European Bioeconomy in Figures 2008 – 2016

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July 2019

Commissioned by

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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 2016, 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. An update of the study with data for 2014 and 2015 had been published in April 2018. Now, the new version of the report is available which spans for the first time the whole period from 2008 to 2016.

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 2016 shows that the turnover of the total bioeconomy, including food and beverages and the primary sectors agriculture and forestry, results in 2.3 trillion Euro in the EU-28. Roughly half of the turnover is accounted for by the food and beverages sector, almost a quarter is created by the primary sectors agriculture and forestry. The other quarter is created by the so-called bio-based industries, such as chemicals and plastics, pharmaceuticals, paper and paper products, forest-based industries, textiles, biofuels and bioenergy.

In 2016, the bioeconomy employed 18.6 million people in total. The primary biomass production, mainly agriculture plus forestry and fishery, generates a lot of employment (55%) but low turnover (20%). 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 2016 study, 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. This sector shows considerable turnover of about 700 billion Euro and 3.6 million employees in the EU-28 in 2016. In the bio-based chemical industry alone, turnover amounted to around 38 billion Euro while the bio-based share of the chemical industry in the EU-28 increased from about 5% in 2008 to 7% in 2016.

1 Introduction

The following is an assessment of turnover and employment of the European bioeconomy for the years 2008-2016, using Eurostat as the primary data source.

This update of the previous versions of this study, including figures for 2016, has become possible thanks to updated statistical data. Note, however, 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. Furthermore, as in the previous studies, slight revisions of the product level bio-based shares have taken place. 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 result from changing total production volumes.

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. For the future, it is planned to harmonize these discrepancies.

2 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 that the product is belonging to according to the NACE classification of economic activities in the European Community (NACE stands for *Nomenclature statistique des activités économiques dans la Communauté européenne*).

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 and 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 (2016), out of the 534 products in the NACE division 20 (Manufacture of chemicals and chemical products), 110 are fully or partly bio-based. From these 110 products, 40% are 100% bio-based (e.g. tanning extracts of vegetable origin, sorbitol, tall oil), 24% products with 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). The majority of products, 424, is therefore currently non-bio-based. 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. These 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 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 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.

[1] http://www.eurobserv-er.org

3 Results

3.1 Turnover

Turnover in the EU bioeconomy (EU-28, 2008-2016)

Figure 1 first shows the development of turnover of the total bioeconomy (including food and beverages and the primary sectors agriculture and forestry) in the period 2008-2016. Apart from the recession in 2009, the data show a continuous increase from less than 2 trillion Euro in 2008 to about 2.3 trillion Euro in 2016. An important contributor to the increase in turnover was especially the food sector.

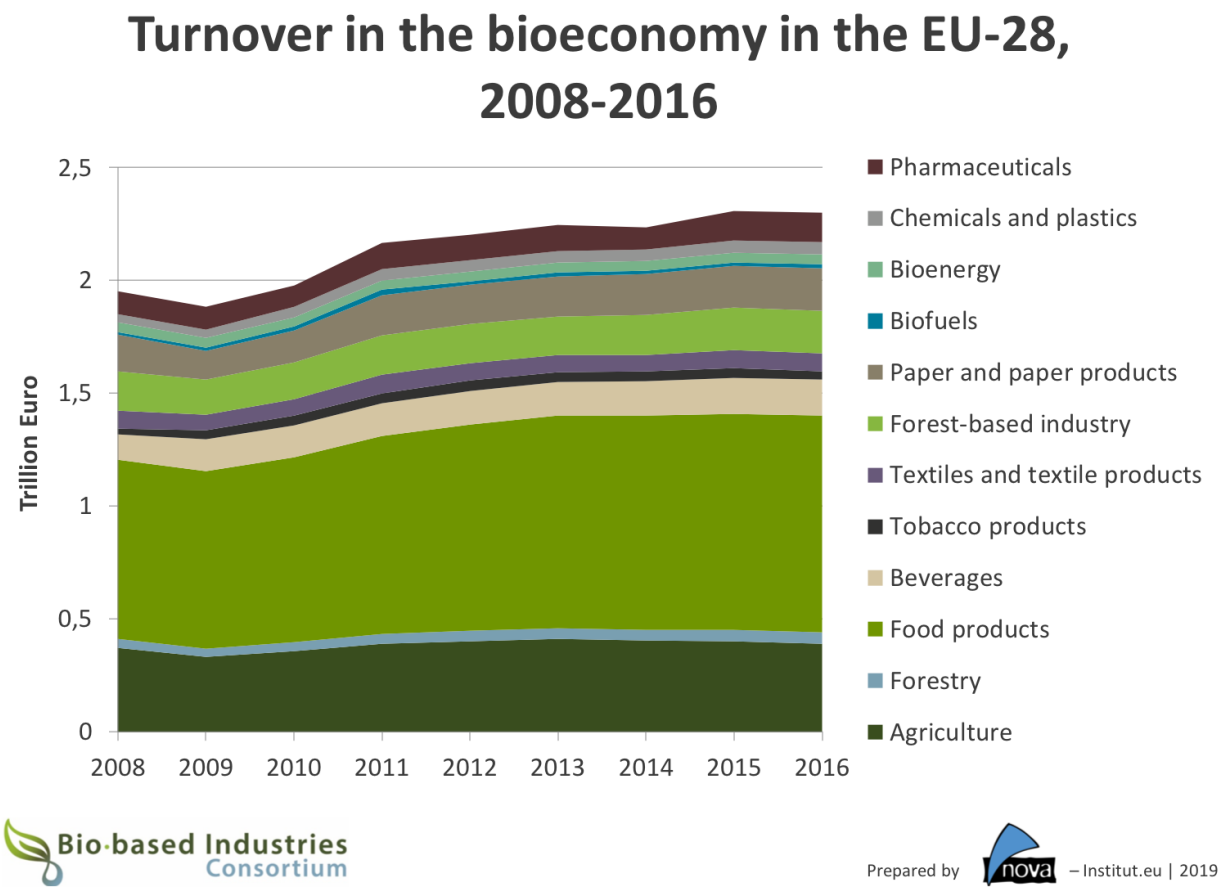

Figure 1: Turnover in the bioeconomy in the EU-28, 2008-2016

Roughly half of the 2.3 trillion Euro in 2016 (see Figure 2) come from the food and beverages sector, almost 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).

