JOBS AND GROWTH GENERATED BY INDUSTRIAL BIOTECHNOLOGY IN EUROPE

EuropaBio®

The European Association for Bioindustries

EXECUTIVE SUMMARY

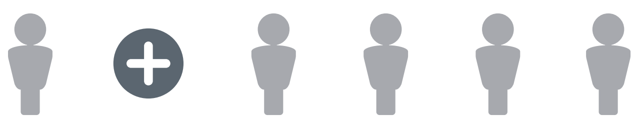
THE ECONOMIC IMPACT OF THE INDUSTRIAL BIOTECHNOLOGY SECTOR TODAY AND BEYOND

This study quantifies the different economic effects associated with the activities of the industrial biotechnology (IB) sector in Europe. These include the direct effect, i.e. the employment related from core IB sector activities such as production of enzymes or antibiotics, as well as upstream effects (employment generated by the suppliers to the IB sector), downstream effects (employment involved with processing and integrating IB outputs) and induced effects (resulting from the spending of employees from the aforementioned categories).

The results show that total employment in the IB value chain amounts to about 486.000 full-time equivalents (FTEs). About 94.000 FTEs are generated in the IB sector itself, while some 269.000 FTEs are created in the upstream part of the value chain, i.e. by the suppliers of good and services to the IB sector. In addition, some 98.000 FTEs are generated downstream of the IB sector, whereas the employment of about 25.000 people is induced by the spending of employees in the earlier categories. Along the IB value chain, more than €31 billion is generated in terms of value added.

	Employment (FTE)	Turnover (B€)	Value addes (B€)
DIRECT	94.000	31,5	8,4
UPSTREAM	269.000	38,6	15,2
DOWNSTREAM	98.000	18,1	5,9
INDUCED	25.000	4,6	2,1
TOTAL	486.000		31,6

For every job in the IB sector, there are 4 jobs created elsewhere in the IB value chain. This high multiplier is driven especially by upstream employment in the IB sector. A high upstream job creation is a general characteristic of chemicals and pharmaceuticals production, but this is augmented by the IB sectors' sourcing of bio-based inputs rather than fossil resources. Indeed, biomass production is much more labour intensive than fossil resource extraction, leading to a 16% higher overall upstream employment.



@IB SECTOR

OUTLOOK TO 2030

Outlook to 2030 shows that employment in the IB value chain may increase to well above one million FTEs. Two different growth scenarios for the IB sector have been considered. The first is the extrapolation of the historical growth rate of IB production observed in the Key Enabling Technologies (KETs) Observatory time series. The second is the market forecast made for the IB sector in the context of the BIO-TIC market roadmap [1]. When we apply the growth rates from both sources to current employment and calculate expected employment by 2030, we find that total employment for IB will lie between 900.000 FTEs (BIO-TIC scenario) and 1.500.000 FTEs (KETs Observatory scenario).

The IB sector is becoming an increasingly important source of employment in the chemical and pharmaceutical sector. As of 2013, the share of IB related employment in total chemicals and pharmaceutical amounted to about 5%. Assuming employment in these two sectors will remain stable, as has been observed over the past years, and combining this with the expected positive growth of IB employment, the share of IB based employment in these two sectors is anticipated to increase to between 10% and 15% by 2030, highlighting the importance of IB for maintaining employment in these key strategic EU sectors. The IB market in the EU is expected to contribute between €57,5 billion and €99,5 billion to the European Economy by 2030.

① BIO-TIC (2015), A roadmap to a thriving biotechnology sector in Europe

INTRODUCTION

Amid growing concerns about greenhouse gas emissions and their detrimental effect in terms of climate change, the need to reduce dependence on fossil carbon has never been more pressing. In addition, the need to use resources more efficiently to provide for a growing global population and the importance of promoting a transition towards a renewable bio-based economy has been increasingly recognised in recent years. Such a bio-based economy would draw on locally produced biomass to produce a variety of outputs, including chemicals and fuels that are currently still largely produced from imported fossil resources, thereby creating local jobs and growth while reducing the environmental impact of these industries. By making better use of biological raw material, by-products and wastes (e.g. forestry residues, food waste), the bio-based economy will constitute an important part of the circular economy.

Following several policy initiatives that have been implemented both at EU and Member State level for promoting the growth of the bio-based economy, there has been a strong demand for better information about both the environmental as well as economic aspects of the bioeconomy. This information is necessary to understand the current impact of the bioeconomy as well as to detect changes and anticipate likely evolutions. Yet, as the bioeconomy and many of its segments are emerging and cut across different sectors, economic data about this is often not readily available in existing statistics such as the production (PRODCOM) database by Eurostat.

As a result, there is a need for data exercises that isolate information on the bioeconomy sector from those of other non-bio-based activities in existing databases. A recent study commissioned by the Bio-based Industries Consortium (BIC), indicated that the bioeconomy employed as much as 18,3 million employees in 2013, and realised about €2,1 trillion turnover [2]. This includes employment that is generated in a broad range of industries, including agriculture, forestry, paper production, food and beverages, textiles, etc. but also covers the parts of the production of chemicals and pharmaceuticals that are bio-based.

A key driver behind the development of new bio-based products is the application of industrial biotechnology (IB). For this reason, and for its potential to boost EU jobs, growth and competitiveness, IB has been recognised in 2009 as one of the six Key Enabling Technologies (KETs) by the European Commission [3]. Industrial biotechnology enables a smart use of microorganisms and enzymes to produce a wide variety of chemicals, pharmaceuticals, food, feed, materials and fuels, which are then applied across the manufacturing sector.

Departing from the importance of industrial biotechnology for promoting the bio-based economy, this study builds on earlier work on the bioeconomy topic in three main ways. Firstly, it zooms in on the economic importance of the IB sector, quantifying the direct economic effect of this sector in terms of employment, turnover and value added. Secondly, it estimates employment in other parts of the IB value chain (both upstream and downstream of the core IB sector), and derives from that the job multiplier of the IB sector. Thirdly, it provides a forecast for employment in the IB sector by 2030, and relates this to evolutions in employment in other sectors.

