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EMPLOYMENT TRENDS IN THE RENEWABLE ENERGY SECTOR

Key words: employment, renewable energy sources, ranking, pair-wise comparison method, European Union

ABSTRACT. The article aims to identify the changes in the number of employees in European Union (EU) countries in the renewable energy sector in 2018 compared to 2014. EurObserv'ER yearbooks were the source of data on employment and capacity for selected renewable energy sources. The paper uses descriptive and pair-wise comparison methods. The largest decreases in employment were observed among countries that are leaders in the RES market (e.g., Germany, France). On the other hand, the greatest increases in employment were determined by source development opportunities in a given country, e.g., biofuels in Romania, Poland, Hungary, or Lithuania. The conducted pair-wise comparison indicated that the relation between the change in the ranking position and the change in the number of employees was significant for EU countries, whose ranking positions are both in the first (combination AA – I) and the second ten (combination CC – II) in the RES sector. Moreover, the results of the statistical analysis indicated a significant relationship and *p-value* significance in 11 out of 12 variables adopted for correlation, covering the number of employed and installed capacity in selected RES sectors in 2014 and 2018.

INTRODUCTION

The traditional use of fossils such as coal, oil and natural gas is associated with the degradation of the world's natural habitat [Jiang et al. 2019, Kanat et al. 2021]. In recent years, the awareness of environmental damage caused by conventional energy has increased [Pohjolainen et al. 2019, Kaya et al. 2019a, Staniszewska 2021]. Actions at a global level, including Europe, have created additional stimulus to restructure the energy sector in this regard. Countries, such as France (by 2021), Sweden (by 2022), Austria, Ireland, Italy and the UK (by 2025), Finland and the Netherlands (by 2029), Portugal and Denmark (by 2030), Germany (by 2038), and Poland (by 2049) have decided to renounce coal power

(a coal phase-out). Despite the implementation of policies to increase investment in renewable energy and reduce dependence on fossil energy sources to mitigate carbon emissions, the sustainable use of fossil energy consumption is important [Destek, Sarkodie 2020]. Measures to reduce the use of conventional energy sources were a consequence of the targets set by the EU as part of “Clean Energy for All Europeans” [EC 2016], concerning, among other things, a reduction of at least 40% in greenhouse gas emissions across the EU economy, compared to 1990. The European Commission, on 14 July 2021, adopted the “Fit for 55” package of legislative proposals under the European Green Deal, which aims to strengthen the EU’s position as a global climate leader. The package aims to modernise existing legislation in line with the EU’s 2030 climate target, which will help deliver the transformational changes needed in the economy, society and industry to achieve climate neutrality by 2050 and, to support this, reduce net emissions by at least 55% (compared to 1990) by 2030 [EC 2021]. In this context, targets in total energy consumption from renewable energy sources of 20% by 2020 [Directive 2009/28/EC] and 40% by 2030 [EC 2021] are relevant. The proposed long-term support budgets for natural resources and the environment (EUR 419.9 billion) [EC 2020] for the period 2021-2027 may have a positive impact on increasing energy efficiency and creating new workplaces.

In 2020, employment in the renewable energy sector worldwide was estimated at 12 million people [IRENA 2021, p. 9]. One-third – 3.98 million people were employed in the photovoltaic industry, while 2.4 million people were in the biofuels sector. Poland ranks eighth among the ten countries employing the largest number of workers in the biofuels sector in recent years [Klepacka 2018a, 2019]. The third place goes to the wind energy sector, where the employment level accounts for 1.25 million jobs. It should be assumed that the level of employment in renewable energy sectors will maintain an increasing trend [IRENA 2021, Makešová, Valentová 2021]. This is especially true for the use of photovoltaics, where year-on-year growth in the number of employees in the sector has been maintained since 2012. Comparing 2012 and 2020, an almost threefold increase in jobs in the photovoltaic sector was observed – from 1.36 to 3.98 million [IRENA 2021, p. 10]. Half as much (46.66%) employment growth was indicated in the bioenergy sector, which includes liquid biofuels, solid biomass and biogas. Similar changes were reported in the wind energy sector (a 66.66% increase).