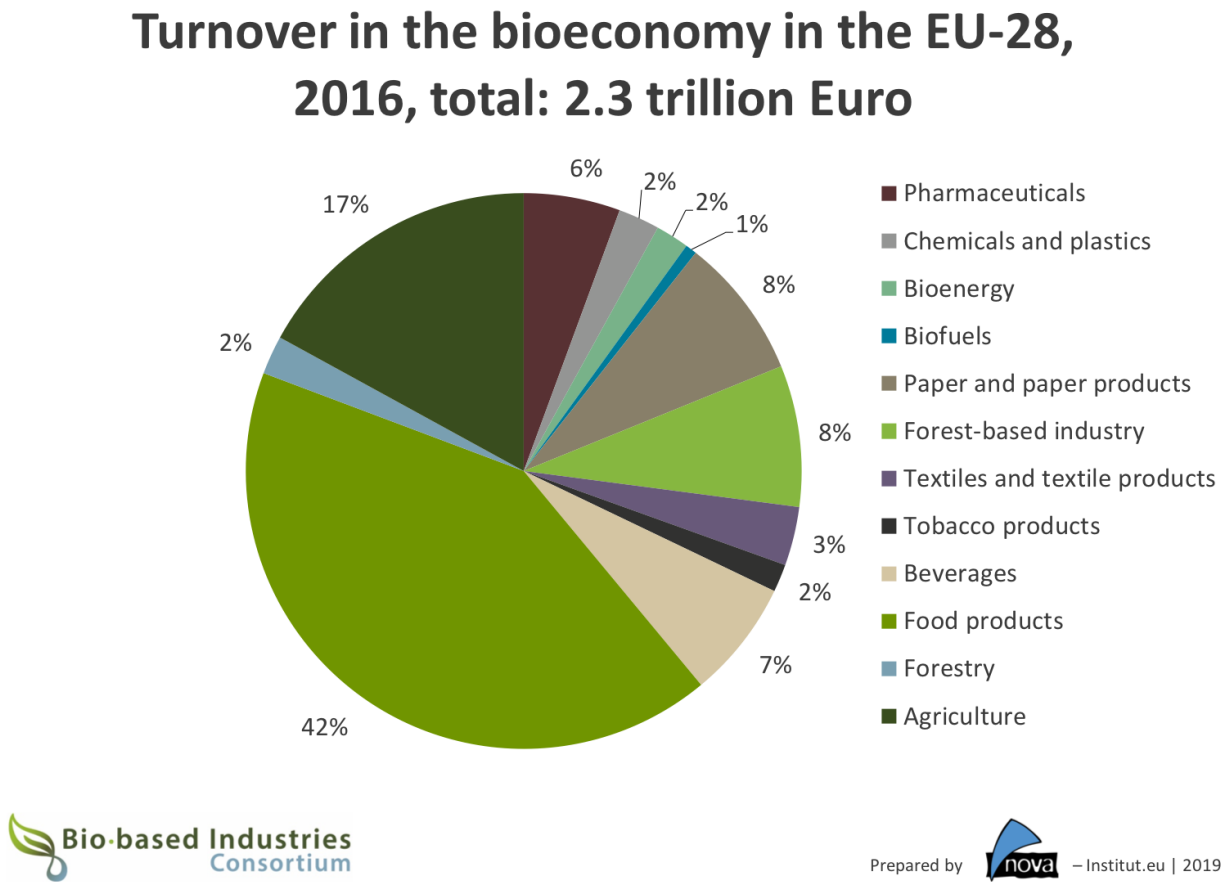

Figure 2: Turnover in the bioeconomy in the EU-28, 2016

Turnover in the EU bio-based sector (EU-28, 2008-2016)

If the sectors food, beverages and tobacco products are excluded, turnover amounted to 1.14 trillion Euro (Figure 3). 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).

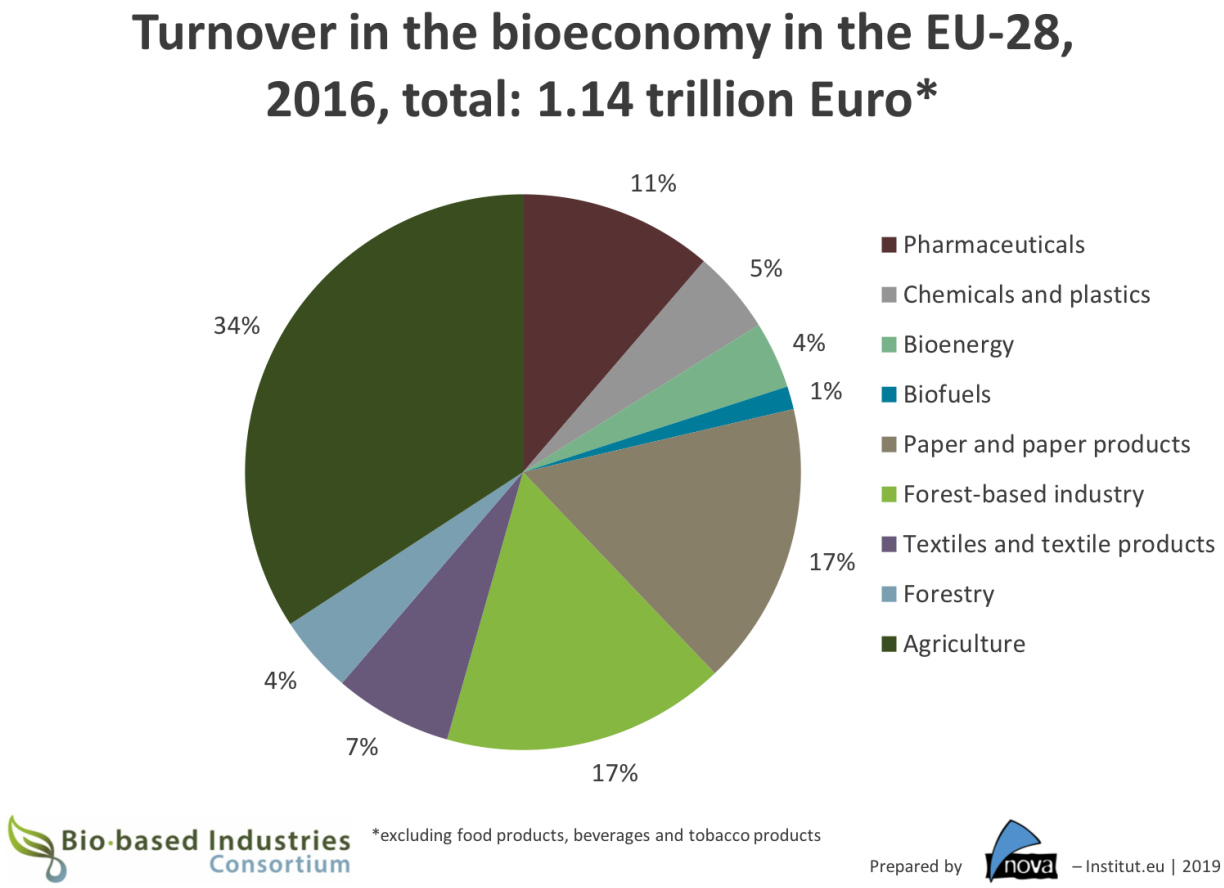

Figure 3: Turnover in the bioeconomy (excl. food products, beverages and tobacco products) in the EU-28, 2016

When also the primary biomass production/extraction is excluded (Figure 4), the analysis shows that biofuels and bioenergy together accounted for roughly 8% of the turnover of the EU industrial sectors that are referred to as the 'bio-based economy', which corresponds to a total amount of approximately 60 billion Euro.

The sectors paper and paper products (27%) and forest-based industry (wood products and furniture, 27%) make up for the largest shares of turnover: together they amount to roughly 380 billion Euro. Bio-based chemicals and plastics accounted for 55 billion Euro. The total turnover of the bio-based industries reached about 700 billion Euro in 2016 (Figure 4), up from about 600 billion Euro in 2008 (Figure 5).

