

## EMPLOYMENT IN VS. EDUCATION FOR THE BIOECONOMY

**Nina DREJERSKA**, Department of European Policy and Marketing, Faculty of Economic Sciences, Warsaw University of Life Sciences, 116 Nowoursynowska Street, 02-787 Warsaw, Poland; [nina\\_drejerska@sggw.pl](mailto:nina_drejerska@sggw.pl)

A number of employees is one of the basic indicators applied for identification of the economic relevance of an industry or an economic sector. Referring to nearly 18.6 million people employed in the 28 EU Member States within the bioeconomy in 2014, it can be stated that this is an economic sphere of significant importance in the European economy. The main aims of the study are to identify a scale of employment in the bioeconomy sector across EU Member States as well as to investigate tertiary education in bioeconomy based on the Polish experience in the Bioeconomy subject area group within the Euroleague for Life Sciences (ELLS). Data used included: (1) the data portal of agro-economics modelling – DataM of the Joint Research Centre of the European Commission, (2) CAWI research among students of WULS-SGGW on their attitudes to the bioeconomy, (3) feedback of participants of the first summer school in bioeconomy coordinated by WULS-SGGW. Research results display that the majority of Polish students did not meet the term of bioeconomy generally as well as at the university. There is also one very important students' comment which can describe their attitude: students of economic disciplines are not very much interested as they think that bioeconomy focuses on life sciences (bio) so it is not appropriate for them; students of different fields of life sciences are not very keen to study bioeconomy as according to them it focuses on economy (as in the name itself).

*Keywords: bioeconomy, employment, tertiary education, student*

### INTRODUCTION

Patermann and Aguilar (2017) refer to the year of 1982, since the European Commission has been in charge of the EU Framework Programmes in Biotechnology and Life Sciences, as they write about the birth of the bioeconomy in the European Union. According to them, the accumulated experience over different Framework Programmes was an essential prerequisite for tackling more ambitious “bio-policy” initiatives as for example the Strategy on Biotechnology in 2002, the concept of the Knowledge-Based Bio-Economy, more commonly known as KBBE and the Strategy on Bioeconomy adopted in 2012. According to this official strategy the bioeconomy encompasses the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy (European Commission, 2012). In this approach, the bioeconomy sector cannot be considered *a priori* as a sustainable approach to growth and development. However, as Maciejczak and Hofreiter (2013) found after a review of a number of definitions of the bioeconomy - the core of this concept lies in the sustainable transformation of renewable biological resources based on innovation in the life sciences and turned into products and processes that aim to meet both private and public expectations. This sustainable approach is clearly visible in present strategies and programmes facilitating practical implementation of this concept. For example we can mention the National Research Strategy BioEconomy 2030 in Germany aiming at establishing the conditions for the vision of a sustainable bio-based economy by 2030 or Horizon 2020 - the biggest EU Research and Innovation programme with a significant part of societal challenges devoted to the bioeconomy. It can be added that currently from the perspective of environmental sustainability, the bioeconomy seems to be perceived not as a single concept but together with elements of Circular Economy as a part Green Economy, which acts as an ‘umbrella’ concept for the two previous ones (D'Amato, et. al. 2017). Whereas the sustainable bioeconomy offers huge opportunities in some areas (e.g. in agriculture or in the forest sector), there are still various challenges related to initiatives in streamlining waste, especially for energy generation so there is a great potential in the utilisation of biomass to feed an expanding bioeconomy and integrate it with the principles of the circular economy (Leal Filho, 2018).

Different indicators can be used in order to identify the economic relevance of the bioeconomy sector. This study focuses on employment, as it depicts a fundamental sociopolitical dimension and is highly important for each economy (Efken, et al. 2016). Referring to nearly 18.6 million people employed in the 28 EU Member States within the bioeconomy in 2014 (DataM, 2017), it can be stated that this is an economic sphere of significant importance in the European economy. It covers a wide range of activities, including: (a) agriculture, (b) forestry (c) fisheries (d) food, beverage and tobacco industry, (e) bio-based textiles, (f) wood products and furniture, (g) manufacture of paper and paper products, (h) bio-

based chemicals, pharmaceuticals and plastics, (i) biofuels and (j) bio-based electricity (European Commission, 2012). The German Research Strategy BioEconomy 2030 is even more detailed stating that the bioeconomy covers agriculture, forestry, horticulture, fisheries and aquaculture, plant and animal breeding, the food and beverage industries, as well as the wood, paper, leather, textile, chemicals and pharmaceutical industries, and aspects of the energy sector. Bio-based innovations also provide growth impetus for other traditional sectors, such as in the commodity and food trade, the IT sector, machinery and plant engineering, the automotive industry, environmental technology, construction, and many service industries. These lists as well as notions of different scientists clearly characterize the bioeconomy as a multisectorial and fast-evolving sector (e.g. the emerging bio-based industries) (Ronzon, 2017), which demand specialists of different disciplines for whom work with renewable biological resources is a common feature. The adoption of a sustainable “greener economy” requires political commitment, technological and physical infrastructure, skilled labor, financial means and solidarity (Scheiterle, 2016).