MATERIAL AND METHODS

This paper aims to identify changes in the number of employees in the RES sector in EU countries in 2018 compared to 2014. EurObserv’ER yearbooks were the source of employment and capacity data for selected renewable energy sources. The employment data presented for individual RES refer to gross employment, i.e., they do not take into account

developments in non-renewable energy sectors or reductions in expenditure in other sectors. Data include both direct and indirect employment. Direct employment includes RES equipment production, RES plant construction, engineering and management, operation and maintenance, biomass supply and operation. Indirect employment concerns secondary activities, such as transport and other services. The descriptive method was used in this study to present results indicating an increase or decrease in the number of employees in the RES sectors. In addition, a pair-wise comparison method was applied. Data on the change in ranking position and the change in the number of employees in the RES sector (2018 compared to 2014) for all EU countries were grouped into three groups and three combinations:

1. Group A: A-A – countries with an increase in ranking position and an increase in the number of employees; A-B – an increase in ranking position, no change in the number of employees; A-C – an increase in ranking position, a decrease in the number of employees.
2. Group B: B-B – countries with no increase or decrease in both ranking position and the number of employees; B-A – no change in ranking position, an increase in the number of employees; B-C – no change in ranking position, a decrease in the number of employees.
3. Group C: C-C – countries with a decrease in ranking and number of employees; C-A – a decrease in ranking, an increase in the number of employees; C-B – a decrease in ranking, no change in the number of employees.

In addition, Groups A, B, C were assigned I (1-10), II (11-20), III (21-28) tenth in the ranking, depending on the position in 2018.

An alphabetical list of EU countries was used in the summaries, rather than a list by position, due to the variation in the development of the respective RES sector. The Pearson correlation and *p-value* were used to assess the relationship and statistical significance between the number of employees and the installed capacity of wind, solar PV and solid biomass investments in 2014 and 2018. 12 variables were adopted: 6 variables that related to employment (e) in the sector: wind energy (w) (2014e_w; 2018e_w), photovoltaics (pv) (2014e_pv; 2018e_pv), and solid biomass (sb) (2014e_sb; 2018e_sb), and 6 variables of installed capacity (p) in the sector: wind energy (2014p_w; 2018p_w), solar PV (2014p_pv; 2018p_pv), and solid biomass (2014p_sb; 2018p_sb) in 2014 and 2018. “Statistica” software was used for the calculations. The results of the study were presented graphically in the form of tables and graphs.

CHANGES IN THE LEVEL OF EMPLOYMENT IN INDIVIDUAL RENEWABLE ENERGY SOURCES IN EUROPEAN UNION COUNTRIES

The Renewable Energy Sources Act has undergone multiple amendments over the last years, including the definition of renewable sources [Journal of Laws, 2021.610]. The latest amendment concerns the prosumer billing system. It does not refer, however, to employment issues. Figure 1 indicates the changes in the number of employees in the renewable energy sources (RES) sectors in the EU between 2014 and 2018. When discussing the changes, the RES sectors are divided into two groups. The first group includes those where employment decreased (wind, solar thermal and geothermal sectors) and the second where employment increased (biofuels, heat pumps, small hydro, municipal waste, solid biomass, photovoltaics and biogas sectors) in 2018 compared to 2014.

In the wind energy sector, job losses affected 3,800 people, representing 1.2%. In terms of numbers, the largest decreases were seen in Germany (42,900 jobs – 28.8%), while in percentage terms, in Italy (21,900 jobs – 73%).

Moreover, among the countries where employment decreased by at least 50% were Poland – 64.3%, Finland – 58.8%, Austria – 58.3% and Sweden – 53.5%. Reasons for the level of employment reduction in the wind energy sector were, among others, the close down of the Adwena (2017) and Powerblades (2018) production facilities and the reduction of employment levels at Siemens Gamesa and Enercon [EurObserv'ER 2019]. In addition, growing public resistance and stricter regulations on the minimum distance between wind turbines have contributed to a reduction in new wind energy investments, including changes in the labour market.