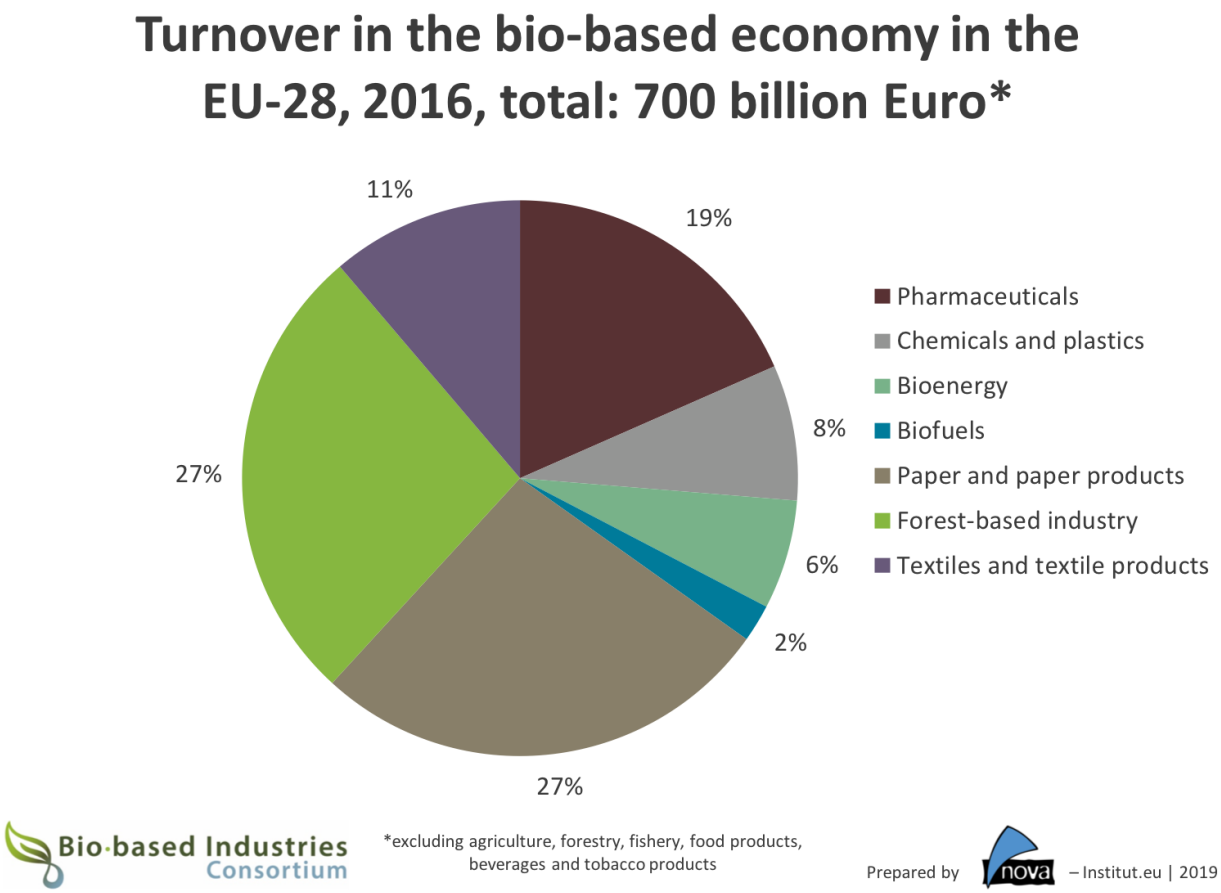

Figure 4: Turnover in the bio-based economy in the EU-28, 2016

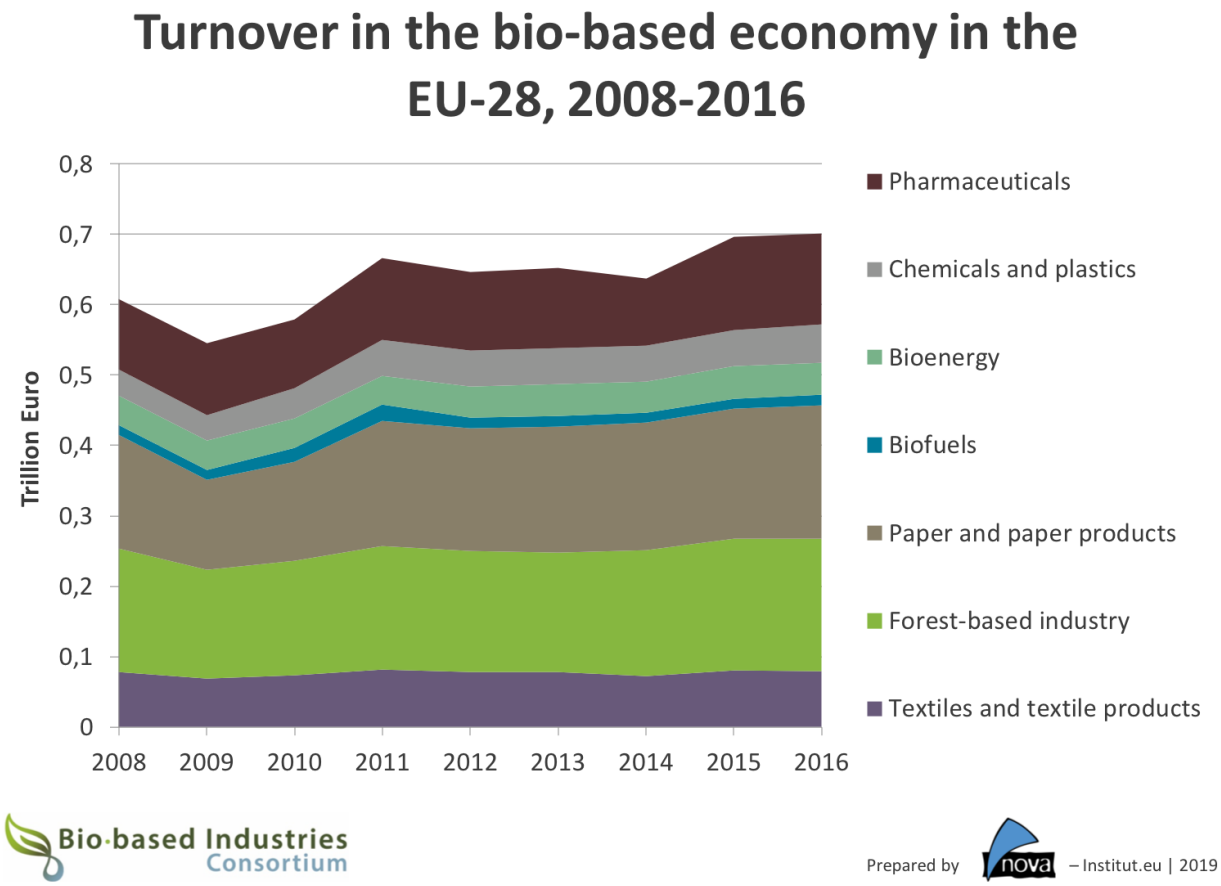

Figure 5: Turnover in the bio-based economy in the EU-28, 2008-2016

3.2 Employment

Employment in the EU bioeconomy (EU-28, 2008-2016)

Similar to the presentation of the turnover, Figure 6 first shows the development of employment for the whole bioeconomy in the period 2008-2016, measured by the total number of employed persons. The comparison of Figure 6 with Figure 1 clearly shows that, contrary to overall turnover, overall employment of the EU bioeconomy is declining. However, as Figure 6 shows, this decline of employment of the total bioeconomy is mainly due to the decline of the agricultural sector while the other sectors have been stable or even increased their employment. In 2016, the total number of employed persons in the EU bioeconomy amounted to 18.6 million (Figure 7).