The main objectives of the study are:

- to identify a scale of employment in the bioeconomy sector across EU Member States as a background justifying demand for education in bioeconomy,
- to investigate tertiary education in bioeconomy based on the Polish experience in the ELLS Bioeconomy subject area group.

Euroleague for Life Sciences (ELLS) was established in 2001. It is a network of leading European universities cooperating in the fields of natural resource management, agricultural and forestry sciences, life sciences, veterinary sciences, food sciences, and environmental sciences. Its focus on joint teaching and learning as well as composition in expertise covering the scope of the bioeconomy makes it a right forum for this study’s purposes. The Bioeconomy subject area group was started within the ELLS’s framework and it includes representatives of: Faculty of Science University of Copenhagen, Swedish University of Agricultural Sciences, University of Hohenheim, Wageningen University and Research Centre, Czech University of Life Sciences Prague, University of Natural Resources and Life Sciences in Vienna and Warsaw University of Life Sciences. Since 2015, attempts have been taken by both academics as well as students to find a common approach to bioeconomy teaching. Experiences of the inter- and transdisciplinary master programme in bioeconomy at the University of Hohenheim, which made the issue of bioeconomy a new research focus in 2014, as well as courses provided at other universities were used in this process. This joint initiative seems to be an important one as the success of the bioeconomy requires an efficient international cooperation (Schütte G., 2018), also in education.

## **RESEARCH METHODS**

Objectives of the study result from a theoretical concept of the Knowledge-Based Bio-Economy (KBBE) which was defined by the European Commission as the process of transforming life science knowledge into new, sustainable, eco-efficient and competitive products (Patermann and Aguiler, 2017). Pyka (2017) presented the possibility of transformation of the global production system towards a knowledge-based bio-economy from the perspective of modern innovation economics referring to Neo-Schumpeterian economics focused on qualitative aspects of economic development and thus on a change of fundamental economic structures over longer periods. This process will lead for example to additional demand for high-skilled workers whereas opportunities for low-skilled workers decrease. To deal with this demand, an interdisciplinary approach for tertiary education in widely understood life sciences is necessary. Due to the importance of inter- and transdisciplinary competences in the bioeconomy and the need for an appropriate knowledge base, the demand for professionals specifically educated in this field is growing (Lewandowski, 2018). In order to make progress, manpower and education have to be at the forefront – it is important to ensure the right mix of education as well as innovation training and a supportive environment (Jonsson, 2017).

To realize objectives set out for this study, the following data was used:

- statistical data characterizing a scale of employment in bioeconomy across the European Union provided by the DataM of the Joint Research Centre of the European Commission - data portal of agro-economics modelling,
- results of Computer-Assisted Web Interview (CAWI) research among students of WULS-SGGW on their attitudes to the bioeconomy carried out in 2016 by students of Warsaw University of Life Sciences engaged into the Euroleague Students Association,
- feedback of participants (students) of the first summer school in bioeconomy coordinated by WULS-SGGW and organized in Warsaw in 2017.

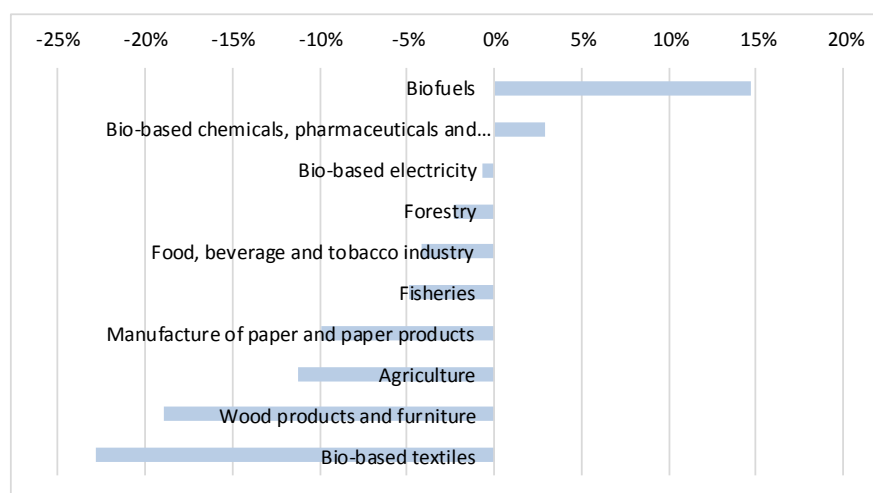
A monographic method was employed in the study. There were used also basic descriptive statistics. Tables and graphs were applied for presentation of selected results of the research process.