Solar energy generated in the sector of solar collectors (various types) and used for hot water production by households, among others, recorded a decline in employment in the EU of 14,950 people (37.1%). Significant decreases were reported in Germany with 7,300 persons, France – 4,100 persons and Italy – 2,400 persons (by 66.4%, 69.5% and 68.6%, respectively) and the Netherlands – 400 persons and Belgium – 450 persons (by 81.8% and 80%, respectively). Despite the outstanding development of the solar collector sector among others in Poland (310,000 m² of installed area in 2018) [IRENA 2019], increased interest in solar collectors is not expected. The main barrier to development is the investment cost, which is borne 100% at the time of purchase. In earlier years (2007-2013), EU support, e.g., in Poland was 85%, which motivated households to make this type of investment [Klepacka et al. 2018, Kaya et al. 2019b]. A potential opportunity for the development of the solar sector may be the formal and legal conditions for newly constructed buildings [Siudek et al. 2020].

The geothermal energy sector, which includes around 200 geothermal districts in the EU, also experienced job losses of 2,150 (18%). Countries with declining employment numbers included Germany, with a decrease of 800 jobs (73%), Italy, with 3,300 (60%),

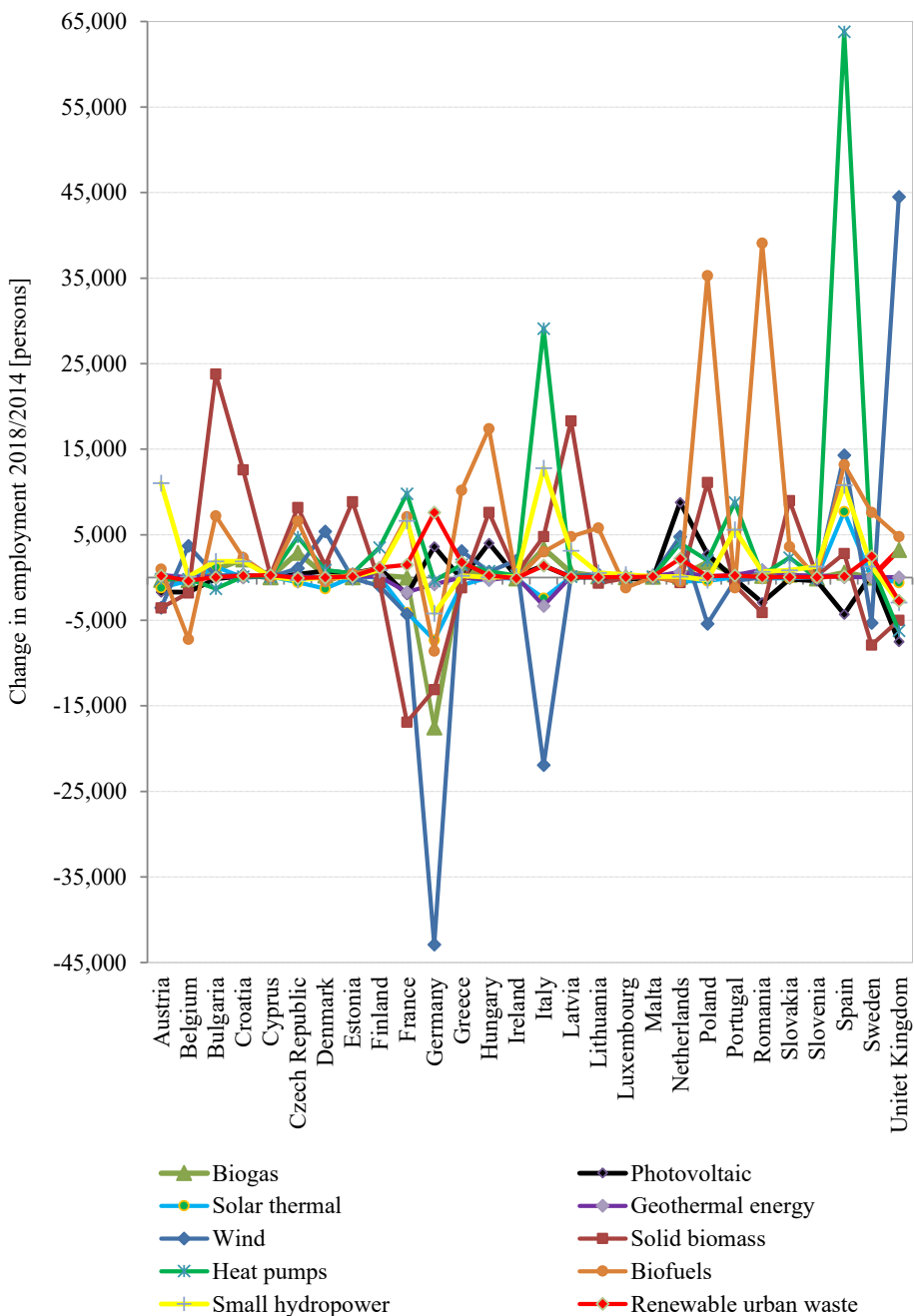


Figure 1. Changes in the number of employees in RES sectors in the EU in 2018 compared to 2014

Source: own study based on [EurObserv'ER 2015, 2019]

France, with 1,700 (65%) and Hungary, with 300 (30%). To partially compensate for the jobs, it is important to point out the development of the sector in Romania and the Netherlands, which employed 900 and 650 people, respectively (an increase of more than 400% in employment compared to 2014). Geothermal heat is used in the horticultural sector, which has a positive impact on socio-economic indicators [IRENA 2019].

The second group with significant increases in the number of employees is the biofuels sector (including biodiesel, bioethanol and biogas for transport in biofuel technologies). The number of employees in this sector increased by 154.80%. It should be noted that the leading countries in terms of employment, such as France for example (ranked 3rd in terms of employment – 29,100 people in 2018), are not necessarily among the largest consumers of biofuels. These include EU Member States with a large area of agricultural land, such as Romania, where employment growth increased by 39,100 jobs, Poland (35,300), Hungary (17,400) or Lithuania (4,800), when comparing 2018 to 2014. Spain (13,200) and Greece (10,200) also experienced significant growth in employment numbers. Poland was the leading employer in 2018 with 41,200 jobs and Romania with 40,000 jobs. Renewable fuel commitments are conditioned by regulations [Klepacka, Mączyńska 2018] that have a decisive impact on the growth of sustainable fuels, including the employment market.