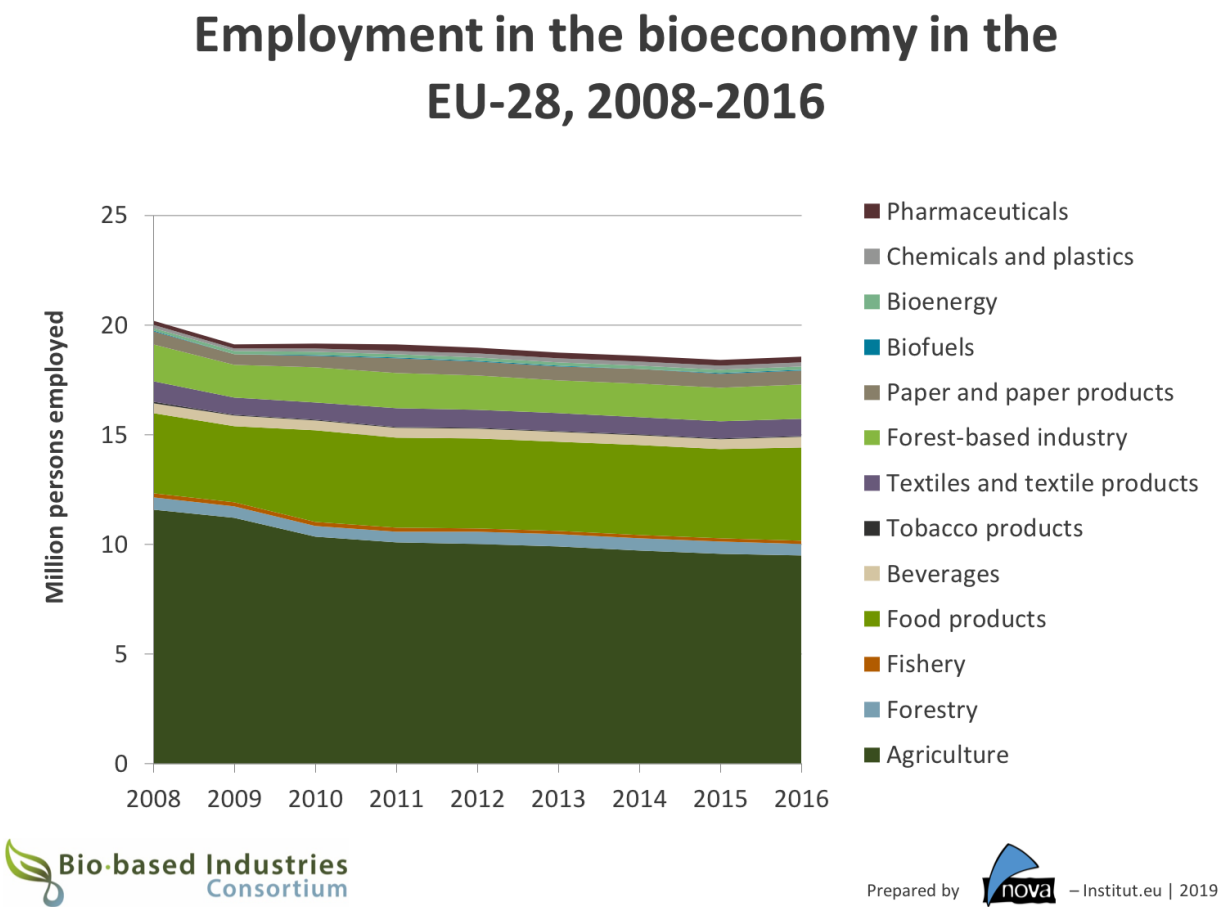

Figure 6: Employment in the bioeconomy in the EU-28, 2008-2016

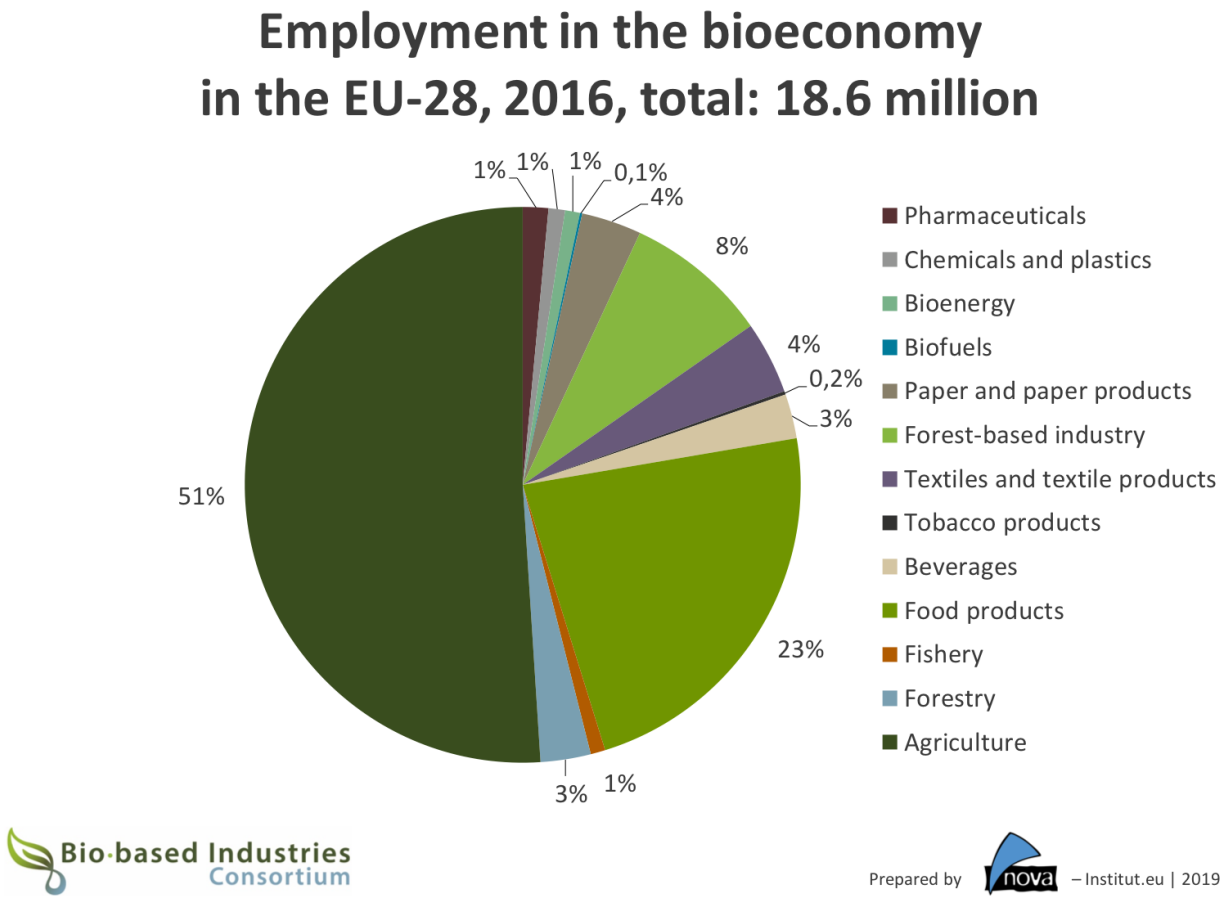

Figure 7: Employment in the bioeconomy in the EU-28, 2016

Employment in the EU bio-based sector (EU-28, 2008-2016)

Figure 8 shows the breakdown of employment excluding the sectors food, beverages and tobacco products. These sectors in total account for 13.8 million jobs with about three quarters located in the primary sector.

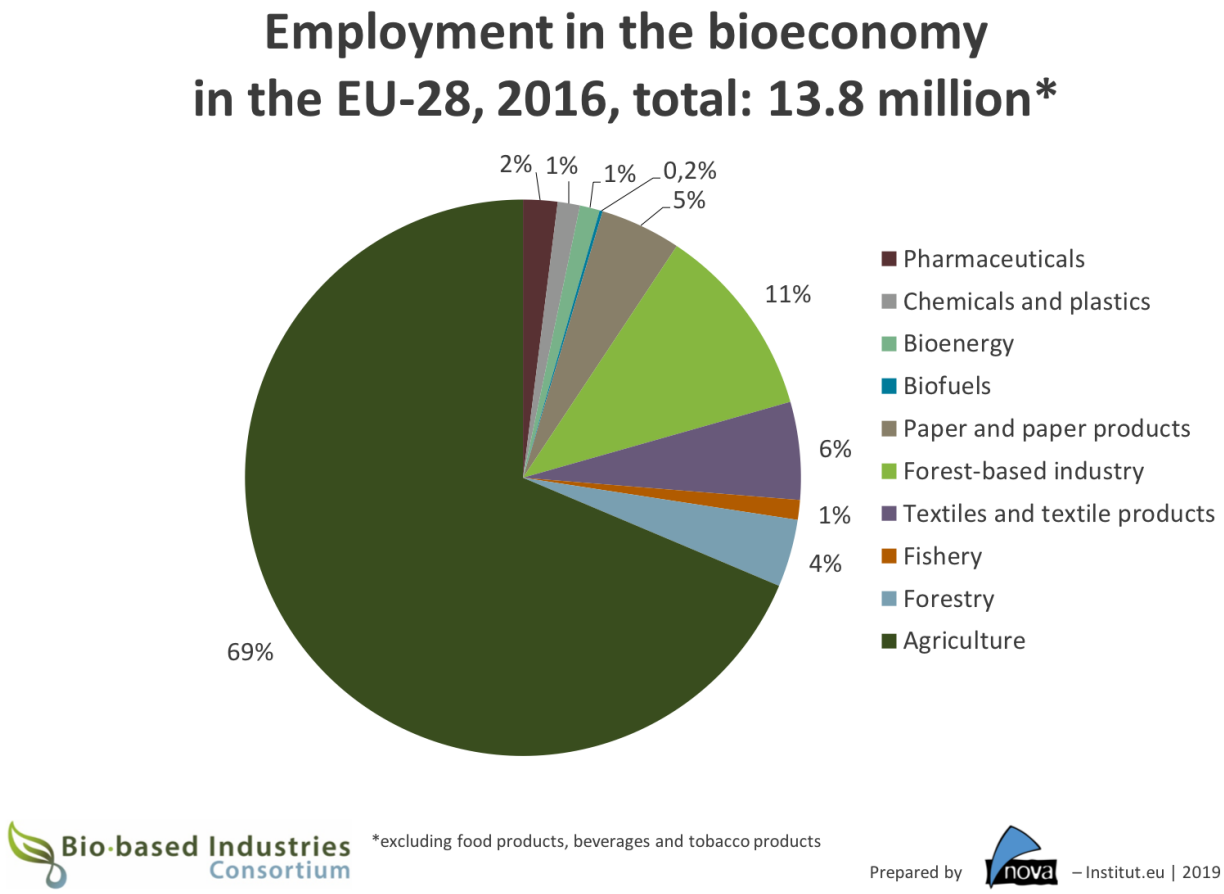

Figure 8: Employment in the bioeconomy (excl. food products, beverages and tobacco products) in the EU-28, 2016

If only the "industrial sectors" are analysed (so excluding also the primary biomass production/extraction), the total employment is 3.6 million jobs in 2016. The most prominent sectors are the forest-based industry, paper and paper products, and the textile industry (Figure 9 and Figure 10).