② Piotrowski, S., Carus, M., Carrez, D. (2016). The European Bioeconomy in Figures.

③ European Commission (2009). Preparing for our future: Developing a common strategy for key enabling technologies in the EU . COM(2009) 512 final.

FRAMEWORK AND SCOPE

PART 1

1 OBJECTIVES & SCOPE

1.1 OBJECTIVES

Industrial biotechnology has been recognised as a Key Enabling Technology (KET) by the European Commission [4], underscoring the strategic importance of this sector as a major driving force behind the development of new innovative products, competitiveness, jobs and growth. Within the context of the KETs Observatory, indicators on the economic as well as technological performance and importance of the six KETs have been produced. Yet, a comprehensive picture of total economic effects of the IB sector, incorporating economic impact along the value chain (from feedstock to final products), is missing. This study aims to fill this gap, by conducting a detailed economic impact assessment of the IB sector, taking the data from the KETs Observatory as starting point. In addition, it presents a forecast of economic impact of the IB value chain by 2030.

1.2 DEFINITION OF THE INDUSTRIAL BIOTECHNOLOGY SECTOR

Industrial biotechnology uses enzymes and microorganisms to make bio-based products from renewable plant-based material in sectors as diverse as chemicals, materials, pharmaceuticals, plastics, food and feed ingredients, detergents, pulp and paper, textiles and bioenergy. It is an enabler for a more sustainable and competitive bioeconomy in Europe. Enzymes and microorganisms (bacteria or fungi) developed through industrial biotechnology play a vital role in transforming 'renewable raw materials' such as biomass, residues and CO2 into everyday products. This provides an alternative to using fossil carbon sources, such as crude oil, natural gas or coal, as the basic feedstock. In the context of the KETs Observatory, the Commission defines industrial biotechnology as "the application of biotechnology for the industrial processing and production of chemicals, materials and fuels. It includes the practice of using microorganisms or components of microorganisms like enzymes to generate industrially useful products in a more efficient way (e.g. less energy use, or less by-products), or generate substances and chemical building blocks with specific capabilities that conventional petrochemical processes cannot provide" [5].

There are many examples of bio-based products made with industrial biotechnology already on the market. Some of the most mature applications are related to enzymes used in the food and beverage, feed and detergents sectors. More recent applications include the production of biochemical and biopolymers from agriculture, forestry, and their residues, as well as the production of second generation bioethanol. As pre-treatment and processing tools advance, lower value biomass streams (e.g. by-products or wastes) become potential feedstocks, thereby contributing to the transition towards a renewable circular economy.

Information on the economic impact of industrial biotechnology is not readily available in existing statistics on patenting, production and trade. In order to obtain metrics for IB, the KETs Observatory has been launched, which has helped to identify IB through sets of IB relevant IPC codes (patenting), PRODCOM codes (production) and HS codes (trade). These can subsequently be used to derive IB specific metrics for countries across the globe. As will be explained further on, these data provide the basis for calculating the economic impact along the IB value chain.

④ European Commission (2009). Preparing for our future: Developing a common strategy for key enabling technologies in the EU. COM (2009) 512 final.

⑤ **See:** https://ec.europa.eu/growth/tools-databases/kets-tools/kets-deployment

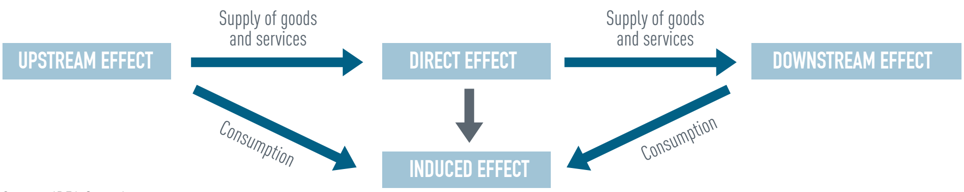
2 FRAMEWORK

2.1 ECONOMIC IMPACT FRAMEWORK

An economic impact analysis measures the change in economic activity in a specific region in case an 'event' occurs, compared to the situation where it does not occur (counterfactual). **In this study, we measure the economic effects of the IB sector activities in the European Union, compared to a situation where this sector would not exist.**

The framework for the economic impact is shown in Figure 1-1. Via its daily operations, the IB sector generates employment and economic added value within Europe. This is indicated by the **direct effect**. Often, the economic impact of a sector or organisation is only measured by means of this direct effect itself, i.e. the employment, value added and output at the organisation itself.

Figure 1-1 Framework for the economic impact assessment of industrial biotechnology.



Source: IDEA Consult

Yet, the total economic impact goes beyond this direct effect. Through upstream relations (with suppliers) and downstream relations (with client-users), an industrial sector creates additional economic effects:

- The IB sector buys goods and services from EU companies in a series of other industries (e.g. biomass, fermentation equipment, logistic services). This in turn leads to additional employment and additional demand of these EU companies upstream. This expanding impact of the IB sector on the economy is what we call its **upstream economic effect.**
- Furthermore, the other sectors buy outputs from the IB sectors and use these for their own products and processes. The additional work that is related to the using and incorporating of IB outputs in downstream industries is called the **downstream impact.**
- The **induced economic impact** is created through the direct, upstream and downstream employment. These employees receive a wage higher than the social benefits at unemployment. This additional income is partly spent in the European economy through consumption of goods and services. This spending generates additional upstream turnover and employment on the suppliers' side.

2.2 DATA

This study employs two main data sources:

- The data on the direct economic impact of the IB sector are derived from the **KETs Observatory,** which covers indicators on performance in terms of technology, production, trade and business turnover for the EU28 Member States and associated countries, countries in North America, East Asia as well as Brazil, Israel, Russia and South-Africa [6] . For all indicators, it has time series from 2003 to 2013. The main indicator used for this study is the production indicator, based on the Eurostat PRODCOM database, as this indicator covers full production on EU soil, both by domestic as well as foreign enterprises.