In the case of the biogas sector, stagnation in the market was evident (0.8% growth in 2018 compared to 2014). The largest increases in the number of employees were recorded in Italy and the UK – by 3,400 and 3,250, respectively, which does not compensate for the significant decrease in employment in Germany – 17,500 jobs. Stagnation in the sector was probably due to the growing fear in many EU countries of the use of food crops, such as maize, as energy crops. Additionally, constraints may have been caused by legal and economic conditions, including a lack of support mechanisms for biogas plants (as was the case in Poland [Powałaka et al. 2013, Gostomezyk 2017]). A promising but slowing development trend is biomethane installations (units that directly inject biogas into local gas networks). The European Biogas Association has indicated 500 biomethane installations in Europe, which could successfully influence employment levels in the biogas sector in the future.

More promising was the number of employees in the solid biomass sector (a 17.6% increase). Comparing 2018 to 2014, the largest increases occurred in Bulgaria (an increase of 23,800 jobs), Lithuania (18,300), Croatia (12,600) and Poland (11,100). The significant increases, especially for Bulgaria, can be explained by the conversion of old coal-fired power plants to solid biomass installations. Solid biomass resources are associated with large, forested areas that provide opportunities for its use [Klepacka 2018b]. However, this has not had a positive impact on the labour market, e.g., in the case of Scandinavian countries (a decrease in employment in both Sweden – 29.5% and Finland – 2.5%).

An additional aspect of the reduction in the use of solid biomass is mild winters, which reduce the demand for heat generation.

A significant employment growth was also observed in the heat pump sector (125,750 jobs). Leading countries in employment were Spain (63,800), Italy (29,100) and France (9,800). Significant increases in employment numbers are probably due to the production, sale and installation of heat pumps within the EU. Therefore, this renewable energy source not only contributes to lowering emissions and reducing dependence on fossil fuel imports, but also promotes economic prosperity in member countries.

