European Bioeconomy in Figures 2008–2017

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1 Executive summary

The bioeconomy comprises those parts of the economy that use renewable biological resources from land and sea – such as crops, forests, fish, animals and micro-organisms – to produce food, materials and bioenergy.

In 2017, a study conducted by nova-Institute on behalf of the Bio-based Industries Consortium (BIC) showed for the first time which macroeconomic effects are generated by these activities, e.g. turnover and employment for the years 2008 and 2013. Now, the new version of the report is available which spans the whole period from 2008 to 2017.

As in the previous reports, Eurostat was used as the main source of data for all sectors of the European bioeconomy. Some sectors, comprising the primary sectors (agriculture, forestry and fishery) as well as the sectors food, beverages, tobacco and paper and paper products, can be considered fully bio-based and are thus fully accounted to the bioeconomy. For the other manufacturing sectors such as the chemical industry, pharmaceuticals and textiles, the bio-based shares were estimated and included in the assessment.

The analysis of the Eurostat data of 2017 shows that the turnover of the total bioeconomy, including food and beverages and the primary sectors agriculture and forestry, results in just over 2.4 trillion Euro in the EU-28, meaning an increase by 25% since 2008. Roughly half of the turnover is accounted for by the food and beverages sector, almost 20% is created by the primary sectors agriculture and forestry. The remaining 30% are contributed by the so-called bio-based industries, such as chemicals and plastics, pharmaceuticals, paper and paper products, forest-based industries, textiles, biofuels and bioenergy.

Since 2008 the employment in the EU-bioeconomy has dropped by 9% from once over 20 million people in 2008 to 18.5 million in 2017. This is mostly due to the ongoing restructuring of the agricultural sector, which led to the loss of 2.2 million employees in the EU-28 between 2008 and 2017. However, the primary biomass production sector, mainly agriculture plus forestry and fishery is still considered the main driver of employment, generating 55% of work in 2017. The turnover of this sector tends to be rather low, though.

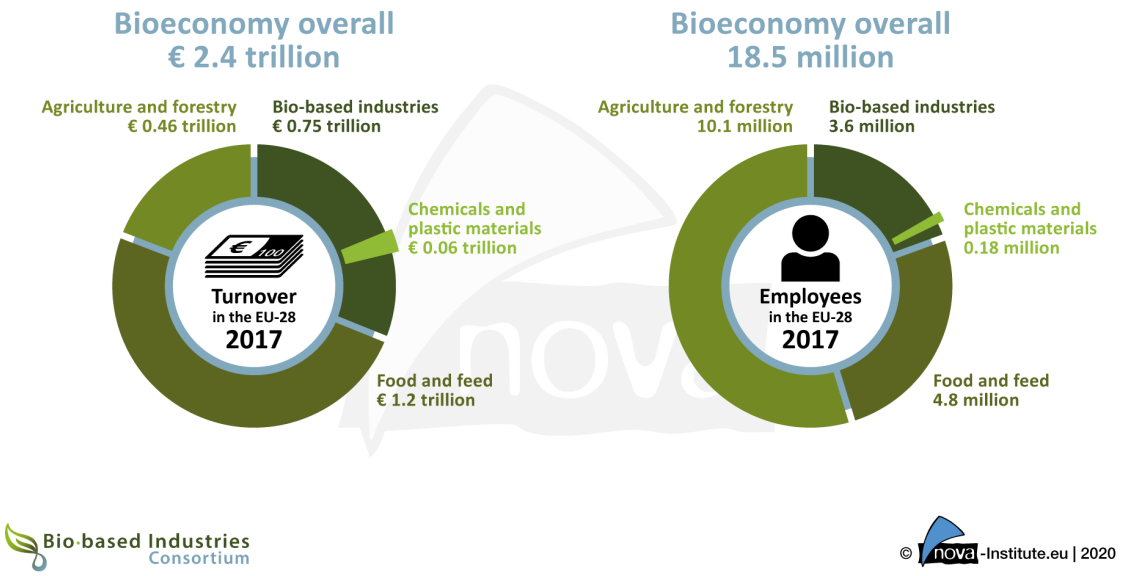

Figure 1: Overall turnover and employment of the bioeconomy and its bio-based industries in the EU–28 in 2017

Furthermore, the data show clear differences between groups of Member States: e.g. the Eastern European countries Poland, Romania and Bulgaria apparently are stronger in less value- adding sectors of the bio-based economy that generate a lot of employment. In comparison, Western and Northern European countries generate much higher turnover compared to the employment generated. The countries with the highest ratio between turnover and employment are Finland, Belgium and Sweden.

As in the 2017 study and all its followers, this update highlights the contribution of the often-underrated bio-based industries, such as chemicals and plastics, pharmaceuticals, paper and paper products, forest-based industries, textile sector, biofuels and bioenergy to the bioeconomy. During the examined time period, this sector increased its turnover by 23% from once 600 million Euro in 2008 to about 750 million Euro in 2017. At the same time employment figures of the bio-based industry declined by 4% to 3.6 million employees in the EU-28 in 2017. In the bio-based chemical and plastics industry alone, turnover amounted to around 60 billion Euro and generated over 180.000 jobs, while the bio-based share of the chemical industry in the EU-28 increased from about 5% in 2008 to 8% in 2017.

2 Introduction

The following is an assessment of turnover and employment of the European bioeconomy for the years 2008-2017, using Eurostat as the primary data source.

This update of the previous versions of this study, including figures for 2017, has become possible thanks to updated statistical data. However, note that in the meantime the statistical data for the previous years have also been slightly revised by Eurostat. In order to be consistent, this update uses the most recent Eurostat data for all years. Due to this fact, small differences with the previous studies are unavoidable. Also, for various products, 2017 data is not complete yet in the Eurostat database. This alters the representativeness of some values and is annotated where necessary. Furthermore, in 2019, the "bio-based shares" that are defined by nova-Institute in collaboration with industry experts and are applied on product level, were significantly revised. However, these revised shares were applied in this year's report also to the Eurostat data of all years since 2008, so there is no visible break between 2017 data and previous data. Rather, there are some changes between this year's overall results and the last years, but they are rather small and seem to be conclusive. Furthermore, since it is very difficult to estimate changes in bio-based shares per product over years, for each product the same share has been assumed for all years. Therefore, the differences in the results of our annual reports stem from changing total production volumes as well as from the recent revision of the bio-based shares.

Note that the principle methodology has been developed in collaboration with the European Commission's Joint Research Centre (JRC). Hence, please also see the publications by Ronzon et al. 2017 and Ronzon et al. 2017a on this topic. However, due to slight differences in the details, data published simultaneously by the JRC are not exactly the same. There have been attempts to further harmonise the approaches, but these have not been completely fruitful, due to differences in objectives and some assumptions. The differences do not impact the overall conclusions in any significant manner.

3 Sources and methodology

The main data source for all sectors of the bioeconomy shown in the following figures is Eurostat, and, more specifically, the two databases PRODCOM (Eurostat 2019) and the Structural Business Statistics (SBS, Eurostat 2019a). PRODCOM contains for all Member States data for the production quantity and production value of about 3,900 manufactured goods. These goods are coded based on the European Classification of Products by Activity (CPA) system, where the first four digits indicate the division, group and class to which the product belongs according to the NACE classification of economic activities in the European Community (NACE stands for Nomenclature statistique des activités économiques dans la Communauté européenne).

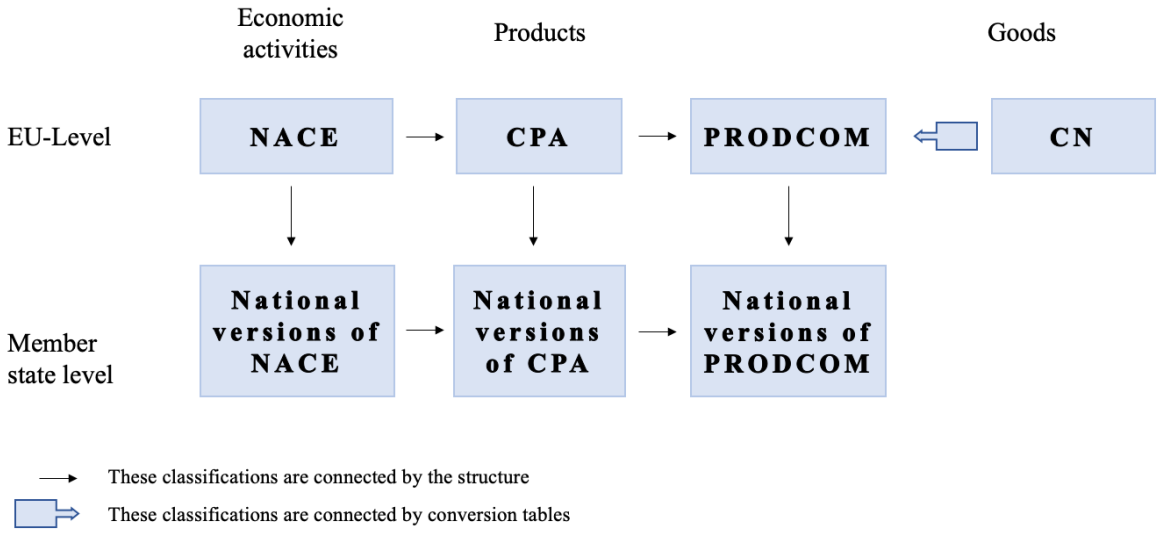

Figure 2: Relation of NACE and CPA classification

Further economic indicators, such as employment and turnover, are only contained in the SBS and other databases at higher levels of aggregation, i.e. the NACE class and division level. The SBS also contain production values at the NACE class level. However, these production values at the NACE class level are strictly speaking not identical to the production values of products summed up to the same NACE class. This is due to fact that NACE classifies enterprises according to their *main* activity, even though they may also produce products belonging to other classes. However, a comparison of both NACE class level production values shows in most cases that the deviation is negligible.