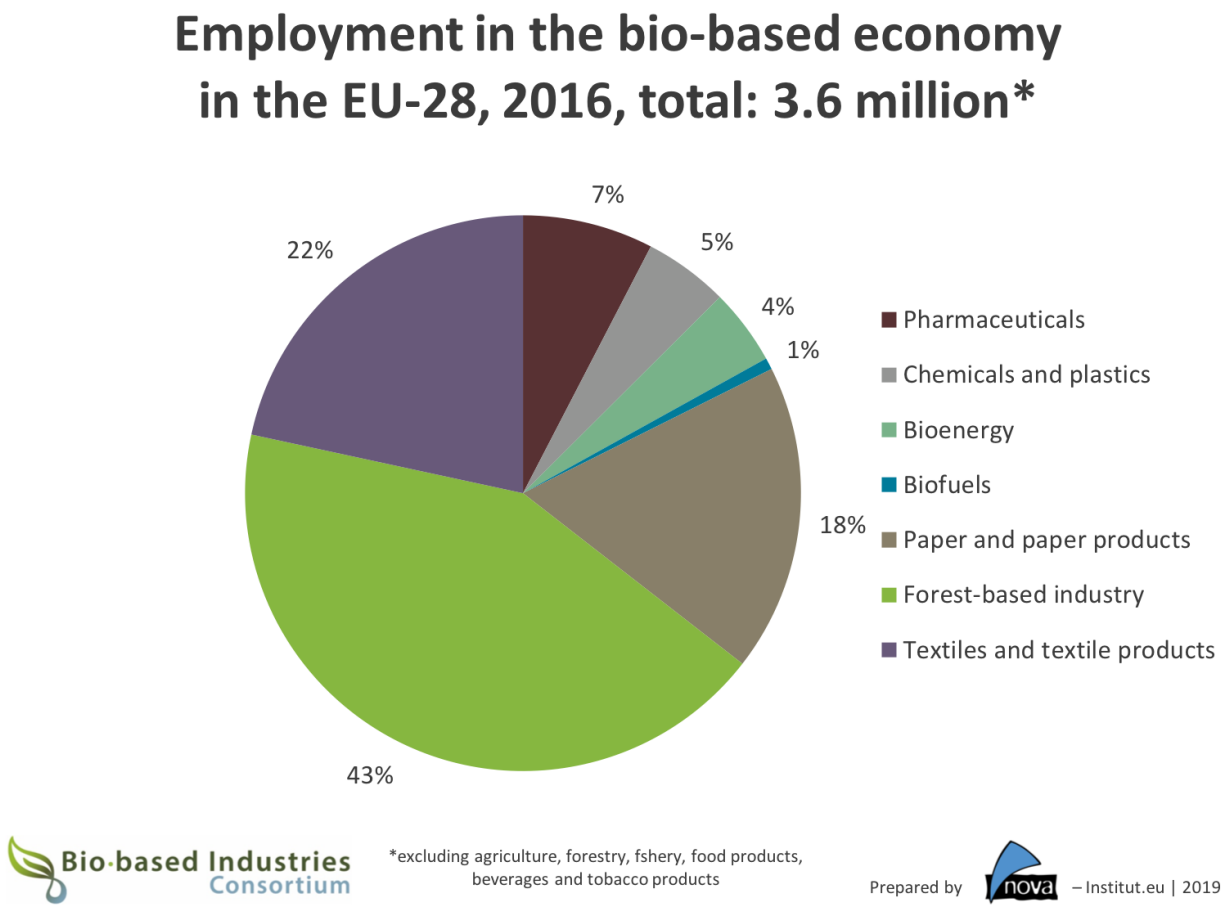

Figure 9: Employment in the bio-based economy in the EU-28, 2016

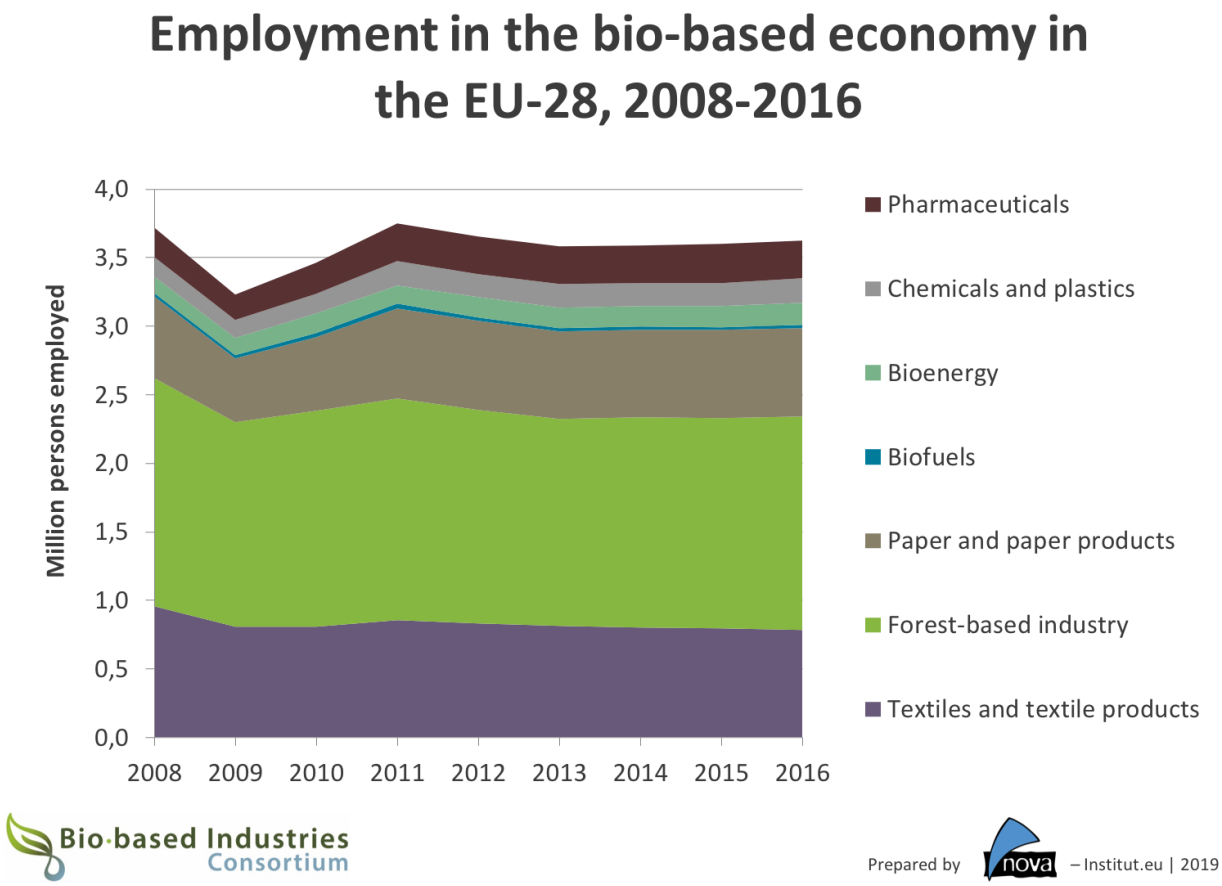

Figure 10: Employment in the bio-based economy in the EU-28, 2008-2016

3.3 Turnover and employment in the EU bio-based economy per Member State (EU-28, 2016)

The following Figure 11 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 2016. 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 ratio between turnover and employment in 2016 are Finland, Belgium and Sweden.