The small hydropower sector has its origins in the 1960s and 1970s. However, it is only now that the sector is quite directly affected, due to changing weather conditions (mainly rainfall) caused by global warming. Despite this, the sector has generated an increase of 52,900 jobs (107.5%) when comparing the number of employees in 2018 to 2014. Significant increases in employment were recorded in Italy (12,800), Austria (11,050), Spain (10,800) and France (6,650), which significantly compensates for the decrease in employment in Germany (4,200), the UK (2,900) and Poland (300).

The renewable urban waste sector has seen a boom in employment over the years under review (17,400 new jobs in the EU). The largest increases were in Germany (7,600), Sweden (2,500), the Netherlands (2,200), Greece (1,800), France (1,500), Italy (1,400) and Finland (1,150), while significant decreases were recorded in the UK (2,700). Changes in the number of employees were probably due to increased primary energy production from renewable urban waste (e.g., in Germany) or the commissioning of new incineration plants combined with energy efficiency improvements in existing production facilities (e.g., in the UK).

Selected European photovoltaic markets experienced a positive balance in the number of employees (an increase of 2,250 jobs in 2018 compared to 2014). Relevant for the labour market were the Netherlands (up 8,800 – 1,100%), Hungary (4,000 – 800%), Germany (3,600 – 9.4%), Poland (2,750 – 786%), Italy (1,400 – 14%) and Finland (1,100 – 1,100%), which offset declines in the UK (7,500 – 47%), Spain (4,300 – 66%), Romania (2,900 – 73%) or France (2,000 – 11.8%), among others. Employment growth has been driven by a very active residential PV market within the framework of e.g., the “SDE+ programme” (Stimulerend Duurzame Energieproductie) [ECN 2021] in the Netherlands or “Clean Air” in Poland [NFOSiGW 2021]. Prospects for the photovoltaic sector are better noticed than for the wind energy sector. The EU, as the main region for the development of the photovoltaic sector, shows an increasing trend, which, at the same time, will favour the employment trend in the RES sectors.

AN EVALUATION OF THE RELATIONSHIP BETWEEN THE RANKING POSITION AND CHANGE IN THE NUMBER OF EMPLOYEES IN THE RENEWABLE ENERGY SECTORS

In order to recognise the trends of labour market changes in the RES sectors, a correlation or lack thereof was indicated by analysing the three groups adopted, taking into account the increase or decrease in the ranking position and the increase or decrease in the number of employees in EU countries (Table 1). The most numerous groups were group A. A significant number of A-A combinations were recorded in the renewable municipal waste sector (16), biofuels (13), biogas, heat pumps and small hydro (11) and photovoltaics and solar thermal (10). The remaining sources recorded 9 A-A combinations each. For combinations A-B and A-C, which were recorded in the solar thermal sector, the results were insignificant (3 combinations and 2 combinations, respectively).

In group B no B-B combinations were recorded. In contrast, combinations B-A were recorded: in the biogas sector – 5, in the hydro and solid biomass sector – 4, in the photovoltaics, heat pumps and municipal waste sector – 3 and 2 combinations in small hydro and 1 in the biogas sector. For combinations B-C there were double or single combinations (the hydropower sector, solid biomass and photovoltaic, biogas, solar thermal and geothermal).

In group C the highest number of C-C combinations was in the photovoltaic sector (12), solid biomass, and solar thermal (11), biofuels (8), wind energy (7), and heat pumps (6). There were 4 combinations for small hydro, municipal waste and biogas and 3 for geothermal energy. A significant number of combinations C-A were recorded in the sector of municipal waste (11), small hydro (10), heat pumps (8), biofuels (6), biogas (5), solid biomass (4) and in the combination C-B in the sector of geothermal energy (4).