In order to derive economic indicators for the partially bio-based sectors, the principal approach of the methodology is to first estimate product-level bio-based shares for all

products in the PRODCOM list. These shares can then be applied to the product-level production value and the resulting bio-based shares in production value can be aggregated to the sector level (NACE classes or higher) and applied to various economic indicators (such as turnover, employment and value added). For those sectors that can be fully attributed to the bioeconomy, the data on turnover and employment was directly obtained from the respective Eurostat datasets. These sectors comprise primary biomass production (agriculture, forestry and fishery) as well as the sectors food, beverages, tobacco, paper and paper products.

The sectors textiles and textile products, forest-based industry, chemicals (including enzymes) and plastics as well as pharmaceuticals only partly contain bio-based products. Therefore, the bio-based shares of these sectors need to be estimated and only these estimated shares are accounted for in the following figures. The sector forest-based industry includes wood products, that are considered fully bio-based, but also furniture, which is only partly bio-based (based on wood and/or natural fibres).

The sectors chemicals and plastics as well as pharmaceuticals include a multitude of fully bio-based (e.g. natural dyes and pigments, enzymes, fatty acids) and partly bio-based products (different chemicals and plastics that are traditionally petro-based but in recent years also partly bio-based). Currently (2017, out of the 534 products in the NACE division 20 (Manufacture of chemicals and chemical products), 110 are fully or partly bio-based. The majority of products, 424, is therefore currently non-bio-based.

Out of the 110 fully or partially bio-based products, 40% are 100% bio-based (e.g. tanning extracts of vegetable origin, sorbitol, tall oil), 24% products have a bio- based share of at least 10% (e.g. ethylene glycol, carboxylic acid, adipic acid) and 36% products of lower bio-based shares (e.g. acetic acid, methanol, epoxy resins). For those product groups that contain partially bio-based products, a percentage share has been estimated in order to provide realistic numbers on the effects of the bio-based economy, same as for the partially bio-based products in the textiles or forest-based industries. The approach to all partially bio-based sectors is the same. The shares have been developed and are continuously being fine-tuned in collaboration with several bio-based economy experts and nova-Institute.

Both biodiesel and bioethanol have dedicated product codes within NACE division 20 (chemicals and chemical products). In order to evaluate the economic effects of biofuels separately from other chemical products, the shares of biodiesel and bioethanol on product level in the total production values of their respective NACE classes (20.14 and 20.59) were therefore calculated and then the assumption was made that the same shares can be applied to the total employment and turnover of these two classes.

In the case of bioenergy for heat and power (biogas and solid biomass), their shares in employment and turnover of total energy production have been estimated, taking into account a higher labour intensity of renewables due to the handling and more decentralised plants. While there are other data sources available for bioenergy and biofuels (mainly the annual reports of EurObserv'ER[1]), these sources are not compatible with Eurostat since they include both direct and indirect jobs and there is no clear indication how to separate both.

The graphs provided in this study differentiate between the overall bioeconomy (incl. primary production as well as food & feed), the bioeconomy excl. food & feed as well as the narrower so- called "bio-based economy" which excludes also primary biomass production. This is a usual categorisation in order to illustrate different effects and characteristics, since the food market for example follows a different dynamic than the chemical industry.

4 Results

4.1 Turnover

Turnover in the EU bioeconomy (EU-28, 2008–2017)

Figure 3 first shows the development of turnover of the total bioeconomy (including food and beverages and the primary sectors agriculture and forestry) in the period 2008–2017. Apart from the recession in 2009, the data show a continuous increase from less than 2 trillion Euro in 2008 to over 2.4 trillion Euro in 2017 with the food sector being the main contributor.

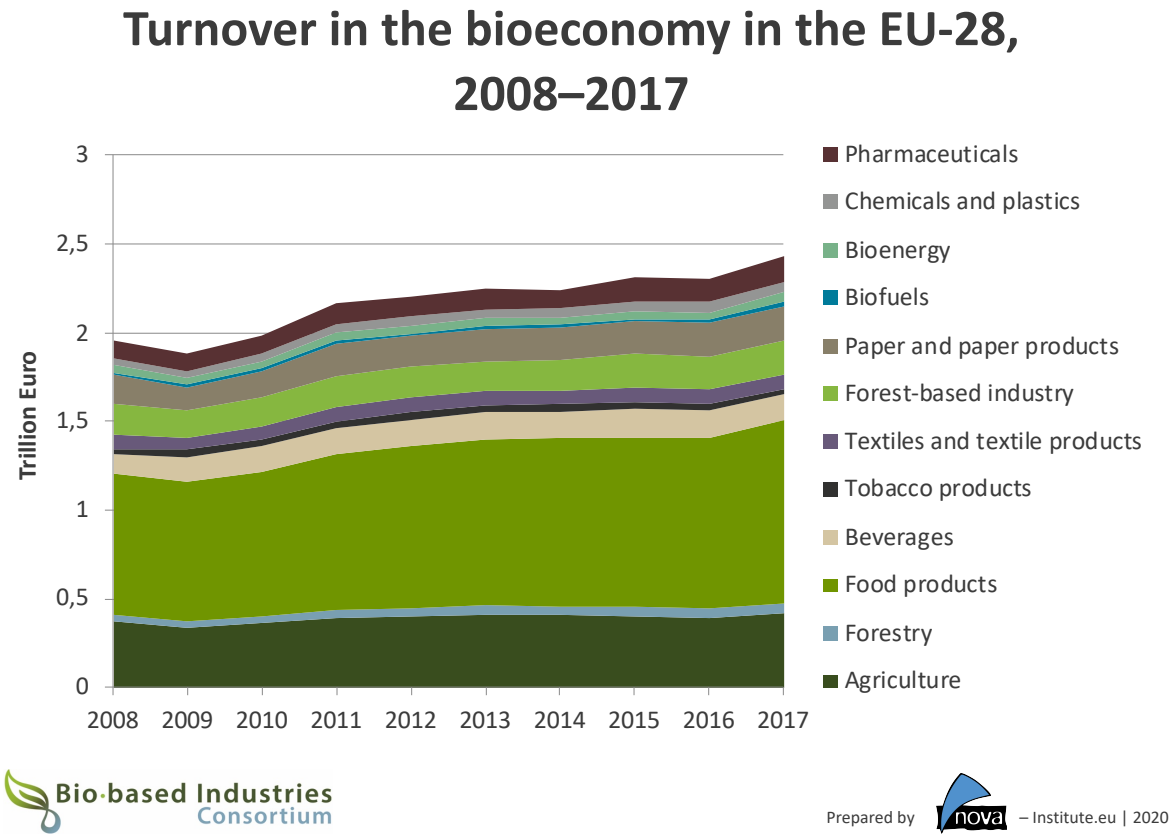

Figure 3: Turnover in the bioeconomy in the EU-28, 2008–2017

Roughly half of the 2.4 trillion Euro in 2017 (see Figure 3) come from the food and beverages sector, nearly a quarter of the turnover is produced by the primary sectors (agriculture and forestry), while the other quarter is produced by the so-called bio-based industries (such as chemicals and plastics, pharmaceuticals, paper and paper products, forest-based industries, textile sector, biofuels and bioenergy).

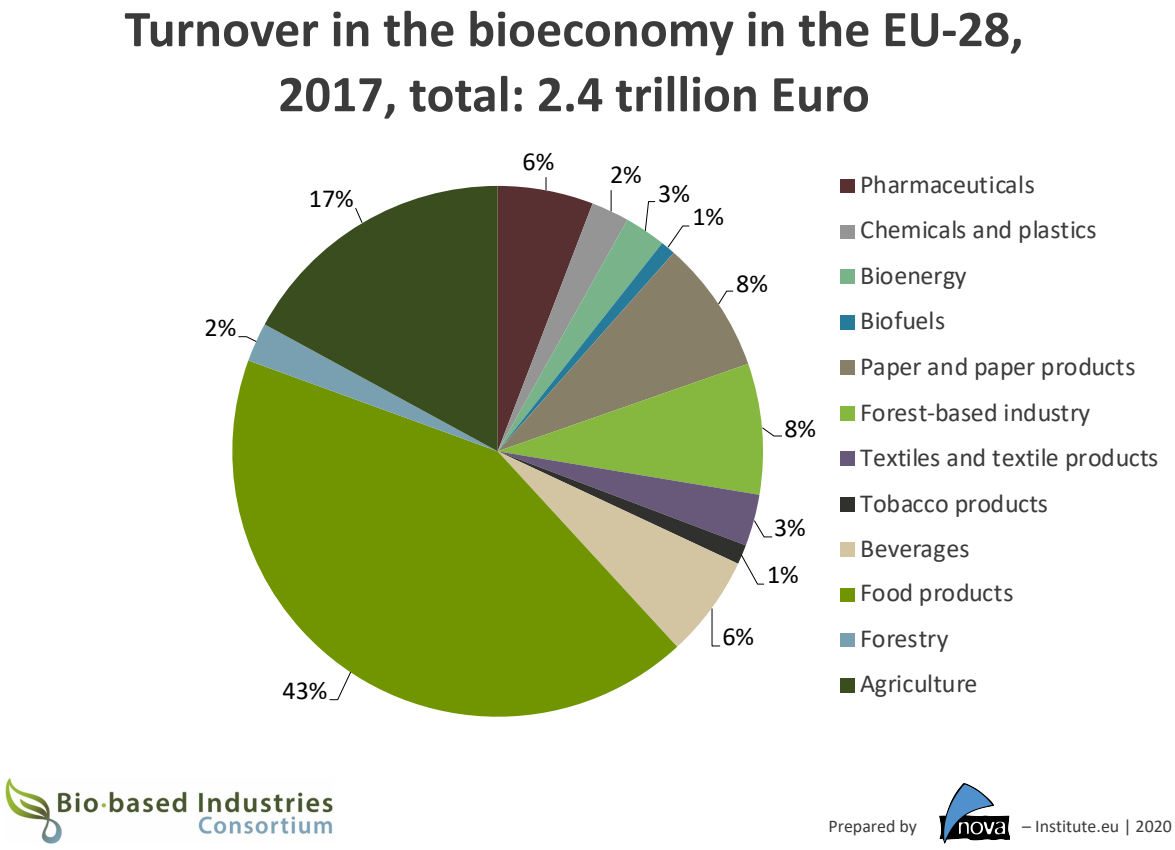

Figure 4: Turnover in the bioeconomy in the EU-28, 2017

If the sectors food, beverages and tobacco products are excluded, turnover amounted to 1.2 trillion Euro (Figure 5). Note that the food sector here always refers to NACE division 10 (Manufacture of food products), which, at least partially, also includes feed products in the form of group 10.9 (Manufacture of prepared animal feeds).