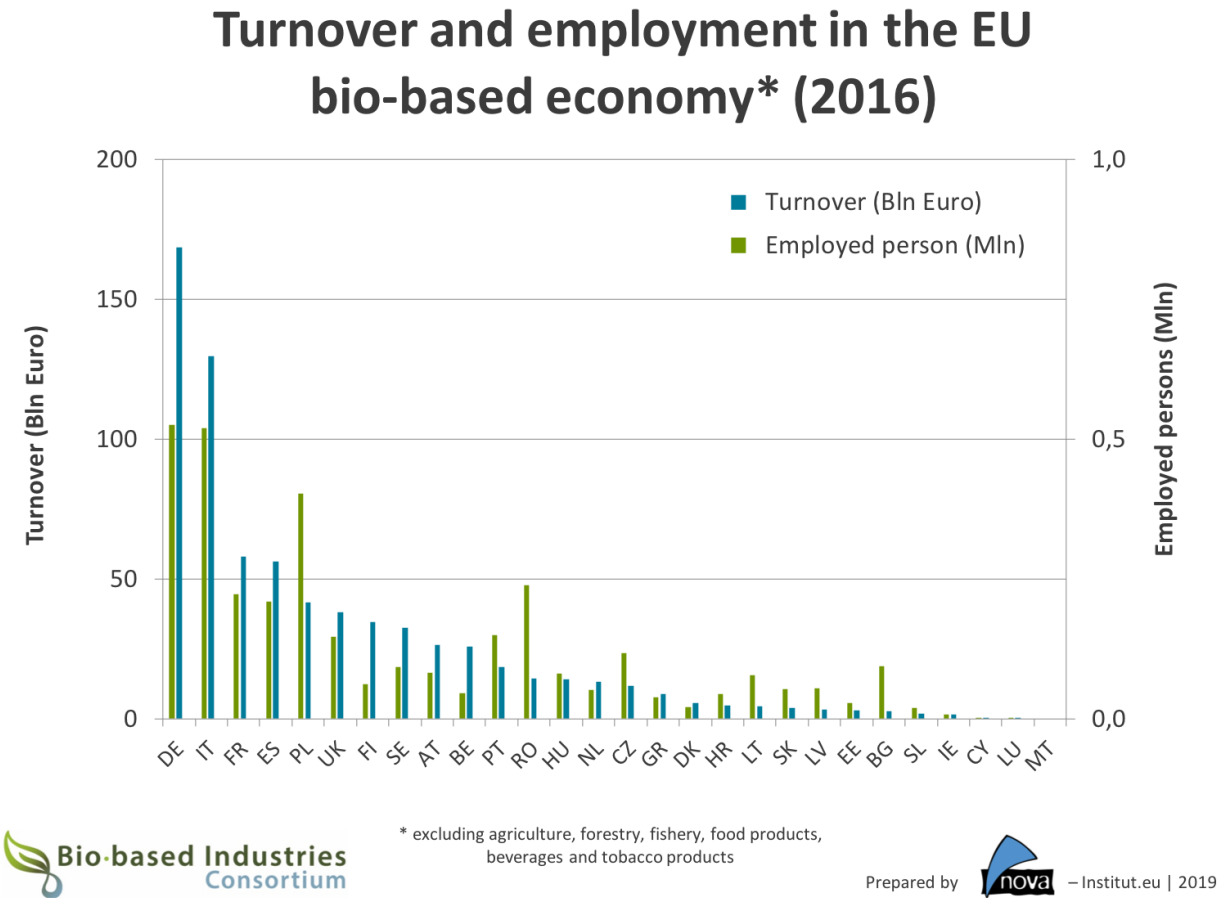

Figure 11: Turnover and employment in the EU bio-based economy per Member State, 2016

3.4 Employment per turnover in sectors of the bio-based economy (EU-28, 2008-2016)

Figure 12 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 2008-2016.

This figure shows that biofuels generate the lowest employment compared to their turnover, followed by pharmaceuticals. In comparison, the sectors textiles and textile products as well as forest-based industry are relatively labour-intensive sectors with comparably low turnover. Note that employment and turnover here always refer to the end product manufacturing stage only, i.e. 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.

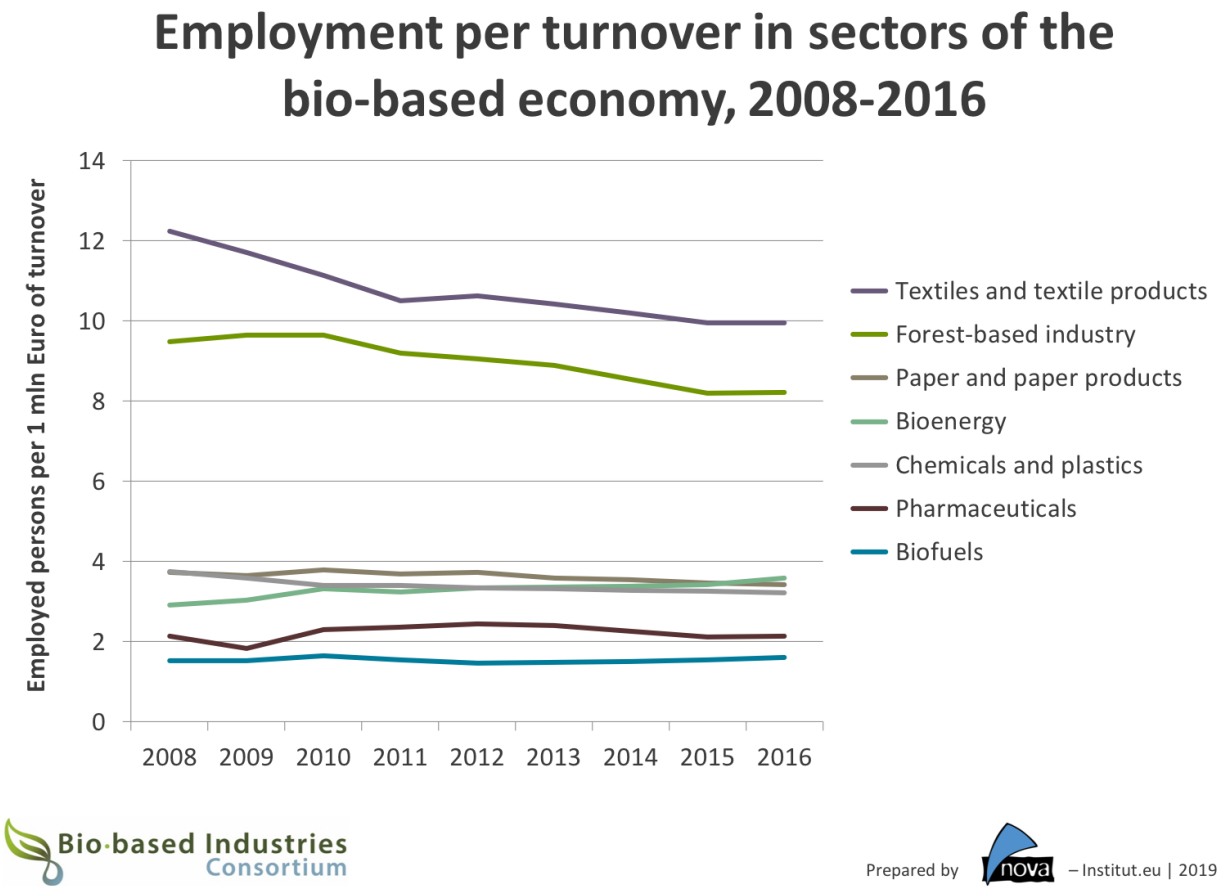

Figure 12: Employment per turnover in sectors of the bio-based economy, 2008-2016

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

The following Figure 13 compares the estimated overall bio-based share in the NACE division 20 (Chemicals and chemical products, excluding biodiesel and bioethanol) between 2008 and 2016 for the EU-28 as well as for each single Member State.

According to Figure 13 Denmark and Latvia stand out as the Member States with the highest bio-based share over the whole period from 2008-2016. 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.

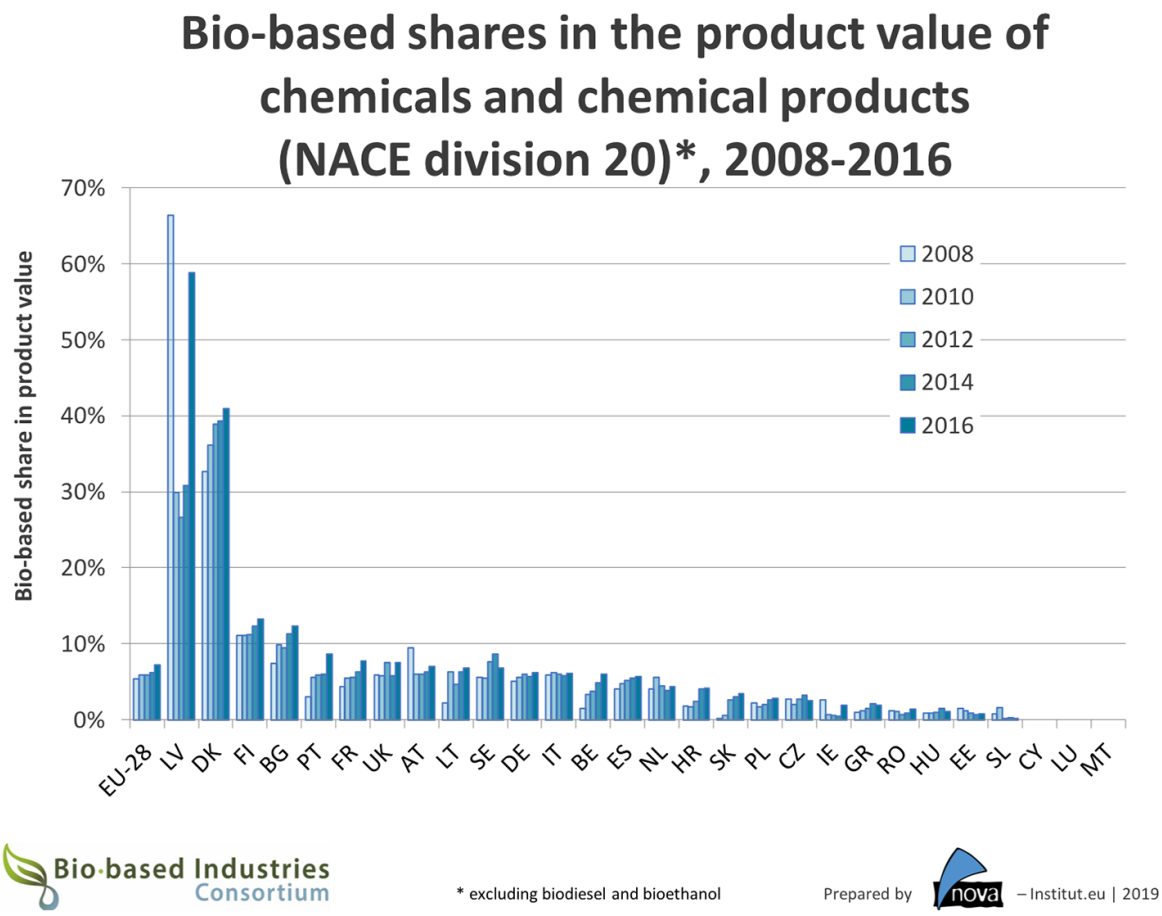

Figure 13: Bio-based shares in the product value of chemicals and chemical products, 2008-2016

The data show an overall increase in the bio-based share in the EU-28 from about 5% in 2008 to 7% in 2016. 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 14% in 2016 (Table 1). Additionally, Figure 14 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.