The results of the analysis indicate that there is no clear relationship between the A-A combination and the top ten ranking position. However, more than a dozen A-A combinations per sector were recorded, which would indicate that the relationship between the change in ranking and the change in the number of employees and a country's top ten ranking is significant. Examples of such relationships were the following sectors:

- wind energy: Belgium, the Netherlands and Spain,
- solid biomass: Bulgaria, Croatia, Italy, Lithuania and Poland,
- biogas: Bulgaria, Croatia, Slovakia, Spain and the UK,
- photovoltaics: the Czech Republic, Hungary, the Netherlands and Poland,
- heat pumps: the Czech Republic, Finland, the Netherlands, Portugal and Spain,
- biofuels: Greece, Hungary, Poland and Romania,
- small hydropower plants: Austria, France, Ireland, Lithuania, Portugal and Spain,
- solar thermal collectors: Bulgaria and Spain,

- municipal waste: Finland, Germany and Greece,
- geothermal: Austria, the Netherlands, Portugal, Romania and Slovenia.

A different trend was noted for C-C combinations. The results of the analysis show a correlation between the C-C combination and the position in the second ten in the ranking, compared to the number of C-C combinations and the number in the first and third ten in the ranking of a country. Examples of C-C combinations and position in the second ten in the ranking are the following sectors:

- wind energy: Austria, Finland, Poland, Portugal and Sweden,
- solid biomass: Austria, the Netherlands, Portugal, Romania and the UK,
- biogas: Austria and Belgium,
- photovoltaics: Belgium, Bulgaria, Greece, Portugal and Romania,
- heat pumps: Austria, Bulgaria, Slovenia and the UK,
- biofuels: Belgium,
- solar collectors: the Czech Republic and Poland,
- municipal waste: Belgium and the Czech Republic.

In addition to the presented correlations, it is also important to point out the correlation between the combinations and the leading countries in the ranking. An example is Germany, which was the leader in the number of employees in the five RES sectors. The results of the analysis indicated that it belonged to group C in 50%, to group B in 40% and to group A in 10%. The combination C-C concerned the sectors: biofuels, heat pumps, small hydro, solar collectors and geothermal energy. On the other hand, combination B-C concerned the wind energy sector, biogas and solid biomass and, in the case of combination A-A, the municipal waste sector. The same was the case in France, where the membership of groups C, B, A corresponded to the percentage distribution, as it did in Germany. However, only for the wind, solid biomass, solar collectors and geothermal sectors were the combinations the same. In contrast, for the UK, there was an 80% affiliation to group C, 10% to group B (wind energy) and for the biogas sector to group A.

Thus, it should be concluded that the relationship between the change in ranking position and the change in the number of employees is significant for EU countries, whose ranking positions are both in the first and second ten in the RES sector. However, it has to be kept in mind that the number of employees in the EU RES sectors (issues discussed in section one) was influenced by both legal regulations, financial constraints or agro-environmental conditions. The policy framework, dominant industries and energy mix of the study area play a key role in the employment impact potential of renewable energy [Lambert, Silva 2012]. It should also be added that during the period under study there was an increase in installed capacity (as will be discussed in the next section), mainly in electricity generation technologies such as wind, photovoltaics and solid biomass, which could also have contributed to employment changes in the labour market [Wasiuta 2018].

Table 1. Changes in the ranking position and number of employees in RES sectors in EU countries in 2014 and 2018

Country	Ranking position in		Change in 2018/2014		Ranking position in		Change in 2018/2014	
	2014	2018	position	number of employees	2014	2018	position	number of employees
	wind				solid biomass			
Austria	9	14	C	C	9	16	C	C
Belgium	10	7	A	A	20	23	C	C
Bulgaria	19	20	C	A	21	4	A	A
Croatia	17	17	B	A	15	10	A	A
Cyprus	23	24	C	A	27	26	A	A
Czech Republic	20	16	A	A	11	11	B	A
Denmark	3	3	B	A	16	19	C	A
Estonia	18	22	C	C	18	13	A	A
Finland	16	19	C	C	4	7	C	C
France	5	5	B	C	2	2	B	C
Germany	1	1	B	C	1	1	B	C
Greece	14	9	C	A	22	24	C	C
Hungary	21	18	A	A	14	14	B	A
Ireland	12	11	A	A	25	25	B	A
Italy	4	6	C	C	6	5	A	A
Latvia	24	23	A	A	13	6	A	A
Lithuania	22	21	A	A	19	21	C	C
Luxembourg	25	25	B	A	26	27	C	C
Malta	28	26	A	A	28	28	B	A
Netherlands	15	8	A	A	17	20	C	C
Poland	8	12	C	C	7	3	A	A
Portugal	11	13	C	C	12	17	C	C
Romania	13	15	C	B	10	18	C	C
Slovakia	26	27	C	A	23	15	A	A
Slovenia	27	28	C	A	24	22	A	A
Spain	6	4	A	A	8	9	C	A
Sweden	7	10	C	C	3	8	C	C
United Kingdom	2	2	B	A	5	12	C	C

Table 1. Cont.

