained; technical and organisational solutions to implement the process(es), with special attention to the cascading approach; scale at which the process(es) should be activated; etc.;

    b. **establishing cooperation with other business operators** - including those from other sectors - and **with other relevant actors** (institutions; research centres; educational centres; etc.).

11. **Encourage business operators** which are about to develop biobased production processes to:

    a. **Secure the availability of skilled workers,** through cooperation with educational centres and/or in-house training.

    b. **Support public institutions and private entities** (technical colleges, universities, non-profit foundations, etc.) willing to offer **technical education in the field of bioeconomy,** especially by offering the opportunity for hands-on training in their biobased production units.

    c. **Explore, and take advantage of the available incentives and funding opportunities for the development of biobased production processes,** as well as non-monetary forms of support, with special attention to **technical counselling.**.

12. **Encourage sectoral and inter-sectoral business associations** willing to promote the development of bioeconomy to:

   a. **Support public institutions and private entities** (technical colleges, universities, non-profit foundations, etc.) willing to offer **technical education in the field of bioeconomy.**

   b. Contribute actively to the **adaptation of the existing EU-level and national-level instruments** to promote the development of bioeconomy, as well as to **the elaboration of new ones**, to ensure that national, regional and **especially sectoral specificities are taken into account** wherever opportune.

   c. Contribute actively to the **elaboration of EU-level and national-level initiatives aimed at promoting the development of bioeconomy** (e.g. through research and education, granting of financial incentives, minimisation of regulatory constraints, etc.).

   d. Undertake initiatives aimed at **sensitising business operators** which are about to develop biobased production processes on the **critical importance of the conditions at points 10 and 11 above** for a successful implementation of their projects.

   e. Undertake initiatives aimed at:

   - **improving their knowledge of the bioeconomy**;
   - **improving awareness of, and general knowledge about bioeconomy,** within their membership base, i.e**. among entrepreneurs** (e.g. through elaboration of informative material, workshops and seminars, etc.).

6.2.2 ... TO LOCAL AND REGIONAL GOVERNMENTS?

Trade unions and workers' representatives should:

13. Encourage local and regional governments to **promote the development of local biobased industries** which can **create new jobs especially in rural areas**.

6.2.3 ... TO NATIONAL GOVERNMENTS?

Trade unions and workers' representatives should:

14. **Encourage** national governments to **involve trade unions, workers' representatives and social partners** in general in the **elaboration of national policies aimed at promoting the development of bioeconomy.**

15. **Encourage** national governments to:

   a. **Include basic or advanced teaching in the fundamentals of bioeconomy in national**

educational programmes, tailoring the notions to be transmitted to the different educational profiles (primary, general secondary, specialist secondary, etc.).

b. **Support public institutions and private entities** (technical colleges, universities, non-profit foundations, etc.) willing to offer **technical education in the field of bioeconomy,** with special attention to **initiatives targeted at unemployed people.**

c. **Promote the offer of hands-on training in biobased production units to prospective workers,** through monetary and non-monetary incentives to the concerned businesses (e.g. tax benefits).

d. **Undertake initiatives to promote cooperation among different stakeholders interested in developing the bioeconomy,** including trade unions (e.g. through government-promoted inter-sectoral dialogue groups).

e. **Contribute actively to the adaptation of the existing EU-level instruments** to promote the development of bioeconomy, as well as to **the elaboration of new ones,** to ensure that **national/regional specificities are taken into account** wherever opportune.

f. **Ensure effective and efficient implementation of all the EU-level actions** (see § 6.2.4) **on their national territories,** taking into account national/regional specificities wherever this is allowed by the type of legislative instrument used (Directives).

g. **Elaborate and implement national initiatives aimed at promoting the development of bioeconomy** (e.g. through research and education, granting of financial incentives, minimisation of regulatory constraints, etc.), wherever this is not in conflict with EU legislation. National initiatives should be aimed at **completing EU-level ones and/or at seeking synergic effects** with them, and should instead **avoid any duplication** which can result in inefficient use of resources.

6.2.4 ... TO EU INSTITUTIONS?

Trade unions and workers' representatives should:

- **sensitise** the relevant EU institutions about the **importance of the conditions defined at points 16, 17, 18 and 19** for the **development of a socially, economically and environmentally sustainable bioeconomy**, consistently with the model defined at § 5;
- **encourage** the relevant EU institutions to **take action along the lines defined at points 16, 17, 18 and 19.**

16. **Scientific and techno-economic knowledge about bioeconomy must be improved** through both scientific and applied research. The diverse aspects of bioeconomy must be explored further, in order to promote full and sustainable exploitation of all the opportunities that bioeconomy offers, and to effectively address the challenges related to its development. There are already operational EU-level instruments whose contribution to improved knowledge about bioeconomy can be fostered (e.g. the Knowledge Centre for Bioeconomy, the Bio-based Industries Joint Undertaking, etc.). Additional ad hoc instruments can be devised and implemented upon initiative of the European Commission itself, or through EU-funded research

and technological development programs.

17. **Awareness of, and knowledge about bioeconomy among EU citizens must also be improved** through both general and specialist education, through existing instruments available to DG Education and Culture, and possibly through ad hoc initiatives. General education shapes the workers and consumers of tomorrow. Improved awareness of and knowledge about bioeconomy among EU citizens can:

    a. increase the attractiveness of biobased production units as workplaces;

    b. stimulate consumers' demand for biobased products and bioenergy;

    c. promote the positive image of bioeconomy as an environmentally conscious approach to efficient exploitation of natural resources.

18. The **availability of financial incentives to business operators** willing to contribute to the development of a biobased economy in the EU **must be increased**. Priority should be given to:

    a. entrepreneurs lacking the financial resources to implement techno-economically sound projects, irrespective of their scale;

    b. clusters of business operators and non-business actors (e.g. research centres) whose projects are characterised by an inter-sectoral approach based on the application of the cascading approach and on cooperation among stakeholders.

19. **Regulatory constraints to full exploitation of biomass along the "value pyramid"** (i.e. through both food and non-food biobased value chains, according to the cascading approach) **must be addressed** through opportune **amendments to the relevant EU legislation**, without putting at risk its coherence with the other political priorities of the European Union (safety of workers, consumer protection, environment conservation, etc.). In particular, the scope for promoting the production of safe food ingredients from side streams, wastes and residues of the food industry through adequate EU legislation should be explored.

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