Table 1: Bio-based shares in the product value of chemicals and chemical products in the EU-28, 2008-2016

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%

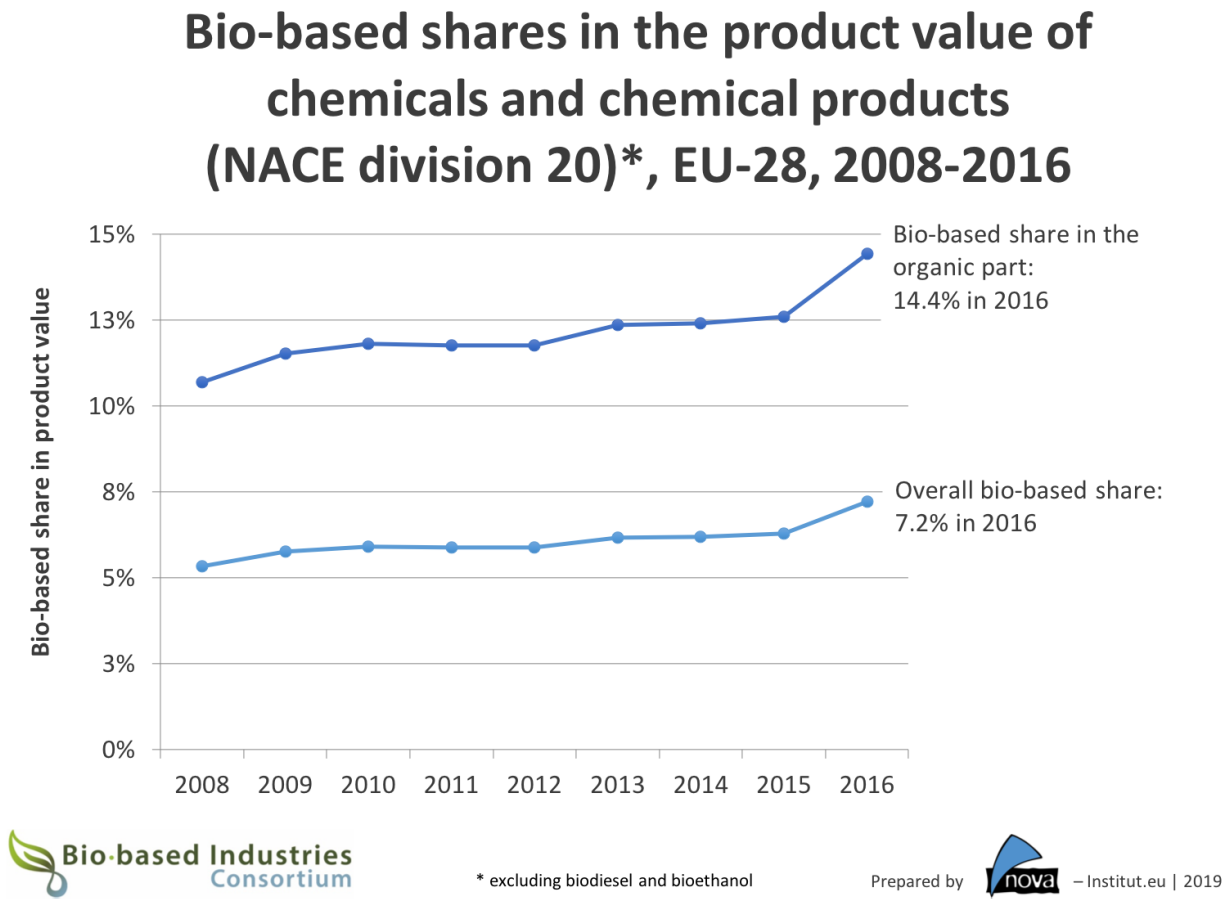

Figure 14: Bio-based shares in the product value of chemicals and chemical products in the EU-28, 2008-2016

Figure 15 shows in more detail which NACE classes have contributed to the overall increase of the bio-based share of the chemical industry. The figure illustrates how the bio-based product values of the different NACE classes in division 20 have added up to the total bio-based product value in division 20. Hence, the total product value of bio-based chemicals of 27.7 bln Euro in 2016 is equal to the overall bio-based share of 7.2% as shown in Figure 13.

Figure 15 also clearly shows that the remarkable increase of the bio-based share between 2015 and 2016 was mainly due to an increase of the production value of class 20.53 (essential oils).

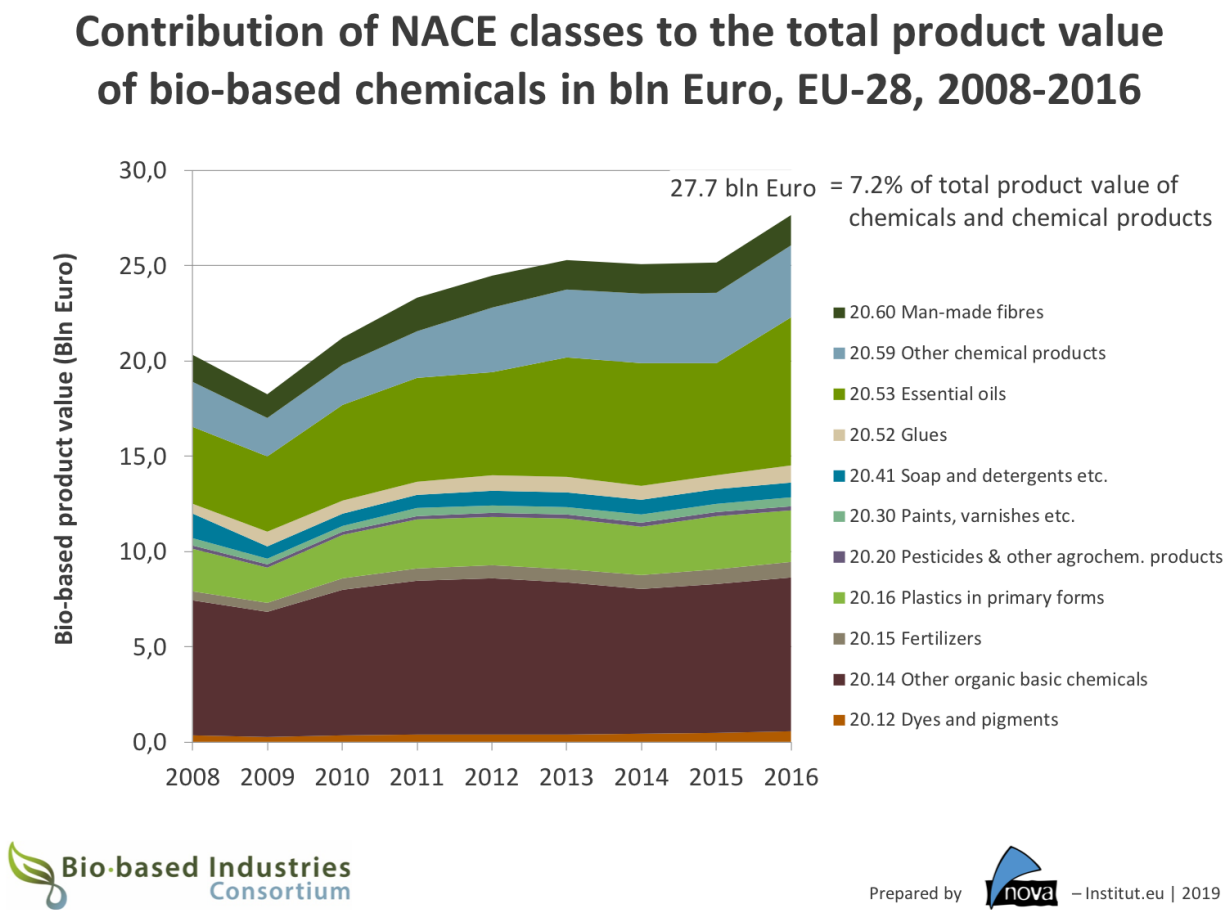

Figure 15: Contribution of NACE classes to the total product value of bio-based chemicals, EU-28, 2008-2016

While Figure 15 indicates the total bio-based production value that the NACE classes within division 20 have contributed to the overall bio-based production value in the chemical industry, a deeper look is necessary to understand which products make the largest contribution to this total value. Therefore, Table 2 shows the 20 partly or fully bio-based chemical products with the highest bio-based production value in 2016. It shows, for example, that odoriferous substances for food or drink industries alone contributed 4.8 bln Euro (17% of the total value of 27.7 bln Euro) to the bio-based production value of division 20 in 2016, followed by enzymes with a production value of 2.06 bln Euro.