- In order to derive production statistics for IB, each 8-digit PRODCOM code has been screened and weighted for its relevance to IB. By multiplying the production values of the selected codes together with their assigned IB weight, the production turnover of the IB sector as a whole can be derived. From this turnover data, value added and employment data can be derived through sectoral value added/turnover and employment/turnover ratios, available from the Eurostat structural business statistics database. This provides the basis to calculate indirect and induced economic effects.

- In order to go beyond the direct effects of the IB sector (i.e. the impact of its core activities), **EU input-output tables** published by Eurostat are used [7]. These tables contain information for each of the 64 sectors (defined at two digit NACE level, or an aggregate thereof) about their purchasing in other sectors within the EU (hence resulting in a 64x64 matrix). In addition, it contains information on use of imported goods, as well as employee compensation and other economic parameters. The latest version of input-output tables for the EU28 is for 2010.

- The information about linkages between sectors allows for modelling of the effect of the presence of economic activity in one sector on the other sectors that have a buying or selling link to it. This allows us to calculate indirect effects related to the supply of goods and services to the IB sector (the upstream effect) as well as the buying and using of outputs from the IB sector (the downstream effect).

⑥ **See:** https://ec.europa.eu/growth/tools-databases/kets-tools/kets-deployment
⑦ **See:** http://ec.europa.eu/eurostat/web/esa-supply-use-input-tables

ECONOMIC IMPACT OF THE INDUSTRIAL BIOTECHNOLOGY SECTOR

PART 2

1 DIRECT ECONOMIC EFFECT

1.1 METHODOLOGY

The direct economic effect is measured at the level of the industrial biotechnology sector. It reflects the core activities of the IB sector, i.e. the manufacturing of all products which are directly based on the use of IB, such as an enzyme, a chemical or a biofuel. Through these core activities, turnover, value added and employment are generated.

Measuring the direct economic effect is done based on data delivered by the KETs Observatory [8], which is a central monitoring mechanism that provides various indicators about KETs deployment by countries across the world. It measures performance of countries in terms of technology generation (patent indicators) as well commercialisation (measured by production, trade and business turnover indicators).

The current study builds on the production statistics for the EU28 for the KET industrial biotechnology. In the context of the KETs Observatory, an in-depth screening of all 8-digit product codes in the EU PRODCOM database has been conducted, identifying for each code how much of the production value can be attributed to IB. For each 8 digit product code, a weight (ranging between 0 and 1) has been determined which reflects the relevance of IB for that code. As such, IB related production could be derived from this database, which has been the starting point for other calculations:

- It is used to derive direct employment and value added, which are presented together with direct turnover in section 1.2.
- It is used to derive upstream and downstream turnover, employment and value added, which are presented in sections 2 and 3 respectively.

1.2 RESULTS

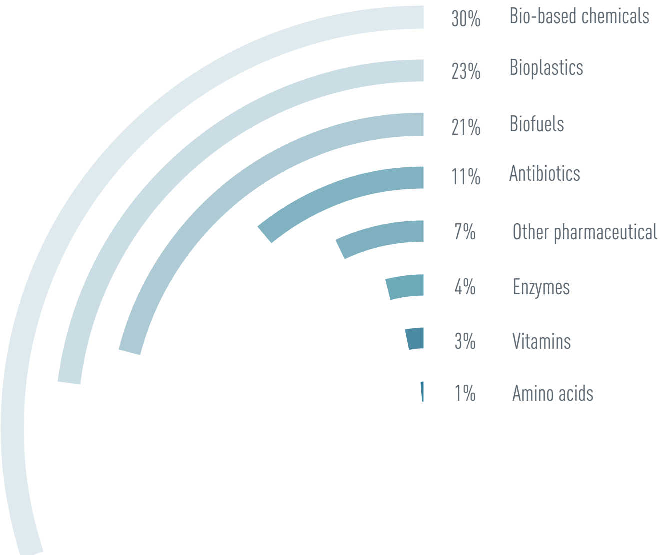
- **Direct economic impact: the IB sector employed about 94.000 workers (FTEs) in 2013.**

The direct economic effect of the IB sector is defined by its in-house activities, i.e. the people it employs and the turnover and added value it creates as a sector. In 2013, the IB sector employed about 94.000 full time equivalents (FTEs) for its core activities in the EU28.

This employment is quite evenly spread over its different IB product segments (Figure 2-1). The largest employment is generated in the market of bio-based chemicals, followed by bioplastics and biofuels. Also a number of pharmaceutical applications, notably antibiotics, account for a substantial share of IB employment.

8 https://ec.europa.eu/growth/tools-databases/kets-tools/kets-deployment

Figure 2-1 Share in direct employment by IB product group (2013)



Source: IDEA Consult

► Direct turnover worth €31,5 billion per year, and value added worth €8,4 billion per year.

In 2013, the total turnover generated by the IB sector in the EU amounted to €31,5 billion. Of this turnover, about 27% or €8,4 billion was generated in terms of value added. As discussed in more detail in section 6, the IB sector is expected to reach a turnover between €57,5 and €99,5 billion in 2030.

2 UPSTREAM ECONOMIC EFFECT

To support their activities, the IB sector buys goods and services from companies in a series of other industries. The activities of the first tier suppliers of the IB sector lead in turn to additional demand for other suppliers, and so on. This expanding effect on the economy is what we call the upstream economic effect.

2.1 METHODOLOGY

The starting point for the calculation of the upstream effect is the turnover of the core IB industry, i.e. the direct economic effect discussed above. From this turnover figure, an estimate of the percentage of it that is spent on purchase of goods and services by the IB sector can be derived using sectoral ratios. Subsequently, the impact of this spending throughout the EU economy needs to be quantified. This can be done by modelling the effect of the spending of the IB sector in EU input-output tables [9], which contain information on the buying and selling linkages between 64 sectors, and hence can be used to calculate how a certain economic change transmits throughout the rest of the economy.