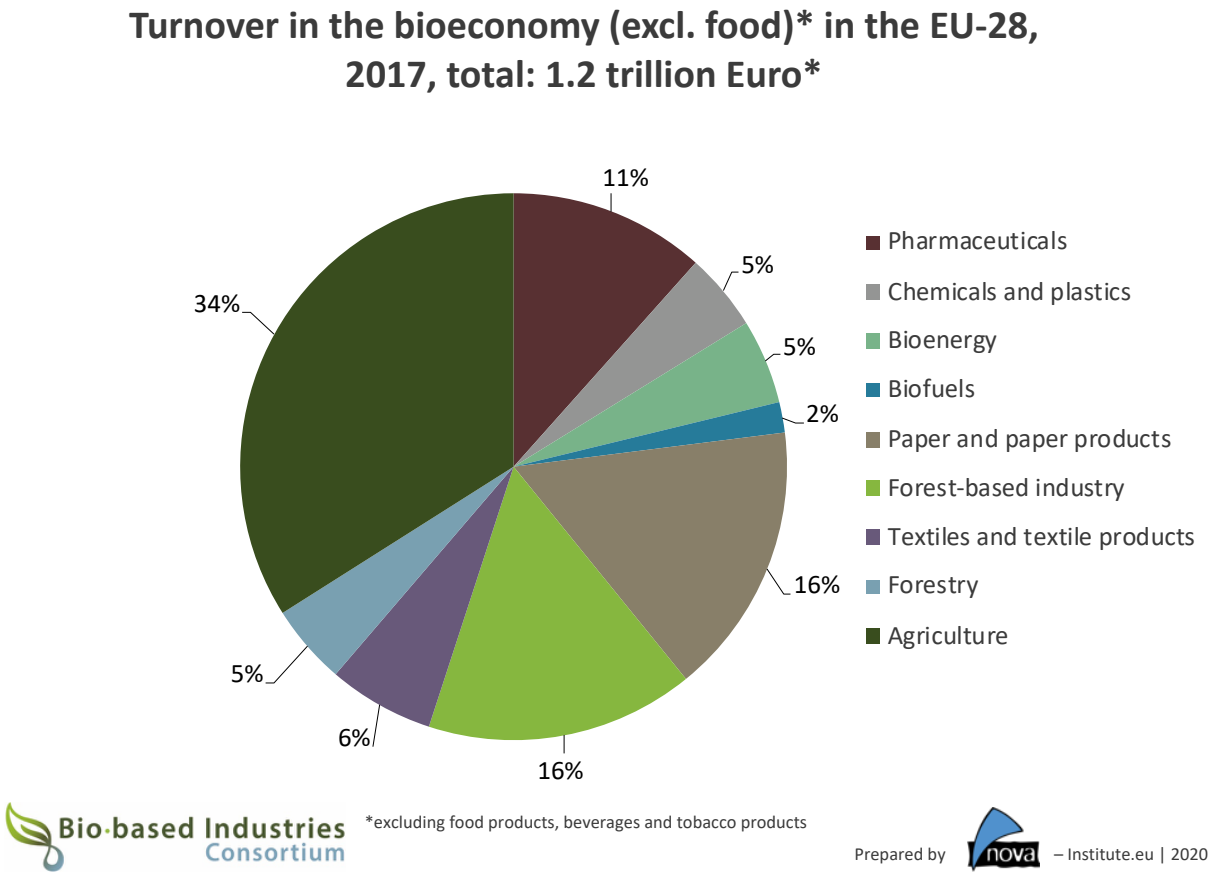

Figure 5: Turnover in the bioeconomy (excl. food products, beverages and tobacco products) in the EU-28, 2017

Turnover in the EU bio-based sector (EU-28, 2008–2017)

When also the main biomass production/extraction is excluded (Figure 6), the analysis indicates that biofuels and bioenergy together accounted for roughly 11% of the turnover of the EU industrial sectors that are referred to as the 'bio-based economy', which corresponds to a complete amount of approximately 82.5 billion Euro.

The sectors paper and paper products (26%) and forest-based industry (wood products and furniture, 26%) make up for the largest shares of turnover: together they amount to roughly 315 billion Euro. Bio-based chemicals and plastics accounted for 60 billion Euro. The total turnover of the bio-based industries reached about 750 billion Euro in 2017 (Figure 4), up from about 600 billion Euro in 2008 (Figure 5).

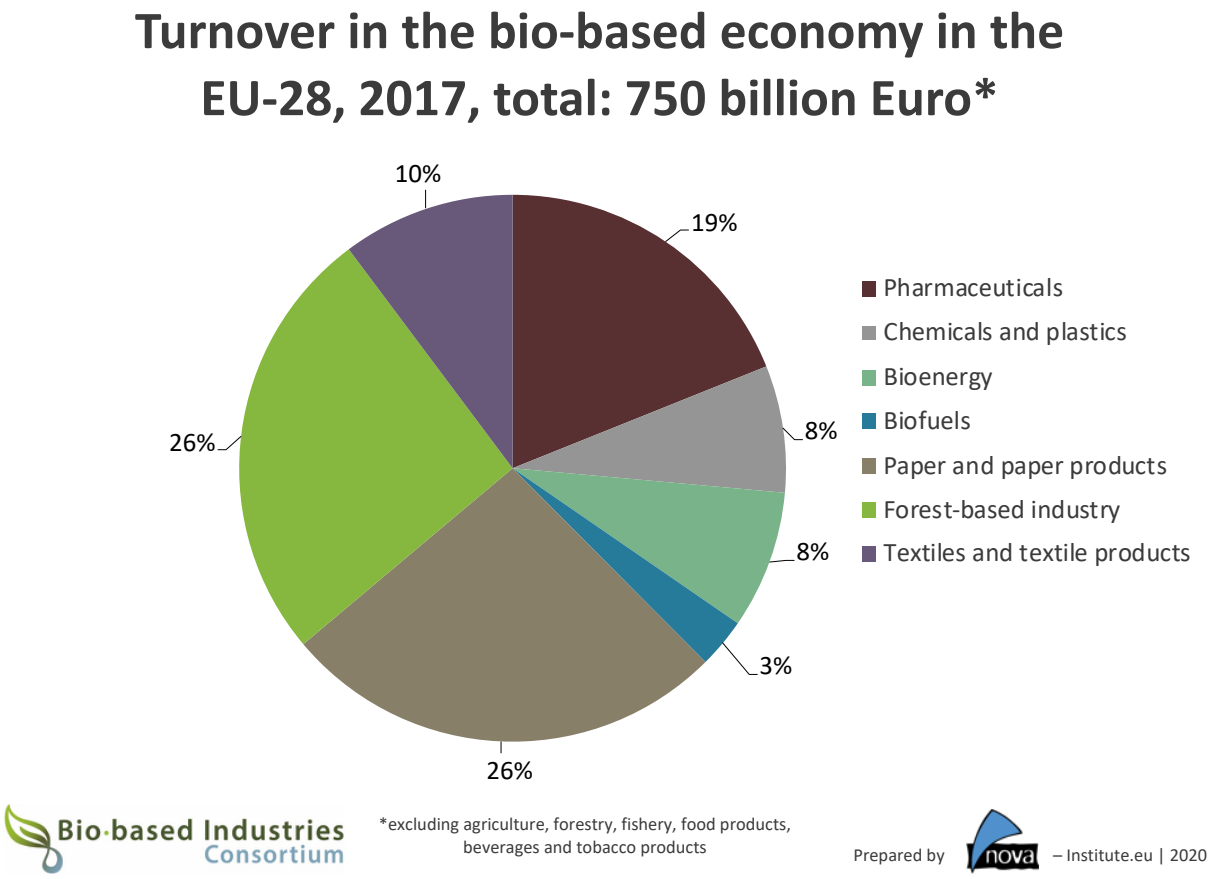

Figure 6: Turnover in the bio-based economy in the EU-28, 2017

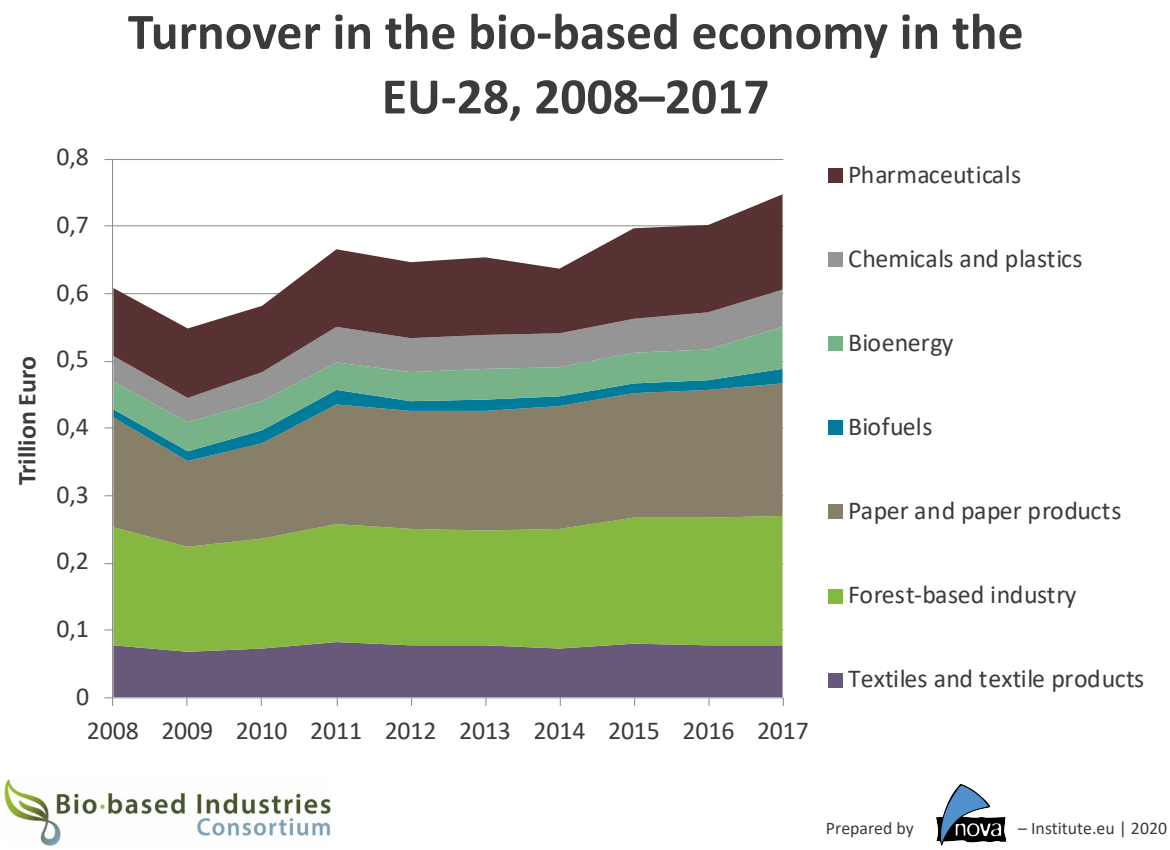

Figure 7: Turnover in the bio-based economy in the EU-28, 2008–2017

4.2 Employment

Employment in the EU bioeconomy (EU-28, 2008-2017)