Table 2: The 20 partly or fully bio-based chemical products with the highest bio-based production value in the EU-28, 2016

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	4.80
20.14.64.70	Enzymes; prepared enzymes (not elsewhere specified or included) (excluding rennet and concentrates)	2.06
20.53.10.79	Mixtures of odoriferous substances (excluding those of a kind used in the food or drink industries)	1.92
20.16.59.40	Cellulose and its chemical derivatives, n.e.c., in primary forms	1.11
20.59.60.80	Gelatin and its derivatives (excluding casein glues, bone glues and isinglass)	1.06
20.16.59.60	Natural and modified natural polymers, in primary forms (including alginic acid, hardened proteins, chemical derivatives of natural rubber)	1.05
20.60.21.20	Artificial filament tow and staple fibres (not carded, combed or otherwise processed for spinning), of viscose rayon	1.00
20.53.10.20	Essential oils	0.91
20.14.32.80	Lauric acid and others; salts and esters	0.84
20.15.80.00	Animal or vegetable fertilisers	0.83
20.59.59.94	Other chemical products, n.e.c.	0.69
20.52.10.80	Prepared glues and other prepared adhesives, n.e.c.	0.54
20.14.71.50	Rosin and resin acids; and derivatives; rosin spirit and oils; run gums	0.50
20.14.34.73	Citric acid and its salts and esters	0.49
20.14.31.95	Industrial monocarboxylic fatty acids distilled (excluding stearic, oleic tall oil)	0.49
20.12.22.70	Colouring matter of vegetable or animal origin and preparations based thereon (including dyeing extracts) (excluding animal black)	0.49
20.59.20.00	Animal or vegetable fats and oils chemically modified	0.48
20.30.11.70	Other paints, varnishes dispersed or dissolved in an aqueous medium	0.47
20.14.21.00	Industrial fatty alcohols	0.46
20.14.23.33	D-glucitol (sorbitol)	0.45

Finally, Figure 16 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, clothings 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. However, not surprisingly, as Table 3 shows, other products dominate in terms of bio-based production quantity. According to Table 3, animal and vegetable fertilisers alone contribute 6.6 mln t (33% of the total of 19.6 mln t) to the bio-based production volume of division 20 in 2016.

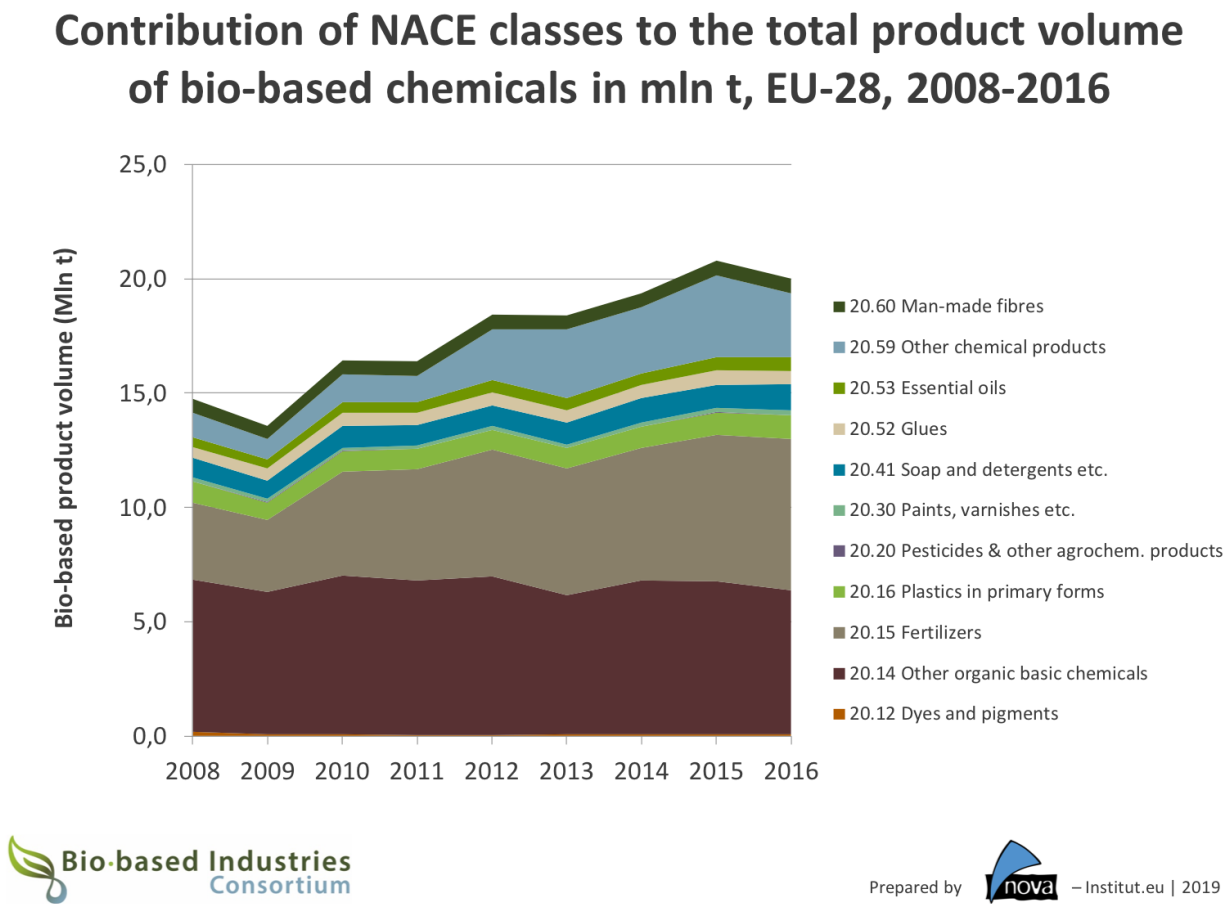

Figure 16: Contribution of NACE classes to the total product volume of bio-based chemicals, EU-28, 2008-2016

Table 3: The 20 partly or fully bio-based chemical products with the highest bio-based production volume in the EU-28, 2016

PRODCOM-code	Name	Bio-based production volume (mln t)
20.15.80.00	Animal or vegetable fertilisers	6.60
20.59.59.94	Other chemical products, n.e.c.	1.25
20.14.71.20	Activated natural mineral products; animal black	0.74
20.59.20.00	Animal or vegetable fats and oils chemically modified	0.68
20.41.10.00	Glycerol (glycerine), crude; glycerol waters and glycerol lyes	0.65
20.14.23.60	Glycerol (including synthetic; excluding crude, waters and lyes)	0.53
20.14.31.95	Industrial monocarboxylic fatty acids distilled (excluding stearic, oleic tall oil)	0.52
20.60.21.20	Artificial filament tow and staple fibres (not carded, combed or otherwise processed for spinning), of viscose rayon	0.48
20.14.23.33	D-glucitol (sorbitol)	0.46
20.16.59.40	Cellulose and its chemical derivatives, n.e.c., in primary forms	0.41
20.53.10.75	Mixtures of odoriferous substances of a kind used in the food or drink industries	0.39
20.14.34.73	Citric acid and its salts and esters	0.39
20.14.71.30	Tall oil; whether or not refined	0.38
20.52.10.80	Prepared glues and other prepared adhesives, n.e.c.	0.36
20.14.32.80	Lauric acid and others; salts and esters	0.32
20.14.71.50	Rosin and resin acids; and derivatives; rosin spirit and oils; run gums	0.30
20.14.64.70	Enzymes; prepared enzymes (not elsewhere specified or included) (excluding rennet and concentrates)	0.30
20.16.59.60	Natural and modified natural polymers, in primary forms (including alginic acid, hardened proteins, chemical derivatives of natural rubber)	0.29
20.14.21.00	Industrial fatty alcohols	0.29
20.14.72.00	Wood charcoal whether or not agglomerated (including shell or nut charcoal)	0.28

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