The upstream effect consists of the first order and higher order effects. The first order refers to the immediate relations with the IB sector suppliers. The higher order effects relate to the purchases that the first tier suppliers of the IB sector make at their suppliers. In order to calculate the total upstream effect, the first and higher order effects are added up.

A point to be noted with the use of input-output tables is that new intersectoral linkages developed by emerging industries such as IB are not (yet) well captured in the tables. The IB sector falls under NACE sector 20 (Chemicals and chemical products) and sector 21 (Basic pharmaceutical products and pharmaceutical preparations), but currently represents only a minor share of these two sectors. As a consequence, the linkages contained in the input-output tables for these two sectors predominantly reflect 'traditional' processes for manufacturing chemicals and pharmaceuticals, and not biotechnology enabled methods.

A particularly high disturbance is noted on the input (raw material) side, as traditional chemical activities are largely based on fossil resources, while IB activities use by definition biomass as feedstock. In order to remedy this, purchases pertaining to the fossil resource supplying sector were shifted to the agriculture sector, and the corresponding effects in terms of employment and value added were recalculated.

⑨ Input-output tables are created and published by Eurostat. For this study, the most recent available data (for the year 2010) for the EU28 was used. For more info, see: http://ec.europa.eu/eurostat/web/esa-supply-use-input-tables

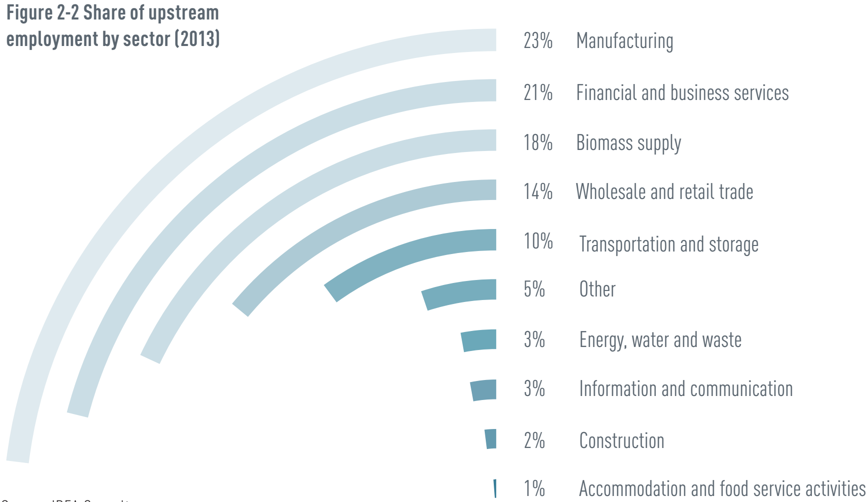
2.2 RESULTS

► Indirect employment of about 269.000 FTEs in 2013.

In 2013, the demand of goods and services by the core IB sector was estimated to create an additional 269.000 FTEs in supplying sectors. This implies that for every job in the core IB sector, there are about 3 jobs in supplying sectors. The IB sector generates additional employment across a wide range of different industries (Figure 2-2). The highest impact is on the manufacturing sector, which captures about 23% of upstream employment. This relates to the supply of various manufacturing equipment such as fermentation tanks and process control technologies to the IB sector.

The supply of various business services, ranging from financial tasks to outsourced R&D, accounts for about one fifth of the generated jobs. Biomass supplying sectors, here understood as NACE sectors 1-3 [10] , capture about 18% of upstream employment. Interestingly, the sourcing of inputs from biomass (e.g. sugars used for fermentation) rather than fossil resources results in a significant positive economic effect. Indeed, the employment generated in upstream sectors is about 16% higher compared to a situation where fossil resources would be the main raw material. This positive difference in terms of employment arises because of the much higher labour intensity of agriculture compared to fossil resource extraction. Significant upstream employment effects are also observed in the retail and transport sectors.

Figure 2-2 Share of upstream employment by sector (2013)



Source: IDEA Consult

► Indirect turnover worth over €38,6 billion per year, and indirect value added creation of around €15,2 billion per year.

Next to the employment generated at the suppliers of goods and services, there is also substantial turnover and value added generated there. In 2013, this amounted to about €38,6 billion turnover, and €15,2 billion value added, which hence also lie well above the turnover and value added realised at the core IB sector itself. The value added figures are calculated by multiplying sectoral turnover with the corresponding value added/turnover ratio, which are subsequently aggregated.

(10) These are: NACE 1: Products of agriculture, hunting and related services

NACE 2: Products of forestry, logging and related services

NACE 3: Fish and other fishing products; aquaculture products; support services to fishing

3 DOWNSTREAM ECONOMIC EFFECT

The IB sector sells its products to other sectors, where these are used for subsequent economic activity (e.g. the production of certain chemicals using an enzyme, or the use of a bioplastic to produce a consumer product). The employment associated with using and integrating IB outputs is referred to as downstream effects.

3.1 METHODOLOGY

The starting point for the calculation of the downstream effect is again the turnover of the core IB industry (direct effect). However, this time the analysis focuses on the what the IB sectors supplies to downstream sectors, rather than what its buys from other sectors. By processing and integrating the products supplied by the IB sector for their own activities, downstream sectors create value added and employment as well. Hence, the downstream effects highlight the enabling effects that IB outputs have in downstream activities, e.g. by providing an enzyme which can catalyse a certain chemical reaction much faster and using less resources than could be done with other means.