Similar to the presentation of the turnover, Figure 8 first shows the development of employment for the whole bioeconomy in the period 2008–2017, measured by the total number of employed persons. The comparison of Figure 8 with Figure 3 clearly shows that, contrary to overall turnover, overall employment of the EU bioeconomy is declining. However, as Figure 8 shows, this decline of employment of the total bioeconomy is mainly due to the decline of the agricultural sector, which is due to the increasing optimization, automation and digitalization of this sector. Other sectors have been stable or even increased their employment. In 2017, the total number of employed persons in the EU bioeconomy amounted to 18.5 million (Figure 8).

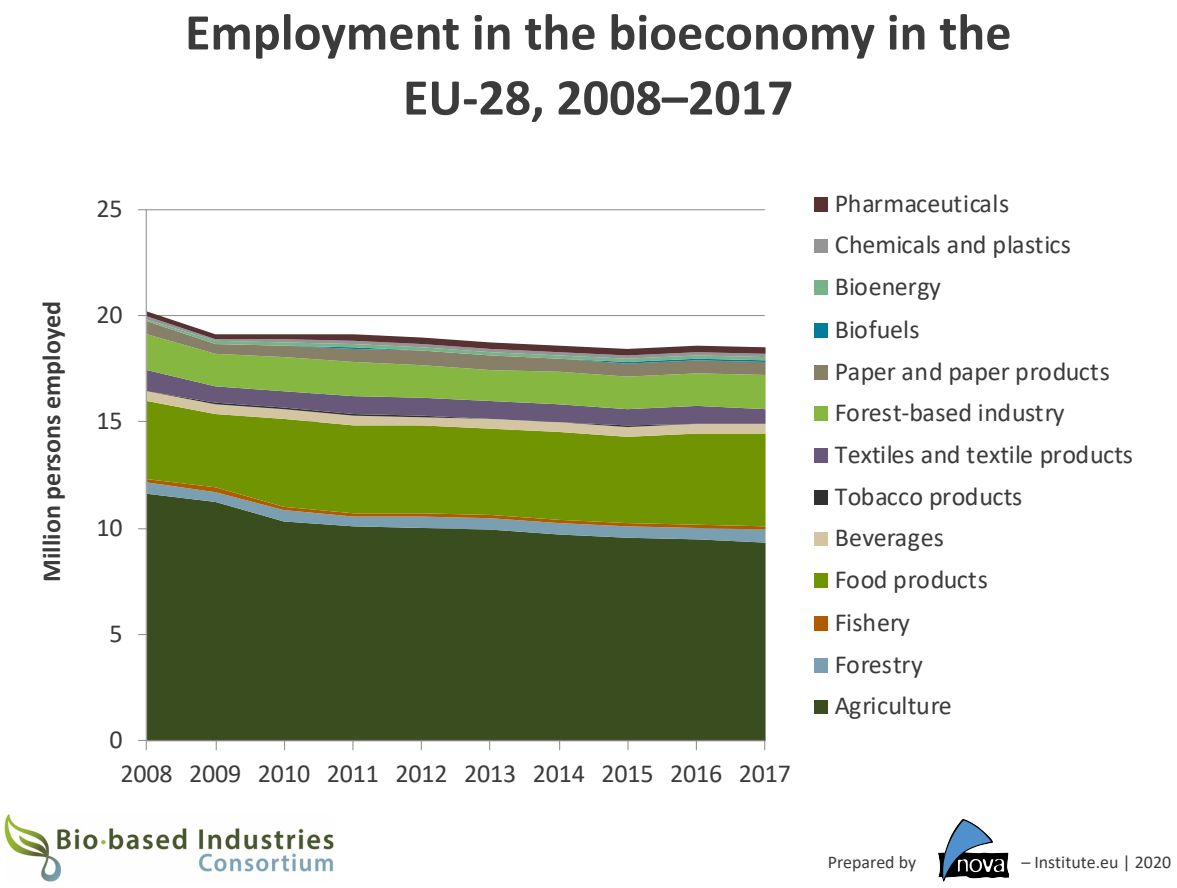

Figure 8: Employment in the bioeconomy in the EU-28, 2008–2017

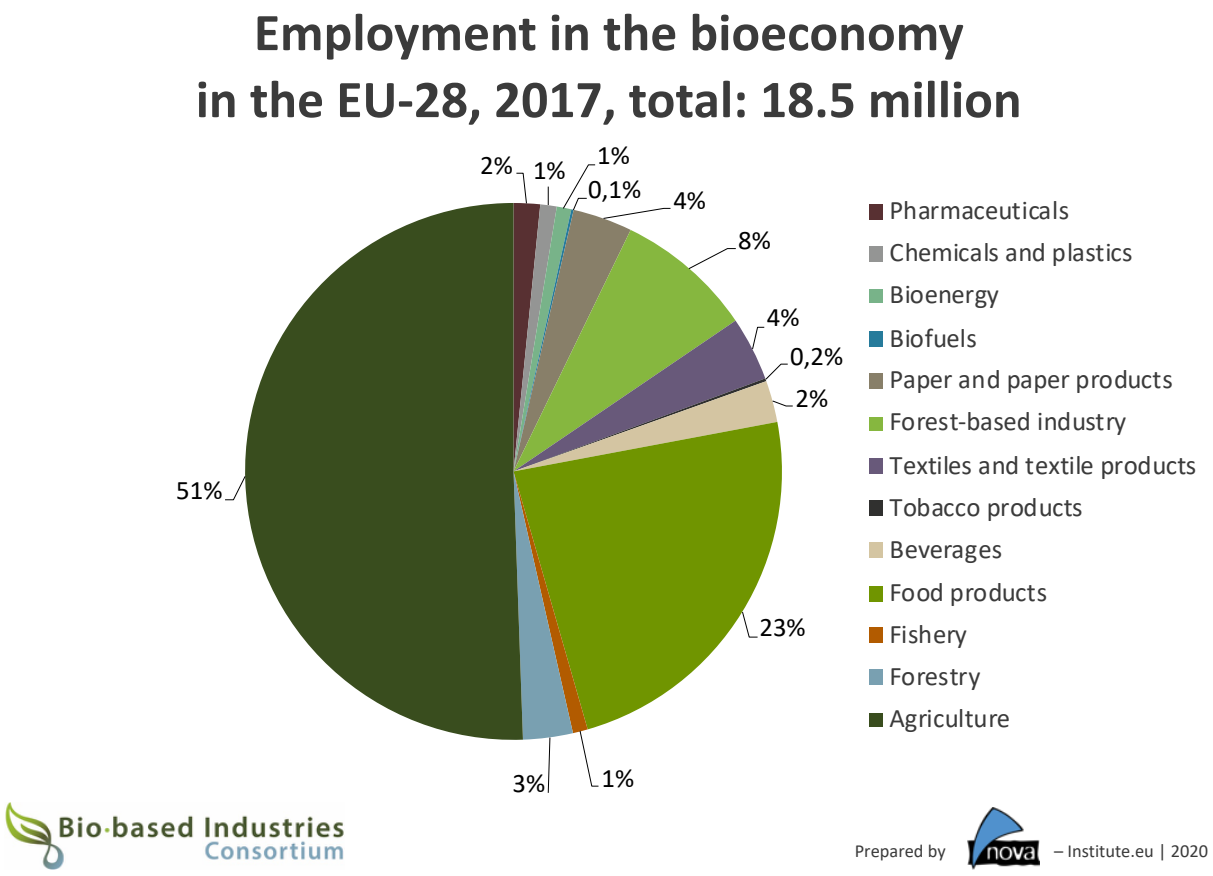

Figure 9: Employment in the bioeconomy in the EU-28, 2017

Figure 10 shows the breakdown of employment excluding the sectors food, beverages and tobacco products. These sectors in total account for 13.7 million jobs with about three quarters located in the primary sector.