Country	Ranking position in		Change in 2018/2014		Ranking position in		Change in 2018/2014	
	2014	2018	position	number of employees	2014	2018	position	number of employees
	biogas				photovoltaic			
Austria	9	18	C	C	8	9	C	C
Belgium	8	19	C	C	9	12	C	C
Bulgaria	23	10	A	A	14	18	C	C
Croatia	24	7	A	A	22	20	A	A
Cyprus	25	23	A	A	23	21	A	B
Czech Republic	5	5	B	A	12	10	A	A
Denmark	12	16	C	A	13	13	B	A
Estonia	26	24	C	A	28	19	A	A
Finland	15	17	C	A	24	15	A	A
France	3	4	C	B	2	2	B	C
Germany	1	1	B	C	1	1	B	A
Greece	18	11	A	A	10	11	C	C
Hungary	19	13	A	A	16	6	A	A
Ireland	13	22	C	C	25	22	A	A
Italy	2	2	B	A	4	4	B	A
Latvia	16	12	A	A	26	25	A	A
Lithuania	20	20	B	A	27	26	A	A
Luxembourg	27	25	A	A	21	27	C	C
Malta	28	26	A	A	18	23	C	C
Netherlands	10	14	C	A	6	3	A	A
Poland	6	6	B	A	20	7	A	A
Portugal	14	15	C	A	11	14	C	C
Romania	21	21	B	A	7	16	C	C
Slovakia	7	9	A	A	19	24	C	C
Slovenia	17	27	C	C	17	28	C	C
Spain	11	8	A	A	5	8	C	C
Sweden	22	28	C	B	15	17	C	A
United Kingdom	4	3	A	A	3	5	C	C

Table 1. Cont.

Country	Ranking position in		Change in 2018/2014		Ranking position in		Change in 2018/2014	
	2014	2018	position	number of employees	2014	2018	position	number of employees
	heat pumps				biofuels			
Austria	11	16	C	C	15	19	C	A
Belgium	9	10	C	C	4	20	C	C
Bulgaria	12	19	C	C	21	12	A	A
Croatia	23	23	B	A	23	17	A	A
Cyprus	24	24	B	A	26	25	A	A
Czech Republic	16	9	A	A	12	11	A	A
Denmark	13	11	A	A	14	21	C	C
Estonia	14	15	C	A	27	22	A	A
Finland	10	8	A	A	10	16	C	A
France	1	2	C	A	2	3	C	A
Germany	2	4	C	C	1	6	C	C
Greece	25	17	A	A	17	7	A	A
Hungary	19	18	A	A	18	5	A	A
Ireland	18	20	C	A	20	24	C	C
Italy	3	3	B	A	6	10	C	A
Latvia	26	25	C	A	25	14	A	A
Lithuania	20	26	C	A	22	13	A	A
Luxembourg	21	27	C	A	13	26	C	C
Malta	27	28	C	A	28	27	A	A
Netherlands	8	6	A	A	9	18	C	C
Poland	15	12	A	A	5	1	A	A
Portugal	6	5	A	A	11	23	C	C
Romania	28	22	A	A	16	2	A	A
Slovakia	22	13	A	A	19	15	A	A
Slovenia	17	21	C	C	24	28	C	C
Spain	7	1	A	A	3	4	C	A
Sweden	5	7	C	A	8	8	B	A
United Kingdom	4	14	C	C	7	9	C	A

Table 1. Cont.