We employ again the EU input-output tables which contain information on the linkages between NACE sectors. From these tables, it can be derived how much other sectors (e.g. automobile) source from the sector 20 (Chemicals) and 21 (Pharmaceuticals), under which the IB sector is contained. Employment enabled in downstream sectors is considered proportionally to the share of the inputs they source from the IB sector. As such, downstream employment can be calculated. New intersectoral forward linkages developed by IB, such as the many new applications of IB in the food sector, tend to be underrepresented as traditional chemical and pharmaceutical sectors typically supply much less to this sector. However, we have adapted the input-output parameters in order to reflect better the industrial biotechnology characteristics. To this end, we build upon the framework of the KETs Observatory technology diffusion approach [11] to apply a corrective factor to the input-output table parameters.

3.2 RESULTS

► **Downstream employment of about 98.000 jobs (FTE) in 2013.**

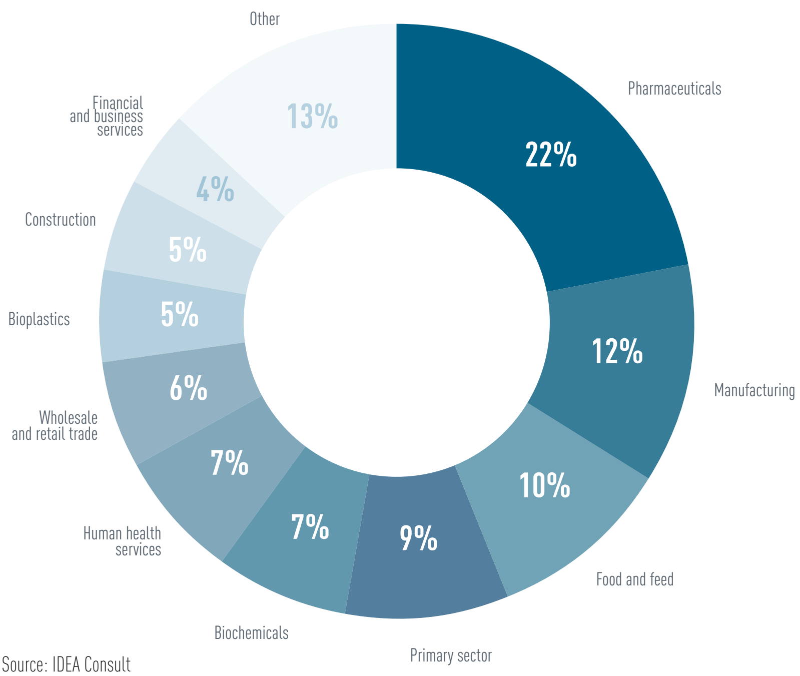
The employment in downstream sectors enabled by IB outputs amounted to about 98.000 FTEs, which is at about the same level as the direct effect, underscoring the importance of accounting for the downstream effect. Figure 2-3 shows that the impact is concentrated in a number of sectors. The highest downstream employment is linked to processing of IB-based ingredients and precursors for pharmaceutical products (22%). Relatedly, the IB sectors also supplies products to the health services sector, which accounts for 7% of downstream employment.

(11) https://ec.europa.eu/growth/tools-databases/kets-tools/

Apart from health-related sectors, a number of other sectors generate significant downstream employment based on processing IB outputs as well. The manufacturing sector [12] represents about 12% of downstream employment. In this manufacturing sector, the automobile sector is the most important subsector in terms of employment. An example of a downstream link that generates employment for this subsector is the integration of bioplastics in the interior of a car. The food & feed sector represents about 10% of downstream employment and constitutes also a key destination market of IB products, which it uses to support food production processes (e.g. enzymes) or uses directly as ingredients (e.g. vitamins). The primary sector accounts for 9% of downstream employment.

Other sectors with high downstream employment are the biochemicals and bioplastics sectors, with 7% and 5% of downstream employment respectively. In these cases IB outputs serve as input for producing other more complex chemicals, or serve as building block for producing plastics.

Figure 2-3 Share of downstream employment by sector (2013) [13]



Source: IDEA Consult

▶ **Downstream turnover worth over €18,1 billion, and value added creation of around €5,9 billion per year.**

The processing and integration of IB outputs leads to further value added and turnover throughout the economy. This amounts to about half of the turnover of the direct effect, or about €18,1 billion. These turnover and value added are realised in the same sectors as shown in the pie chart above, although the precise share of each sector may differ slightly as labour intensive sectors such as construction or the primary sector will have higher shares in terms of employment than in terms of turnover.

⑫ The manufacturing sector, which normally covers NACE sectors 10-33, is defined here as excluding food & feed related sectors (NACE 10-12) and chemicals, pharmaceuticals and plastics (NACE 19-22), which are taken up as separate entities because of their high downstream employment figures.

⑬ In this figure, the category 'biochemicals' includes biofuels

4 INDUCED EFFECT

The induced economic effect is created through the IB sectors' direct and indirect (upstream and downstream) employment. Persons employed in these categories now receive a wage which is higher than an unemployment benefit. They spend part of their additional income in the European economy through consumption of goods and services, and in turn this spending generates additional turnover and value added in the European economy.

4.1 METHODOLOGY

The IB sectors' activities generate income for their employees (direct effect), for the additional employees at their suppliers (first order indirect effect) and further upstream in the supply chain (higher order indirect effect). The spending of this additional income in the economy provides a third type of economic effect: the 'induced effect'. The total additional wage expenses of the households, minus the amount of VAT [14], for their part create additional output in several sectors. As we have no information as to how these wages are spent precisely, we estimate the induced value added and induced employment based on economy-wide average ratios of value added over turnover and employment over turnover [15].

It is important to recall that we compare the situation 'as is' with the counterfactual that the IB sector would not be active. We thereby assume that employees (direct and indirect) would be unemployed if the IB sector did not exist. The additional impact is thus the difference between employment and unemployment of the direct and indirect employees. In this situation, we assume that the unemployed would receive an unemployment benefit, so that their income would not decrease to 0. Many other impact studies in the field do assume that the unemployed have zero income in the counterfactual, which leads to an overestimation of the additional effects.