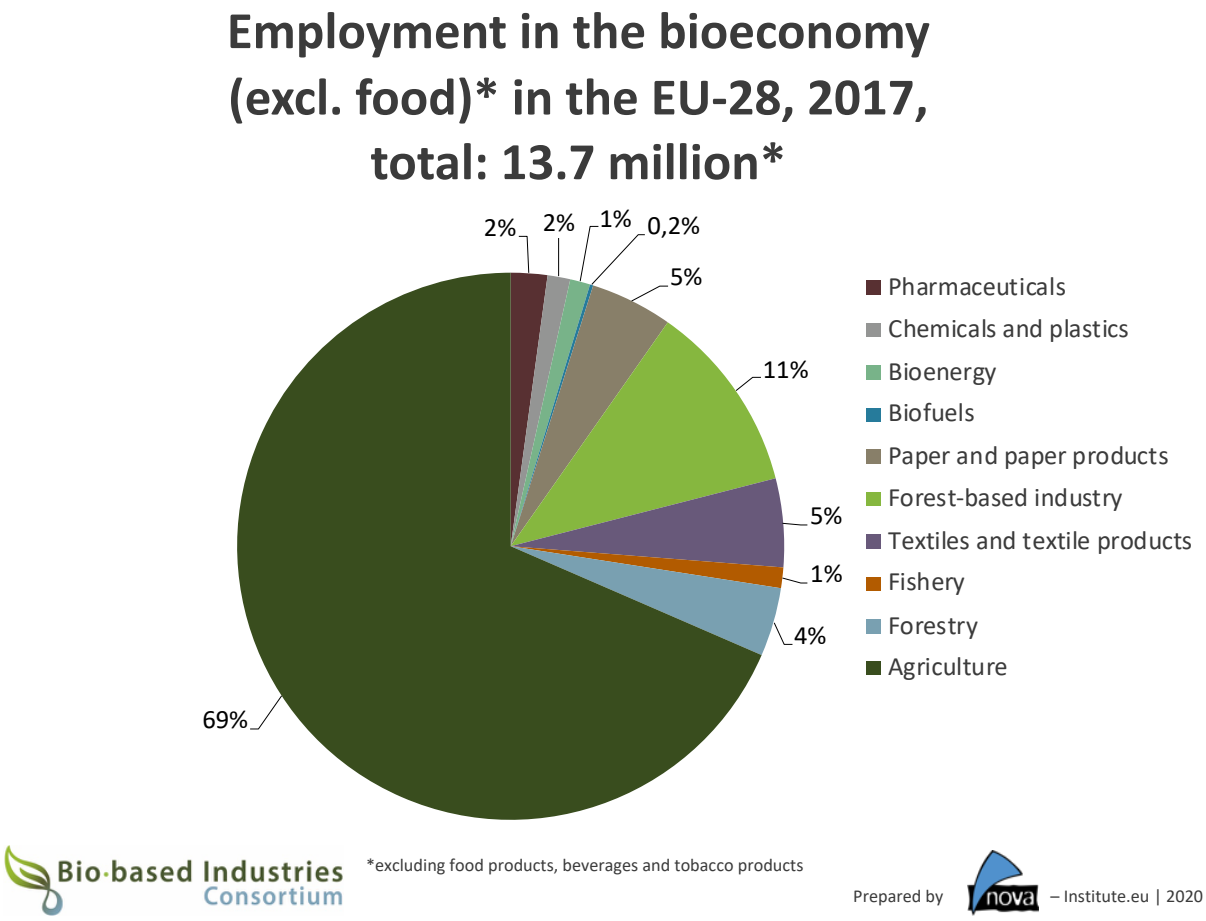

Figure 10: Employment in the bioeconomy (excl. food products, beverages and tobacco products) in the EU-28, 2017

Employment in the EU bio-based sector (EU-28, 2008–2017)

When only the "industrial sectors" are analysed (so excluding also the primary biomass production/extraction), the total employment is 3.6 million jobs in 2017. The most prominent sectors are the forest-based industry, paper and paper products, and the textile industry (Figure 11 and Figure 12).

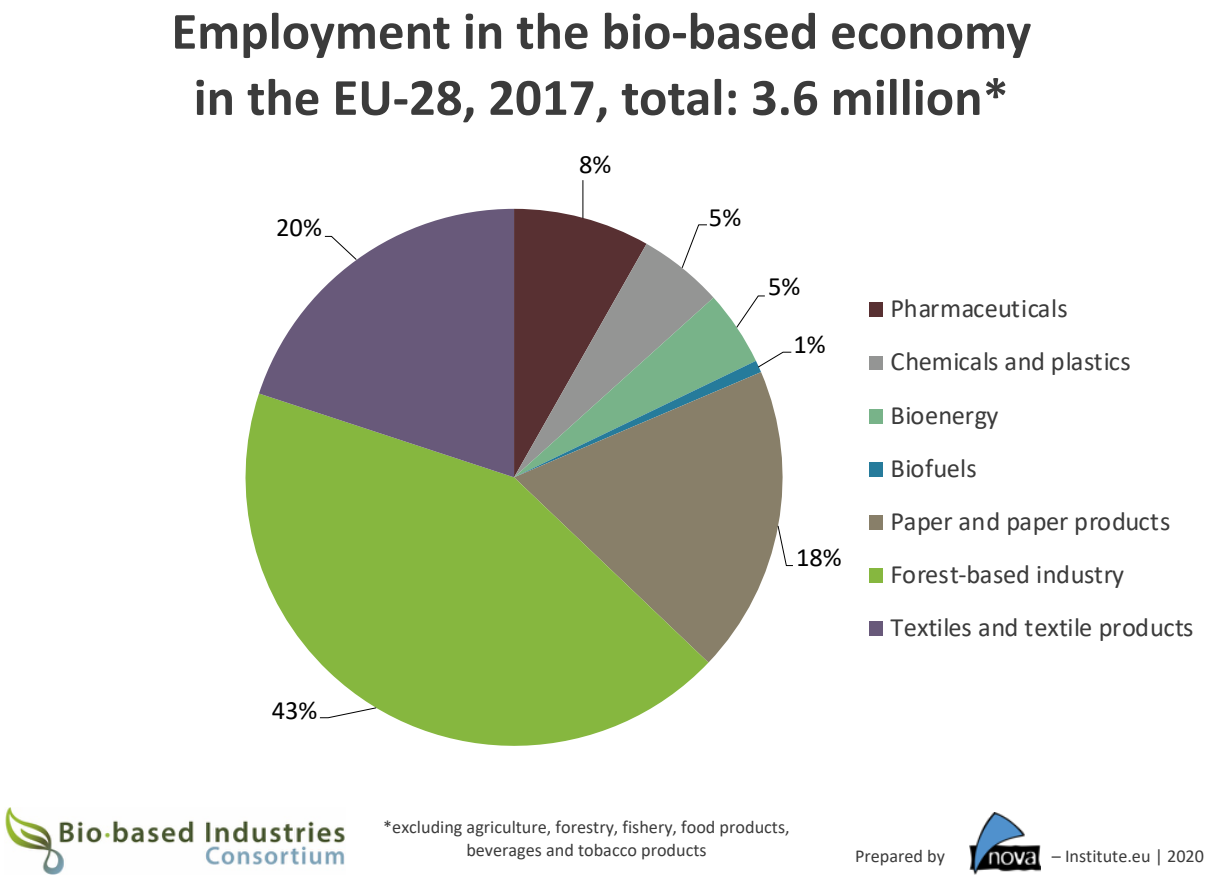

Figure 11: Employment in the bio-based economy in the EU-28, 2017

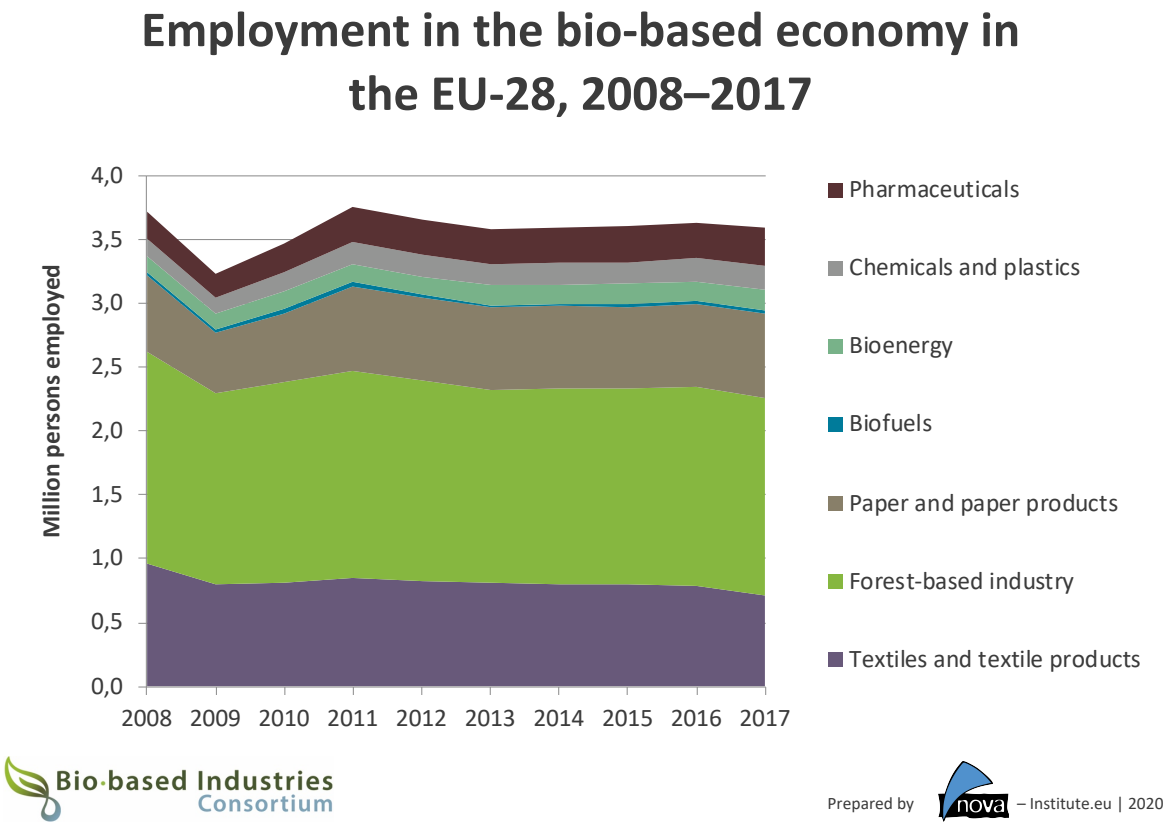

Figure 12: Employment in the bio-based economy in the EU-28, 2008–2017

Turnover and employment in the EU bio-based economy per Member State

The following Figure 13 compares the total turnover and employment of the bio-based economy (excl. agriculture, forestry, fishery, food, beverages and tobacco products) for each Member State of the EU-28 in 2017. The figure shows clear differences between groups of Member States, e.g. the Eastern European countries Poland, Romania and Bulgaria apparently are stronger in less value-added sectors of the bio-based economy that generate a lot of employment.