## **RESEARCH RESULTS**

Bioeconomy as a significant sector of employment in the European Union

A review of the state of the art suggests that bioeconomy plays an important role as an employment sector in the EU Member States. For example, Pilvere and others (2015) refer to possible growth of employment in the forest sector, which is also indicated as an advantage for society resulting from use of a domestic resource promoting employment and regional development (Stupak et al, 2017). According to the data provided by the DataM of the Joint Research Centre of the European Commission, decrease in the number employed in the bioeconomy sector from 20.79 million in 2008 to

18.59 million people took place whereas the turnover per person employed increased from 101 to 120 thousand euro. Figure 1 presents this tendency according to more specific activities covered by this sector (Fig 1).



Source: own based on the DataM of the Joint Research Centre of the European Commission.

Figure 1. Change in employment in the bioeconomy sector in 28 EU-Member States in the period 2008-2014

A similar tendency of bioeconomy shrinking as an employment sector but increase in its efficiency (turnover per person employed) can be observed in majority of EU Member States, including for example Poland or Baltic States (Lithuania, Latvia, Estonia). However, there are differences in deeper insight into composition of these changes across the EU Member States. The above mentioned indicators characterizing national bioeconomy sectors across the UE used for single countries can place them in a comparative context conducive to highlighting issues of international competitive advantages and disadvantages (Hilgartner, 2007). Moreover, this different compositions of the bioeconomy sectors in European countries contributes also to some exceptions from the general trend mentioned above, as for example:

- Cyprus and Malta recorded a slight decrease in turnover per person employed,
- Hungary experienced no change in turnover and increase in employment especially due to increase in employment in agriculture and forestry,
- France and the United Kingdom recorded increase in employment thanks to especially employment increase in agriculture, whereas Luxemburg due to employment increase in food, beverage and tobacco industry.

Although table 1 is wide and full of detailed information on employment in bioeconomy, it is necessary to refer to it in order to present complexity of European bioeconomy as a sector of employment. Data on a number not a structure was applied intentionally in order to display a scale of different parts of this sector as well as bioeconomy in total. A simple assumption from a perspective of this paper was set up: a scale of particular bioeconomy activities leads to different demand for educational services (also tertiary) in these fields.

There are countries in the EU with significant employment in particular subsectors of the bioeconomy – for instance Poland, Italy and Romania in the case of the forestry, whereas for other countries like Luxemburg or Malta this is not important. A similar situation resulted from geographical and natural conditions can be found in the case of fisheries. Together with agriculture, these three sectors can be perceived as main primary suppliers of biomass for the economy. What is more, agriculture is usually the dominating sector of employment in majority of the EU Member States.

Data on a structure on employment are more useful for an analysis of diversification in the industrial part of the bioeconomy. Due to restrictions of space, attention is paid only to some selected EU countries. More than 40% of bioeconomy employment in food, beverage and tobacco industry can be found in the United Kingdom, Germany, Belgium, Malta and Luxembourg. The highest proportion of employed in bio-based textiles can be found in Portugal (15%), Italy, Bulgaria and Slovakia (10%). Estonia (33%), Latvia, Lithuania, Slovakia and Sweden (19%) represent the highest employment in activities devoted to wood products and furniture. Data on Sweden and Finland proves high employment there in manufacture of paper and paper products (respectively 14 and 11%). Denmark has an outstanding position in bio-based chemicals, pharmaceuticals and plastics (excl. biofuels) – 12% of employment whereas the other countries with a significant employment there represents about 5-6% (Belgium, Germany, Czech Republic). Biofuels and bio-based electricity have a marginal role in employment. Detailed conclusions on trends of the bioeconomy sectors across single EU member states requires for sure much more space as there is a vast literature for each of the countries (e.g. Gołębiewski 2016, Heijman 2016, Purkus et. al, 2018, Vitunskienė et. al, 2017)

However, even this short overview proves that the bioeconomy sector requires specialists of different fields. As a result, demand for various skills and knowledge of labour force in the bioeconomy is diversified across Europe.