As starting point, the figures on direct, upstream and downstream employment were used. These were multiplied with average net wages [16] in the different sectors in the EU where the IB sector creates direct and indirect employment. Subsequently, these were multiplied with average wage-spending quota [17] (= how much of an income is actually spent by a household). Next, the fraction of income that is spent outside the EU was subtracted in order to arrive at net spending in the EU economy induced by the IB sector [18].

However, not all of these expenses can be attributed to the IB sector. Only the part that results from the difference between the average unemployment compensation [19] and the average net wage of the direct and indirect employment can be considered as an induced impact of IB. Therefore this average unemployment compensation was also subtracted from the average net wages.

⑭ Taxation trends in the European Union (2014), DG for Taxation and Customs Union and Eurostat.

⑮ An alternative method is using a closed model of the EU input-output table. However the results have not been found reliable, since import leaks, expenditures of households outside the EU, and savings are not incorporated, and therefore tend to overestimate the real impact. Our approach can be considered as a conservative estimate, indicating the minimum border of potential effects.

⑯ Eurostat data per sector for the EU28.

⑰ Eurostat data. The average domestic wage-spending quotum is the percentage of the wage income of a household that is on average spent on the purchase of goods and services from the domestic market (thus not imported).

⑱ Eurostat data on final consumption expenditures in the EU and abroad.

⑲ Eurostat data for the EU28.

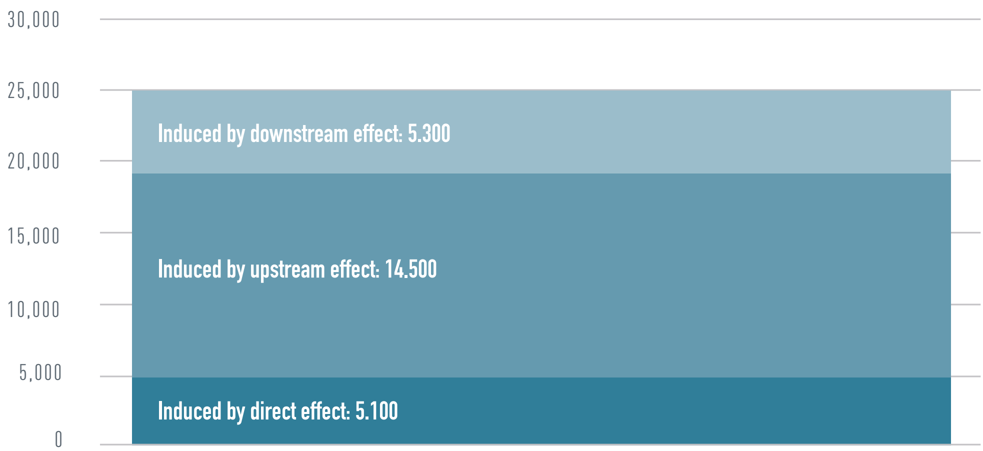
4.2 RESULTS

► Induced employment of about 25.000 jobs (FTEs) in 2013.

The induced economic effect is created through the IB sectors direct, upstream and downstream employment. These directly and indirectly employed people now receive a wage which is higher than an unemployment benefit. They spend part of their additional income in the European economy through consumption of goods and services, and in turn this spending generates additional turnover and value added in the European economy.

The total employment amounts to about 25.000 FTEs in 2013, which is driven predominantly by the spending of the upstream employees (as this is the largest group of employees in the IB value chain), but also spending of employees in the IB sector itself as well as downstream of the sector have significant induced impacts, around 5.000 FTEs each. This is illustrated in Figure 2-4, which shows the employment induced by spending of persons in these three categories.

Figure 2-4 Induced employment by economic effect (in FTEs, 2013)



Source: IDEA Consult

► Induced turnover creation worth over €4,6 billion, and value added of about €2,1 billion.

The turnover generated at companies who benefit from the extra [20] household expenditures from the direct and indirect employees linked to the IB sector, amounted to more than €4,6 billion in 2013. Of this, about €2,1 billion value added was created by enterprises that deliver the goods and services for consumer spending. Enterprises that benefit from this spending can be found in a variety of industries, ranging from food production to utilities, retail and construction.

[20] I.e. on top of what would be consumed if these people were unemployed and received unemployed benefits.

5 ADDING UP THE ECONOMIC EFFECTS

In order to obtain a complete picture of the economic impact of the IB sector, the results from the previous four chapters (direct, upstream, downstream and induced impact) are combined. Aggregating the individual economic effects created by the IB sector (direct, upstream, downstream and induced), results in an estimate of the total economic impact of the IB value chain in the economy.

► **Total employment creation along the IB value chain of about 486.000 jobs in 2013.**

Taking together the employment that is generated directly by the IB sector, indirectly by the suppliers to the IB sector and buyers of IB outputs, as well as the employment induced by the consumption purchases of the employees of these first three categories, the total employment generated amounts to nearly 486.000 jobs (Figure 2-5). The largest share of this (55%) is generated upstream by the suppliers of the IB sector. The direct and downstream activities contribute approximately evenly to the employment in the IB value chain.

Figure 2-5 Estimate of total economic impact (2013)

	Employment (FTE)	Turnover (B€)	Value addes (B€)
DIRECT	94.000	31,5	8,4
UPSTREAM	269.000	38,6	15,2
DOWNSTREAM	98.000	18,1	5,9
INDUCED	25.000	4,6	2,1
TOTAL	486.000		31,6

Source: IDEA Consult

The value added generated along the IB value chain amounts to more than €31,6 billion in 2013. Again the upstream part of the chain is the highest contributor in terms of economic effects. In contrast to employment, for value added the contribution of the direct effect is much higher than that of the downstream effect. The contribution of the induced effect is limited but not negligible, with about €2,1 billion annually.

It should be noted that figures for turnover are not summed up because this would result in a double counting of economic impact (e.g. the turnover of the direct effect includes costs spent on its first tier suppliers, whose turnover is included in the upstream effect).