In comparison, Western and Northern European countries generate much higher turnover compared to the employment generated. The countries with the largest relative difference between turnover and employment in 2017 are France, Finland, Belgium and Sweden.

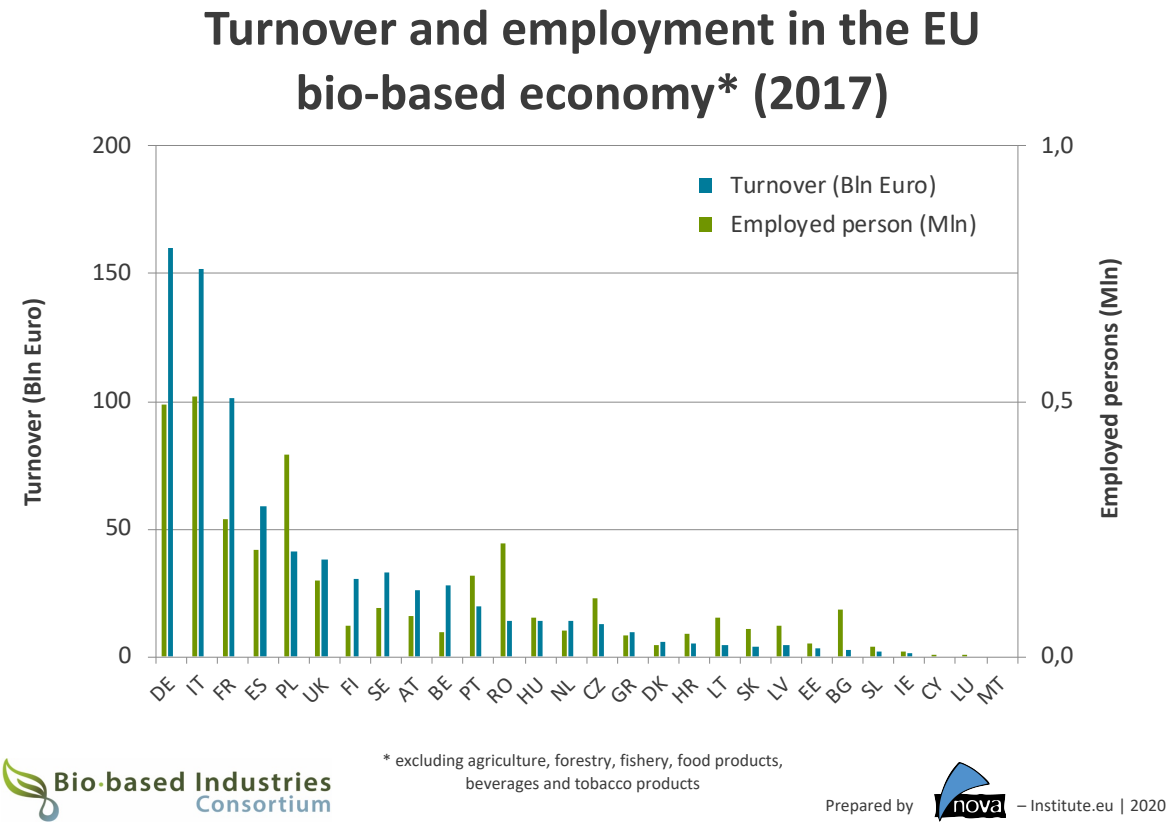

Figure 13: Turnover and employment in the EU bio-based economy per Member State, 2017

Employment per turnover in sectors of the bio-based economy

Figure 14 compares the number of employed persons per one million Euro of generated turnover for the bio-based sectors textiles and textile products, forest-based industry (wood products and furniture), paper and paper products, chemicals and plastics, pharmaceuticals, biofuels and bioenergy over the period 2008–2017.

This figure shows that the sectors textiles and textile products as well as forest-based industry generate relatively high employment at low turnover, while biofuels and pharmaceuticals create a lot of turnover at comparably little employment. Note that employment and turnover here always refer to the end product manufacturing stage only, meaning that neither the employment and turnover in primary biomass production nor indirect effects in other sectors due to machinery purchases etc. are accounted for in any of the industrial sectors.

Chemicals and plastics as well as the pulp and paper sector and bioenergy can be found in an intermediate position. Their production requires more labour but also generates more turnover than textiles and textile products as well as the forest-based industry. The overall decrease in the ratio between employment to turnover hints at improved productivity, indicating a continued competitiveness of Europe. Strongest is the decrease of this ratio in the forest-based industry and the textile industry, which can be explained by the overall economic crisis following the year 2008, and partly by increases in productivity.The rather significant decrease in the turnover to employment ratio for bioenergy is attributed to incomplete data sets in the PRODCOM database and therefore not representative.

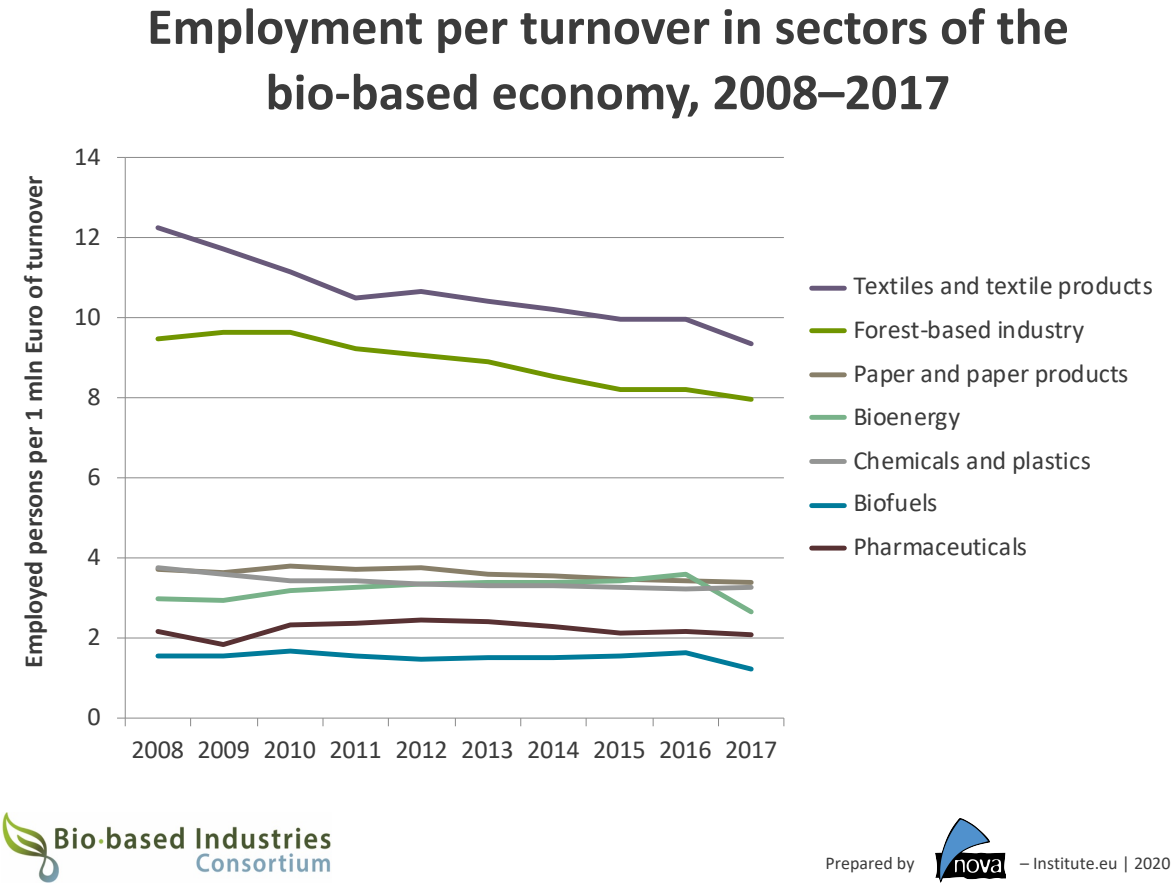

Figure 14: Employment per turnover in sectors of the bio-based economy, 2008–2017

4.3 Bio-based shares in the manufacture of chemicals and chemical products

The following Figure 15 compares the estimated overall bio-based share in the NACE division 20 (Chemicals and chemical products, excluding biodiesel and bioethanol) between 2008 and 2017 for the EU-28 as well as for each single Member State.

According to Figure 15 Denmark and Latvia stand out as the Member States with the highest bio-based share over the whole period from 2008–2017. In the case of Denmark, this is due to the highly relevant enzyme industry which is continuously increasing in importance. In contrast, Latvia is characterised by large production volumes of traditional products such as charcoal and tall oil and both products belong to the NACE division 20. This artefact in the data highlights the importance of looking closely and critically at the results. Further, data for Latvia show major fluctuations, which are mainly due to discontinuous source data from Eurostat.