Table 1. Employment in bioeconomy in EU countries in 2014 (persons)

Country	Agriculture	Forestry	Fisheries	Food, beverage and tobacco industry	Bio-based textiles	Wood products and furniture	Manufacture of paper and paper products	Bio-based chemicals	Biofuels	Bio-based electricity	Total
Austria	186500	11400		82648	10644	53877	16901	9942	959	453	373324
Belgium	53200	2300	355	96201	9271	21556	11820	13315	2665	353	211036
Bulgaria	181100	25100	1349	97897	49763	33136	9245	4367	755	699	403411
Croatia	128300	14500	6764	62062	16999	23452	4345	1428	99	136	258085
Cyprus	15100	500	1549	11352	199	2439	563	118	9	117	31946
Czech Republic	107800	26700		113497	24487	54366	18952	18177			363979
Denmark	61900	3400	1921	63244	1923	9494	6136	19983	1233	218	169452
Estonia	16200	6800	2068	15079	3619	22301	1382	419	29	90	67987
Finland	76200	21800	2219	39761	3424	26806	22306	3425	1026	315	197282
France	695000	28300	28902	621333	59020	102574	65204	55663	6265		1662261
Germany	528500	33000	1686	865182	60382	236625	145232	101012	15706		1987325
Greece	461000	5400	29386	86550	13096	13110	7312	1369	379	574	618176
Hungary	167000	22900		104763	20353	29792	11498	9243	502	329	366380
Ireland	102700	2800	4877	37632	808	5341	3015	3664	604		161441
Italy	737600	51700	31922	427332	274192	215018	71173	30971	4021	1301	1845230
Latvia	46400	17800	680	25819	3632	30668	1383	1351	205	119	128057
Lithuania	105800	13700	763	42504	9844	42891	4105	770	443	129	220949
Luxembourg	3300			5398		644					9342
Malta	2100		556	3832	33	310	239				7070
Netherlands	169800	2000	2590	129122	7996	28680	17493	5760	2866	224	366531
Poland	1734100	77600	8013	418430	64502	240162	56895	27013	2333	1700	2630748
Portugal	363100	14100	20447	105401	103964	49861	9871	4376	563	206	671889
Romania	2391600	47300	3272	183099	111062	102734	12738	12960	1287	1823	2867875
Slovakia	58500	23500		38307	19268	36527	7153	6670	393	250	190568
Slovenia	83900	3700	141	16018	5567	12650	4399	2744	111	168	129398
Spain	677600	24600	53021	356206	70077	88461	41416	28994	3781	805	1344961
Sweden	62300	23000	1947	61289	2784	43008	32278	7885	847	629	235967
United Kingdom	341400	21900	15253	421813	42149	130473	54142	34338	2914	989	1065371

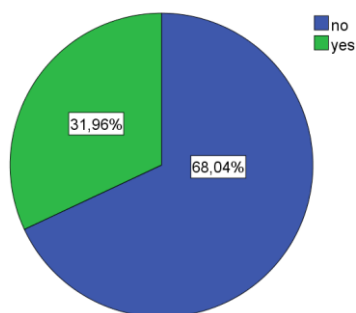
\* including pharmaceuticals and plastics, excluding biofuels

Source: own based on the DataM of the Joint Research Centre of the European Commission.

### TERTIARY EDUCATION FOR BIOECONOMY

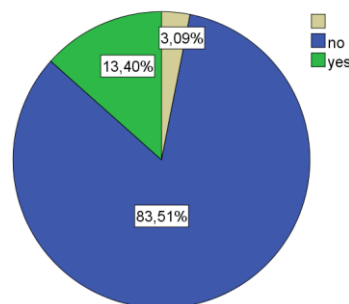
Research among students referred in this paper had a general character but it is worth mentioning that the state of the art brings examples of similar or deeper studies among students on bioeconomy issues (Mastalka and Timonen 2017, Pătări et. al 2017).