► Leverage effect: For each job in the IB core sector, there are 4 additional jobs elsewhere in the IB value chain

The analysis makes clear that there is considerable economic activity in the IB value chain other than in IB sector itself. Indeed, for every job in the IB sector, there are approximately 4 jobs elsewhere. This is illustrated in Figure 2-6, where the direct employment is scaled down to 1, and additional employment created through the other economic effects is scaled accordingly.

The high IB job multiplier is the result of several factors. On the upstream side, a high multiplier is a general characteristic for the chemical and pharmaceutical sector, in which IB is embedded. However, as noted earlier the sourcing of biomass rather than fossil oil as raw material results in a significantly (16%) higher upstream employment, which is due to the fact that the production of biomass is more labour intensive than the extraction of oil. This adds up to the already high job multiplier for activity in chemicals and pharmaceuticals.

As a consequence, the job multiplier of the upstream effect (2,85 additional jobs per direct job) is considerably higher than the average multiplier of the manufacturing sector (1,8 jobs additional jobs per direct job) and the economy wide average multiplier (1,14 jobs additional jobs per direct job).

The forward effects result in about one additional job per direct job. While there are few benchmarks available for the forward effects, it can be reasonably expected that the IB sector, considering its enabling role and position early in the value chain of end-products, will be above average regarding downstream employment multipliers as well. The induced effect in turn leads to an additional 0,26 jobs per direct job in the IB sector.

Figure 2-6 Job multiplier per economic effect (2013)

Source: IDEA Consult

6 OUTLOOK

This chapter discusses the outlook for the economic impact of the IB sector. Based on the calculations of the current impact (see earlier chapters) and growth forecasts for the sector from other sources, it is possible to make a projection for employment numbers that will be reached by 2030.

6.1 METHODOLOGY

The starting point is the data on the direct impact of the IB sector, calculated in Chapter 1 of Part 2, which apply to the year 2013. Subsequently, we multiply the current direct employment figures with the expected growth rate values for the IB sector. We employ two different sources on IB market growth:

- We extrapolate the historical growth rate of 7% observed in the time series of the production statistics of the KETs Observatory [21].
- In the context of the BIO-TIC project, a market growth of 4% annually towards 2030 was calculated [22].

Hence, we use one source which is the extrapolation of past growth rates (assuming a full business as usual) and one source which is a forward looking market study dedicated to the IB sector.

We subsequently calculate future direct economic impact, by combining current direct economic impact with the two IB growth rates. As there is no information on how the job multipliers of the IB sector might change, we assume that the same multipliers will prevail in 2030 and can hence derive total economic impact from direct economic impact that way.

21 For more info, see Second Report of the KETs Observatory, and the indicators available at: https://ec.europa.eu/growth/tools-databases/kets-tools/kets-deployment

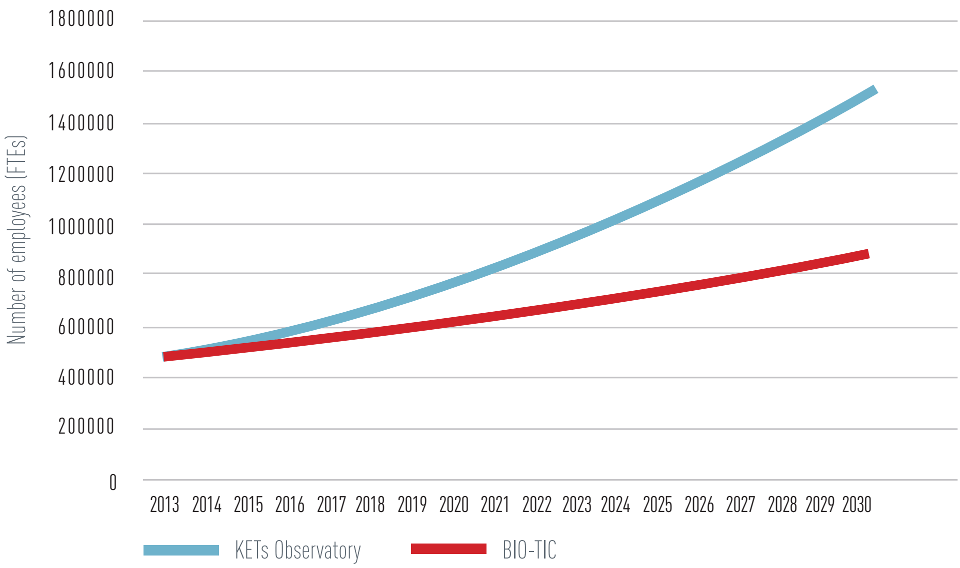
22 Pöyry Management Consulting (2015). Overcoming hurdles for innovation in industrial biotechnology – market roadmap.

6.2 RESULTS

► Employment in IB sector is expected to grow up to between 900.000 and 1.500.000 jobs in 2030.

As shown in Figure 2-7, for both growth scenarios there is a considerable increase in employment in the IB value chain. From slightly less than 500.000 FTEs in 2013, it is expected to increase to between 600.000 and 800.00 FTEs by 2020, and to between 900.000 FTEs and 1.500.000 FTEs by 2030. Among the main driving factors behind IB growth are improved product performance, cost reductions, feedstock cost-competitiveness, increased environmental awareness as well as macroeconomic factors such as GDP and population growth [23].

Figure 2-7 IB value chain employment forecasts



Source: IDEA Consult

It is interesting to put the figures on IB employment into perspective with total employment of the overall chemicals and pharmaceuticals sectors. According to the European Chemical Industry Council (CEFIC) and the European Federation of Pharmaceutical Industries and Associations (EFPIA), the chemical and pharmaceutical industry employed in 2013 in total about 1.800.000 FTEs [24]. That implies that in 2013, IB based (direct) employment constituted about 5,2% of total employment in chemicals and pharmaceuticals.

㉓ Idem

㉔ CEFIC (2016). The European chemical industry – fact and figures 2016. These statistics include bio-based chemicals and fuels falling under NACE sector 20.