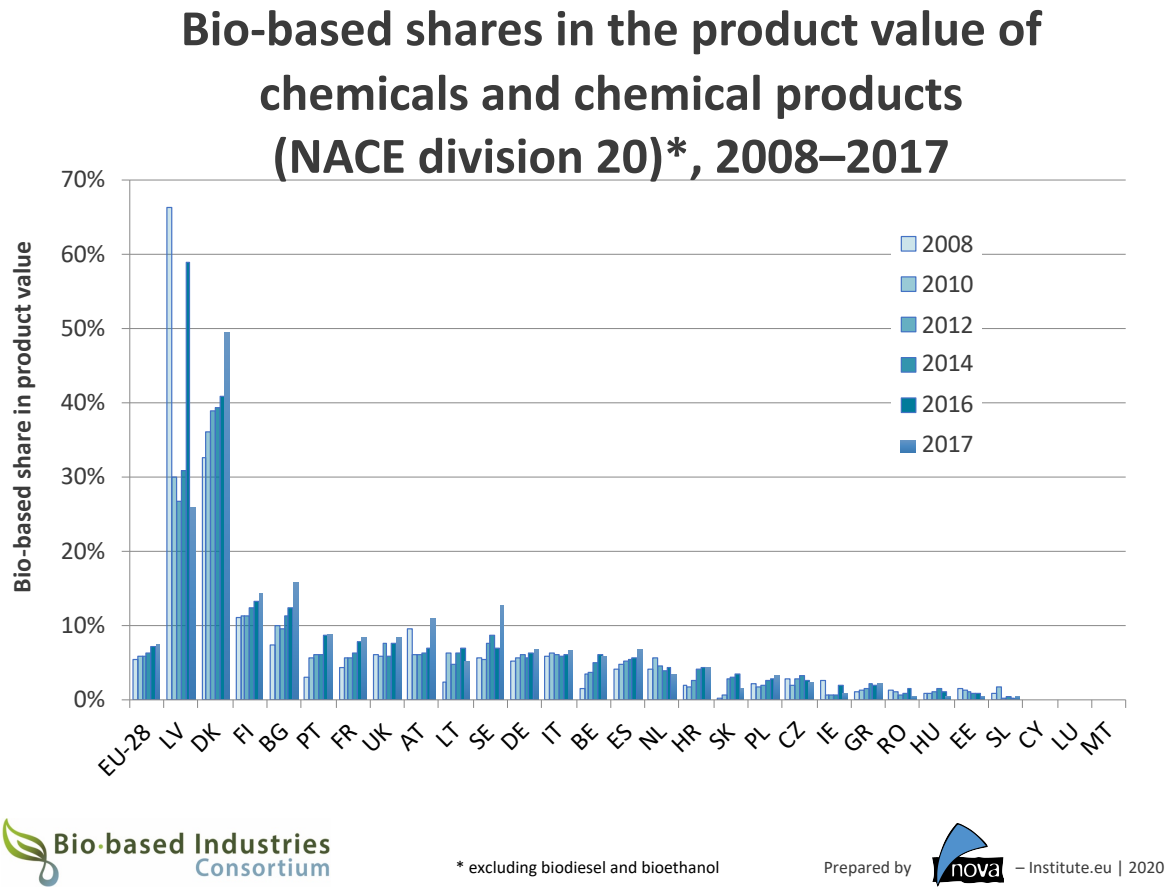

Figure 15: Bio-based shares in the product value of chemicals and chemical products, 2008–2017

The data show an overall increase in the bio-based share in the EU-28 from about 5% in 2008 to 7.5% in 2017. The raw material composition for the chemical industry is about 50% organic (fossil and bio-based) and 50% inorganic (minerals, metals). Only taking the organic part into account, the overall bio-based share therefore increased from 10% in 2008 to 15% in 2017 (Table 1). Additionally, Figure 16 shows these results in graphical form. Note that there are small differences compared to the report published in 2018, due to the slight differences in the Eurostat data and the revisions of the product-level bio-based shares.

Year	Overall bio-based share in the product value of chemical products	Bio-based share in the organic part of chemical products (approx.)
2008	5.3%	10.7%
2009	5.8%	11.5%
2010	5.9%	11.8%
2011	5.9%	11.8%
2012	5.9%	11.8%
2013	6.2%	12.4%
2014	6.2%	12.4%
2015	6.3%	12.6%
2016	7.2%	14.4%
2017	7.5%	14.9%

Table 1: Bio-based shares in the product value of chemicals and chemical products in the EU-28, 2008–2018

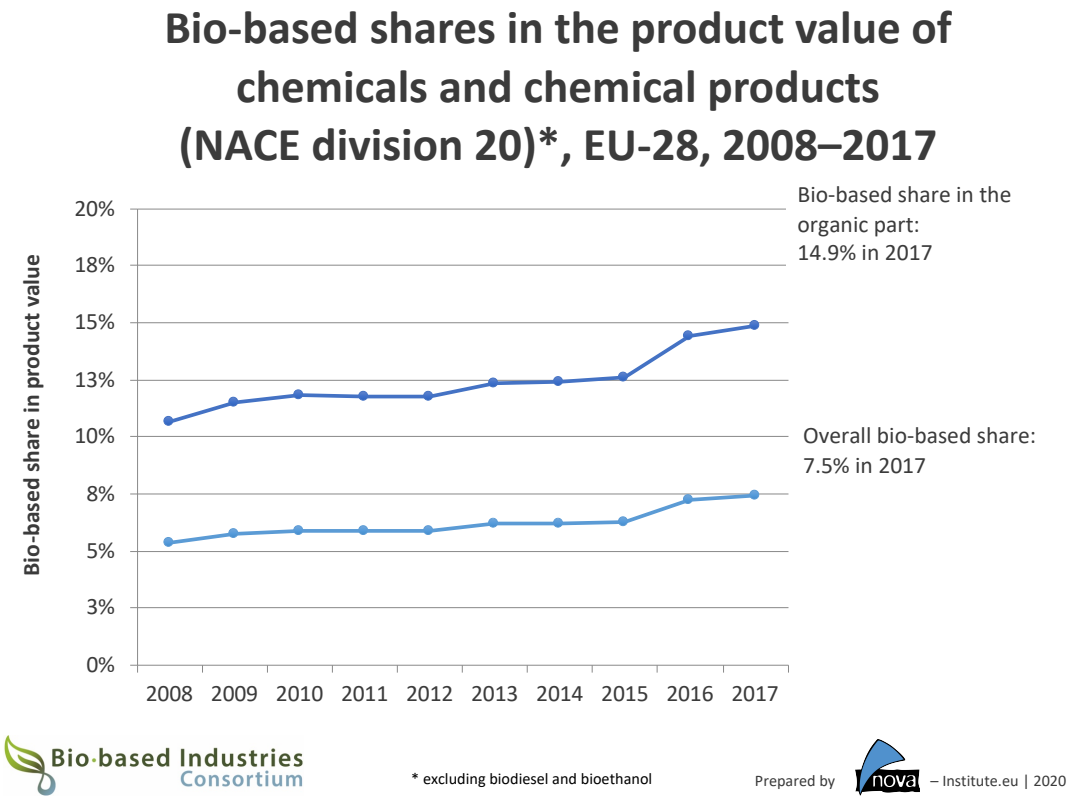

Figure 16: Bio-based shares in the product value of chemicals and chemical products in the EU28, 2008–2017

Figure 17 shows in more detail which NACE classes have contributed to the overall increase of the bio-based share of the chemical industry, by illustrating the development of the bio-based products values in each NACE class of division 20. The resulting total product value of bio-based chemicals of 27.4 bln Euro in 2017 is 7.5% of the overall product value of chemicals and chemical products (both petro- and bio-based), therefore corresponding to the overall 7.5% share of bio-based chemicals shown in Figure 13.

Figure 17 also clearly shows that the remarkable increase of the bio-based share between 2015 and 2017 was mainly due to an increase of the production value of class 20.53 (essential oils), while other organic basic chemicals (20.14) have also shown a moderate, but continued increase.

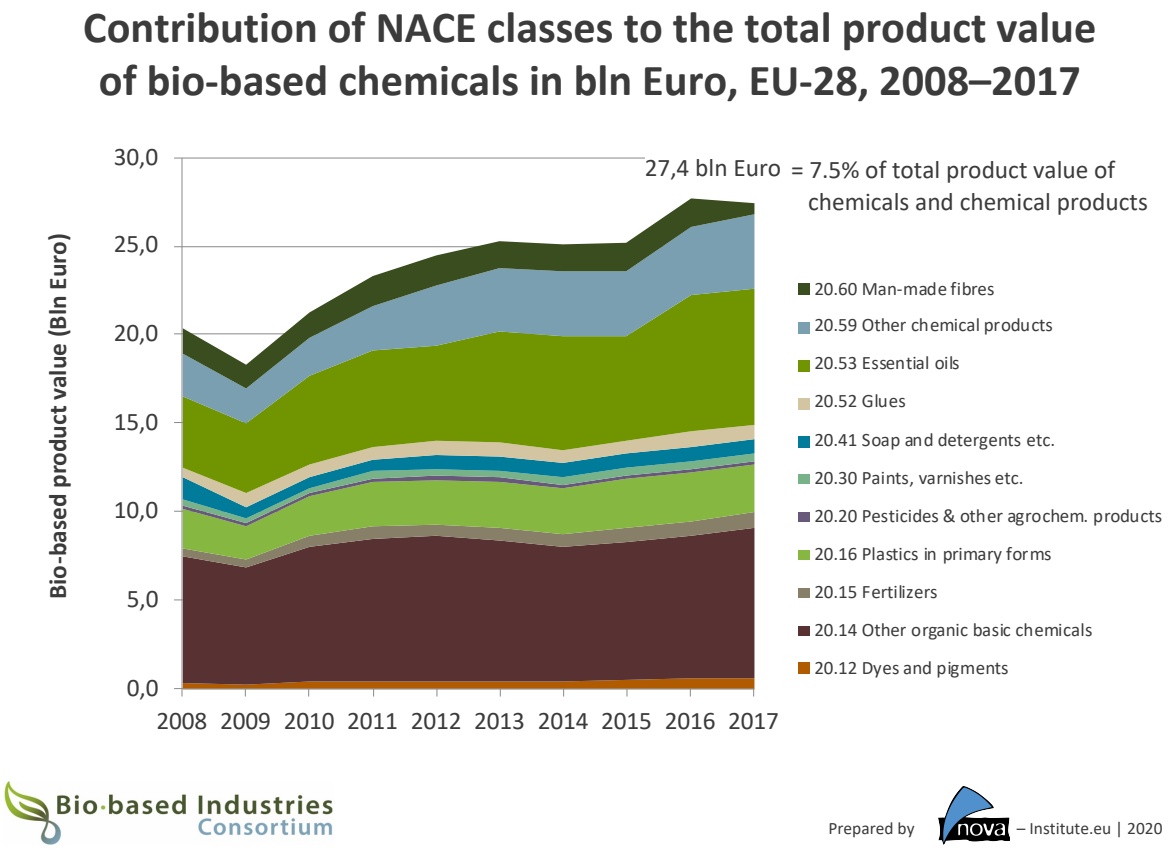

Figure 17: Contribution of NACE classes to the total product value of bio-based chemicals, EU28, 2008–2017

While Figure 17 indicates the bio-based production value contributed by each whole NACE class within division 20 to the overall bio-based production value in the chemical industry, a deeper look is necessary to understand which products make up the lion's share in this total value.