A Computer-Assisted Web Interview (CAWI) research among 96 students of WULS-SGGW on their knowledge and attitudes to the bioeconomy was carried out in 2016. Students from 11 out of 13 WULS-SGGW faculties took part in it. Majority of them studied at the Faculty of Food Sciences (38%) and the Faculty of Economic Sciences (32%). What is more the investigated group consisted mainly of bachelor students (85%). Figure 1 and figure 2 illustrate that majority of investigated students did not hear about bioeconomy and what is important - a vast majority did not hear about this concept at the university.



Source: own research.

Figure 1. Have you heard about bioeconomy?



Source: own research.

Figure 2. Have you heard about bioeconomy at your university?

The next step of the research provided students with a simple definition of the bioeconomy and then they were asked if they were interested in:

- this topic – 70% yes,
- studying this topic for example as an elective course – 63% yes,
- studying this topic for example as an elective course in English – 39% yes.

An interesting conclusions were drawn after discussions of the ELLS bioeconomy subject area (university staff) with representatives of students. It occurred that students of economic sciences were not so much interested in bioeconomy because they associated it purely with a process of production of bio-commodities – so a part of study program suitable for example for students of agriculture or food sciences. On the other hand, students of food or life sciences thought that it was a course appropriate for study programs in economics as “economy” covers a majority of the word “bioeconomy”.

Work of the ELLS bioeconomy subject area resulted in organization of a summer school in bioeconomy which took place at the end of August 2017 at the Warsaw University of Life Sciences. This event was co-organized by representatives of ELLS universities and was attended by 15 students, mainly master and PhD levels. They represented six European universities but they come from countries all over the world. Their most popular motivation to participate was a desire to know more about bioeconomy from different points of view. They acknowledged advantage of the international dimension in this form of education and reported to identify for example a global dimension of bioeconomy. Some of them were students of the bioeconomy master program at the University of Hohenheim so they had already been equipped with some knowledge on bioeconomy. One evaluation comment illustrates how important these students perceived it – “as the bioeconomy issue will be in front in the coming years, having the necessary knowledge and experiences is critical. I believe I will continue to learn more about it and also to some extent see in how far my research could contribute to bioeconomy discussions”.

## **CONCLUSIONS AND DISCUSSION**

The highest shares of employment in bioeconomy in the EU Member States are represented by sectors associated with traditionally rural areas - agriculture, forestry or fisheries. A role of these activities for rural employment is a widely acknowledged phenomenon (for example Drejerska 2015). Although, for instance in case of Poland scientists indicate localization of bio-clusters and bio-parks as well as companies of pharmaceutical biotechnology in the largest cities (Wozniak, Twardowski, 2017). Despite of localization, establishment and development of bioeconomy requires a complex skills and knowledge which can be clearly identified basing on a different structure of bioeconomy employment across Europe. However, an overview of activities employing people in the European bioeconomy arises a question if we need a highly specialized but at the same time narrowly focused experts or maybe graduates representing a comprehensive overview of bioeconomy but not so deeply educated in its particular parts.

Development of knowledge-based bioeconomy requires undoubtedly investment in human capital which, as Rakowska (2011) refers to, is formed basically by formal education. Especially tertiary education is indicated as an element playing crucial role in the process of building innovative society. Taking it into account, efforts put into development of tertiary education in bioeconomy seem to be important. That is why activities of ELLS in this field were referred to in this paper.

Research results displayed that the majority of Polish students investigated in 2016 did not meet the term of bioeconomy generally as well as at the university. Students of economic sciences were not so much interested in this topic as they associated it purely with agriculture or food sciences whereas students of food or life sciences thought that bioeconomy was appropriate for economics as “economy” covers a majority of the word “bioeconomy”. This sets a challenge for education as the infusion of economic information to other disciplines and the expansion of science within the economic curriculum is essential (Zilberman et. al, 2018). Although some academics dealing with sciences already notice a global trend for establishing new courses throughout the world to train students and professionals in the bioeconomy – courses, which encompass many different fields in a multidisciplinary approach, including agronomy, logistics, life cycle assessment, biotechnologies, process design, economics, and, obviously, chemistry (Dumeignil et. al 2017).

Undoubtedly, a fact that this research was carried out about one year ago as well as that a relatively small number of students responded can be perceived as limitations of this study. This also indicates a necessity of further research in this field, including tracking of professional paths of graduates of bioeconomy courses or programs. Nevertheless this low level of knowledge about bioeconomy justify not only a necessity to stress this field in the programmes of tertiary education but also during earlier educational stages, as for example design an educational toolkit to improve the communication of European research on the bioeconomy to school-aged children proposed by Murphy and others (Murphy et. al. 2014).

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