EFPIA (2015). The Pharmaceutical Industry in Figures – key data 2015.

The Eurostat structural business statistics provide data for these sectors until 2011 only, and were therefore not used.

In terms of employment growth, chemicals and pharmaceuticals have witnessed different trends over the past decade [25]. In chemicals, employment has dropped considerably, while pharmaceuticals saw an increase. However, in both sectors employment has been flat over recent years (since 2010 in the case of chemicals and since 2013 in case of pharmaceuticals). Assuming that this continues and employment in these sectors remain stable over the coming years, the employment of the IB sector compared to the employment in the chemical and pharmaceutical sectors will evolve as shown in Table 2-1:

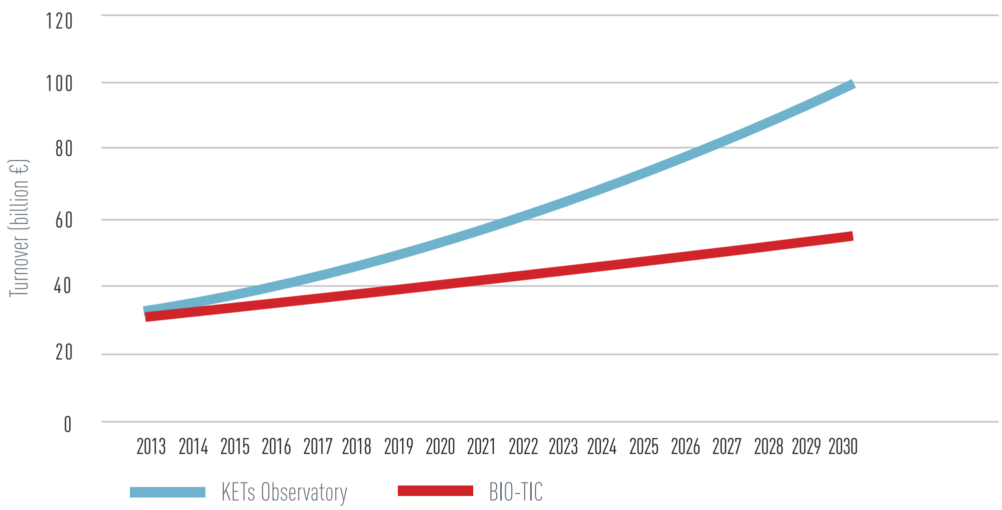
Table 2 1 Projected evolution of share of IB employment in total chemicals and pharmaceuticals employment Source: IDEA Consult

	2013	2020	2030
Bio-TIC forecast	5,2%	6,7%	9,5%
KETs Observatory forecast	5,2%	8,4%	16,5%

As can be seen, the share of the direct IB sector in overall employment of chemicals and pharmaceuticals is estimated to increase significantly over the coming years. In the case of the BIO-TIC scenario, the share of IB employment will have almost doubled, reaching close to 10% of overall employment in these sectors. In case of the KETs Observatory historical growth extrapolation, the share of IB will have more than tripled, reaching 16,5% of employment. Regardless of the scenario considered, however, it is clear that the IB sector will play an increasingly key role in promoting employment in the chemical and pharmaceutical sectors.

In contrast to employment figures, turnover figures are less intuitive when expressed for a complete value chain, because of the risk to double count the turnover of companies in different phases of the value chain. Therefore the projections for turnover are not presented for the entire IB value chain, but cover only the core IB sector. As indicated in section 1, the core IB sector represented in 2013 a turnover of about €31,5 billion. When we project the evolution of this turnover along the lines of the growth scenarios described for employment, we find that the turnover of the IB sector will reach between €57,5 and €99,5 billion in 2030 (Figure 2-8).

Figure 2-8 IB sector turnover forecasts



[25] Idem

SUMMARY AND CONCLUSIONS

PART 3

The importance of a transition towards a renewable bio-based economy has been increasingly acknowledged in recent years to ensure better use of resources, climate change mitigation and food & energy security, in addition to creating jobs and growth in rural, coastal and deindustrialised zones.

Industrial biotechnology is considered a key enabler in this transition, as it facilitates the production of a wide variety of chemicals, materials, food, feed, fuel and pharmaceuticals based on biomass. Yet, until now, data on the economic impact of the bio-economy as a whole, and specifically on the industrial biotechnology sector has been scarce.

This study therefore sought to quantify the economic importance of this sector. Based on KETs Observatory data, it is found that the core IB sector employed about 94.000 FTEs in 2013. Upstream of the IB sector, at the suppliers of goods and services, the associated employment amounts to about 269.000 FTEs. Downstream of the IB sector, at companies who process and integrate IB sector outputs, some 97.000 FTEs are employed. Together with the induced effect, created through the spending of employees in the aforementioned groups, in total 486.000 FTEs are employed along the IB value chain.

This implies that for every job in the core IB sector, there are 4 jobs elsewhere in the value chain. This high job multiplier is a general characteristic of the chemical and pharmaceutical sectors, in which the IB sector is embedded, but is augmented due to the specific characteristic of the IB sector with regard to its sourcing of raw materials in biomass sectors, which creates many more upstream jobs than sourcing fossil resources.

The growth prospects for employment in the IB value chain were explored by considering two scenarios: one in which IB market growth would continue at the same pace as observed in the KETs Observatory historical production data, and one in which the IB sector would grow in line with the market forecast of the BIO-TIC market roadmap. Results indicate that by 2030, employment in the IB value chain would grow to reach between 900.000 FTEs and 1.500.000 FTEs.

Currently, employment in the IB sector represents about 5% of overall employment in the chemicals and pharmaceuticals sector. Assuming that employment in these sectors will remain stable, as has been observed in recent years, the share of IB employment in these sector may increase up to 10-15% by 2030. This underscores the role of the IB sector as a source of employment in the chemicals and pharmaceuticals sector.

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