Therefore, Table 2 shows the 20 partly or fully bio-based chemical products with the highest bio-based production value in 2017. It shows, for example, that odoriferous substances for food or drink industries (part of class 20.53, essential oils) alone contributed 4.32 bln Euro (15.8 % of the total value of 27.4 bln Euro) to the bio-based production value of division 20 in 2017, followed by odiferous substances for non-food and drink related purposes with a production value (also class 20.53) of 2.80 bln Euro. Class 20.14 (other organic basic chemicals) is represented with the highest number (seven) of different products out of the 20 high-value chemicals.

PRODCOM-code	Name	Bio-based production value (bln Euro)
20.53.10.75	Mixtures of odoriferous substances of a kind used in the food or drink industries	4.32
20.53.10.79	Mixtures of odoriferous substances (excluding those of a kind used in the food or drink industries)	2.80
20.14.64.70	Enzymes; prepared enzymes (not elsewhere specified or included) (excluding rennet and concentrates)	2.18
20.16.59.40	Cellulose and its chemical derivatives, n.e.c., in primary forms	1.13
20.59.60.80	Gelatin and its derivatives (excluding casein glues, bone glues and isinglass)	1.11
20.53.10.20	Essential oils	1.04
20.16.59.60	Natural and modified natural polymers, in primary forms (including alginic acid, hardened proteins, chemical derivatives of natural rubber)	0.94
20.15.80.00	Animal or vegetable fertilisers	0.90
20.59.59.94	Other chemical products, n.e.c.	0.77
20.14.32.80	Lauric acid and others; salts and esters	0.75
20.14.23.33	D-glucitol (sorbitol)	0.60
20.14.31.95	Industrial monocarboxylic fatty acids distilled (excluding stearic, oleic tall oil)	0.56
20.59.20.00	Animal or vegetable fats and oils chemically modified	0.56
20.14.34.73	Citric acid and its salts and esters	0.55
20.52.10.80	Prepared glues and other prepared adhesives, n.e.c.	0.52
20.30.11.70	Other paints, varnishes dispersed or dissolved in an aqueous medium	0.48
20.12.22.70	Colouring matter of vegetable or animal origin and preparations based thereon (including dyeing extracts) (excluding animal black)	0.48
20.14.71.50	Rosin and resin acids; and derivatives; rosin spirit and oils; run gums	0.45
20.14.22.65	Lauryl alcohol; cetyl alcohol; stearyl alcohol and other saturated monohydric alcohols (excluding methyl, propyl and isopropyl, n-butyl, other butanols, octyl)	0.45
20.60.21.40	Artificial filament tow, of acetate	0.42

Table 2: The 20 partly or fully bio-based chemical products with the highest bio-based production value in the EU-28, 2017

Finally, Figure 18 looks at the contribution of NACE classes and products to the total product *volume* of bio-based chemicals. This kind of analysis in terms of production volume needs to make use of conversion factors for some product groups for which Eurostat does not report production in metric tonnes but in other units, i.e. for example pieces (e.g. of furniture, clothing etc.), square metres (e.g. textiles and fabrics) or cubic metres (e.g. forestry products). Conversion factors to metric tonnes are available from Eurostat, so that a reporting of all production in metric tonnes is possible.

In the case of chemicals, such a conversion is only necessary for a few groups of products such as industrial gases, which are reported in cubic metres. Figure 16 shows that class 20.14 makes a large contribution also in terms of production volume. As Table 3 shows, however, other products dominate in terms of bio-based production quantity. According to Table 3, animal and vegetable fertilisers alone contribute 6.6 mln t (28.6% of the total of 24.6 mln t) to the bio-based production volume of division 20 in 2017.

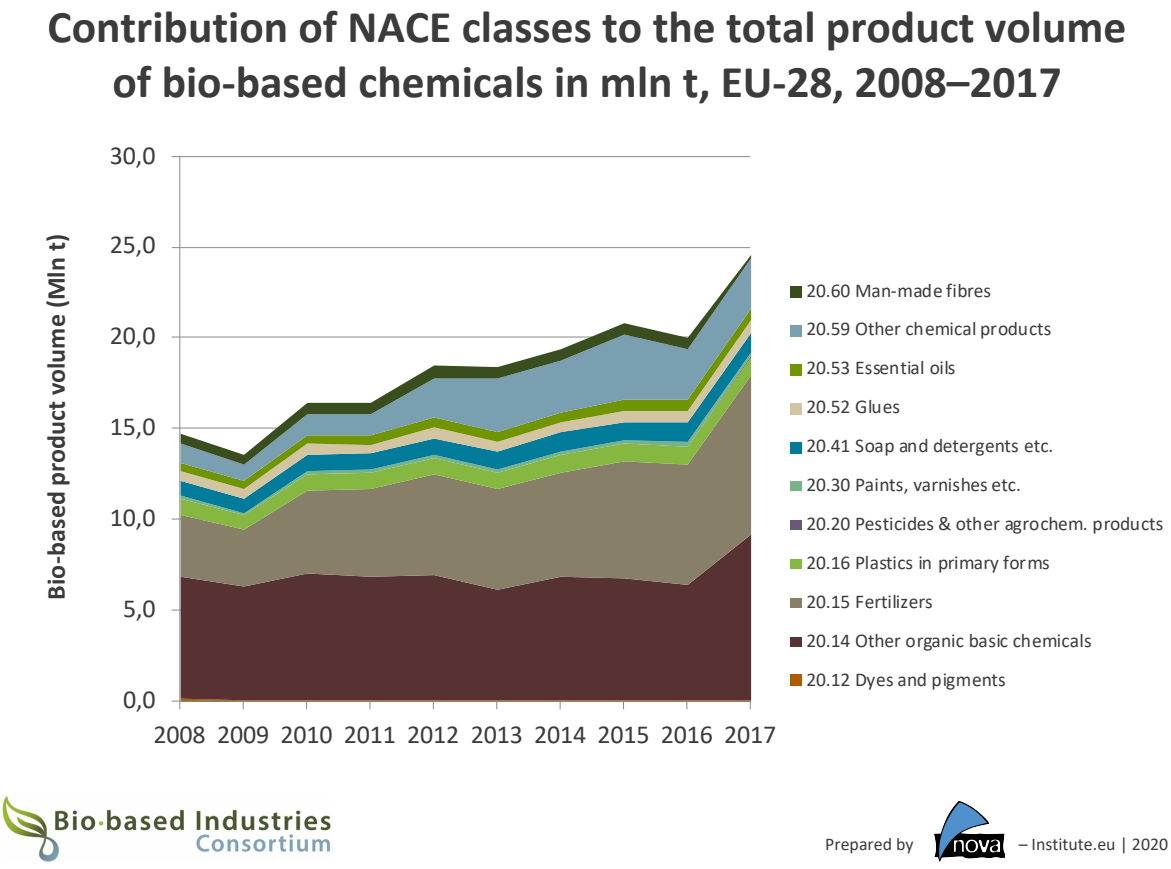

Figure 18: Contribution of NACE classes to the total product volume of bio-based chemicals, EU28, 2008–2017

PRODCOM-code	Name	Bio-based production volume (mln tons)
20.15.80.00	Animal or vegetable fertilisers	6.60
20.14.23.33	D-glucitol (sorbitol)	2.70
20.59.59.94	Other chemical products, n.e.c.	1.25
20.14.71.20	Activated natural mineral products; animal black	0.80
20.59.20.00	Animal or vegetable fats and oils chemically modified	0.73
20.41.10.00	Glycerol (glycerine), crude; glycerol waters and glycerol lyes	0.61
20.14.23.60	Glycerol (including synthetic; excluding crude, waters and lyes)	0.54
20.14.31.95	Industrial monocarboxylic fatty acids distilled (excluding stearic, oleic tall oil)	0.52
20.52.10.80	Prepared glues and other prepared adhesives, n.e.c.	0.48
20.14.34.73	Citric acid and its salts and esters	0.44
20.16.59.40	Cellulose and its chemical derivatives, n.e.c., in primary forms	0.43
20.14.71.30	Tall oil; whether or not refined	0.41
20.14.32.80	Lauric acid and others; salts and esters	0.36
20.53.10.75	Mixtures of odoriferous substances of a kind used in the food or drink industries	0.36
20.14.22.65	Lauryl alcohol; cetyl alcohol; stearyl alcohol and other saturated monohydric alcohols (excluding methyl, propyl and isopropyl, n-butyl, other butanols, octyl)	0.36
20.14.71.50	Rosin and resin acids; and derivatives; rosin spirit and oils; run gums	0.35
20.14.64.70	Enzymes; prepared enzymes (not elsewhere specified or included) (excluding rennet and concentrates)	0.34
20.14.72.00	Wood charcoal whether or not agglomerated (including shell or nut charcoal)	0.30
20.16.59.60	Natural and modified natural polymers, in primary forms (including alginic acid, hardened proteins, chemical derivatives of natural rubber)	0.30
20.14.21.00	Industrial fatty alcohols	0.28

Table 3: The 20 partly or fully bio-based chemical products with the highest bio-based production volume in the EU-28, 2017

5 Conclusion

Reviewing the bioeconomy data of 2017 and the consequentially updated figures, the general trend of a growing European bioeconomy can be reaffirmed. The total turnover generated by the European bioeconomy increased, the bio-based shares in the chemical industries increased further. Despite increasing turnover, the employment in the European bioeconomy decreased further and follows its trend of the previous years. This can be credited to increased productivity and efficiency of individual sectors as well as technological progress in various production processes.

So far, there is no reason to assume changes in these trends in the upcoming years. However, as of mid 2020, it remains to be seen how external influences affect the bioeconomy post 2019. The COVID-19 pandemic took and takes a significant toll on the economy as a whole and will also not shy away from the bioeconomy. Furthermore, the European Green Deal which was firstly presented in late 2019 and is currently further developed, will hopefully have significant positive impact on the European bioeconomy. This is expected to become apparent in the data in the years following its launch. Concluding this year's report, the future of the bioeconomy in Europe remains promising and exciting.

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