Country	Ranking position in		Change in 2018/2014		Ranking position in		Change in 2018/2014	
	2014	2018	position	number of employees	2014	2018	position	number of employees
	small hydropower				solar thermal			
Austria	2	1	A	A	4	4	B	C
Belgium	17	21	C	A	11	16	C	C
Bulgaria	14	12	A	A	21	7	A	A
Croatia	18	13	A	A	15	12	A	B
Cyprus	26	23	A	A	16	11	A	A
Czech Republic	10	15	C	C	9	13	C	C
Denmark	23	24	C	A	7	9	A	C
Estonia	24	25	C	A	22	17	A	A
Finland	15	16	C	A	23	18	A	A
France	5	4	A	A	2	5	C	C
Germany	1	6	C	C	1	2	C	C
Greece	8	11	C	A	5	6	C	C
Hungary	22	26	C	B	17	14	A	B
Ireland	19	22	C	A	14	19	C	C
Italy	4	2	A	A	3	8	C	C
Latvia	20	8	A	A	24	20	A	A
Lithuania	25	19	A	A	25	21	A	A
Luxembourg	21	20	A	A	26	22	A	A
Malta	27	27	B	A	27	23	A	A
Netherlands	28	28	B	A	10	24	C	C
Poland	12	18	C	C	6	3	A	C
Portugal	9	5	A	A	12	10	A	B
Romania	7	9	C	A	18	25	C	C
Slovakia	16	17	C	A	19	26	C	C
Slovenia	13	14	C	A	28	27	A	A
Spain	11	3	A	A	13	1	A	A
Sweden	6	7	C	A	20	28	C	B
United Kingdom	3	10	C	C	8	15	C	C

Table 1. Cont.

Country	Ranking position in		Change in 2018/2014		Ranking position in		Change in 2018/2014	
	2014	2018	position	number of employees	2014	2018	position	number of employees
	renewable urban waste				geothermal energy			
Austria	NA	14	A	A	8	6	A	A
Belgium	7	18	C	C	14	13	A	A
Bulgaria	13	19	C	A	15	11	A	A
Croatia	NA	15	A	A	9	14	C	B
Cyprus	NA	13	A	A	21	15	A	A
Czech Republic	9	16	C	C	22	16	A	A
Denmark	5	9	C	B	10	17	C	B
Estonia	NA	20	A	A	23	18	A	A
Finland	14	8	A	A	24	19	A	A
France	6	6	B	A	2	3	C	C
Germany	NA	1	A	A	3	9	C	C
Greece	NA	7	A	A	11	20	C	B
Hungary	12	12	B	A	4	5	C	C
Ireland	11	21	C	C	25	21	A	A
Italy	3	5	C	A	1	1	B	C
Latvia	15	22	C	A	26	22	A	A
Lithuania	16	23	C	A	12	23	C	B
Luxembourg	17	24	C	A	27	24	A	A
Malta	NA	25	A	A	28	25	A	A
Netherlands	2	3	C	A	6	4	A	A
Poland	18	17	A	A	16	12	A	A
Portugal	10	11	C	A	13	7	A	A
Romania	19	26	C	A	5	2	A	A
Slovakia	20	27	C	A	7	8	C	A
Slovenia	21	28	C	A	17	10	A	A
Spain	8	10	C	A	18	26	C	A
Sweden	4	4	B	A	19	27	C	A
United Kingdom	1	2	C	C	20	28	C	A

Source: own study based on [EurObserv'ER 2015, 2019]

AN EVALUATION OF THE RELATIONSHIP BETWEEN THE NUMBER OF EMPLOYEES AND INSTALLED POWER CAPACITY

For the analysis of the relationship between the number of employees and installed power capacity, three leading renewable sources were adopted: wind energy, photovoltaics and solid biomass. The results on changes in the number of employees in the RES sectors are presented in the earlier section. However, comparing 2018 to 2014, significant changes in installed capacity were recorded for wind and photovoltaic energy in Germany (16,387 MW and 6,945 MW), the UK (6,548 MW and 7,694 MW) and France (4,431 MW and 3,963 MW). In contrast, for solid biomass, there were increases in installed capacity in the UK and France (9680 GWh and 2,036 GWh) and decreases in installed capacity in

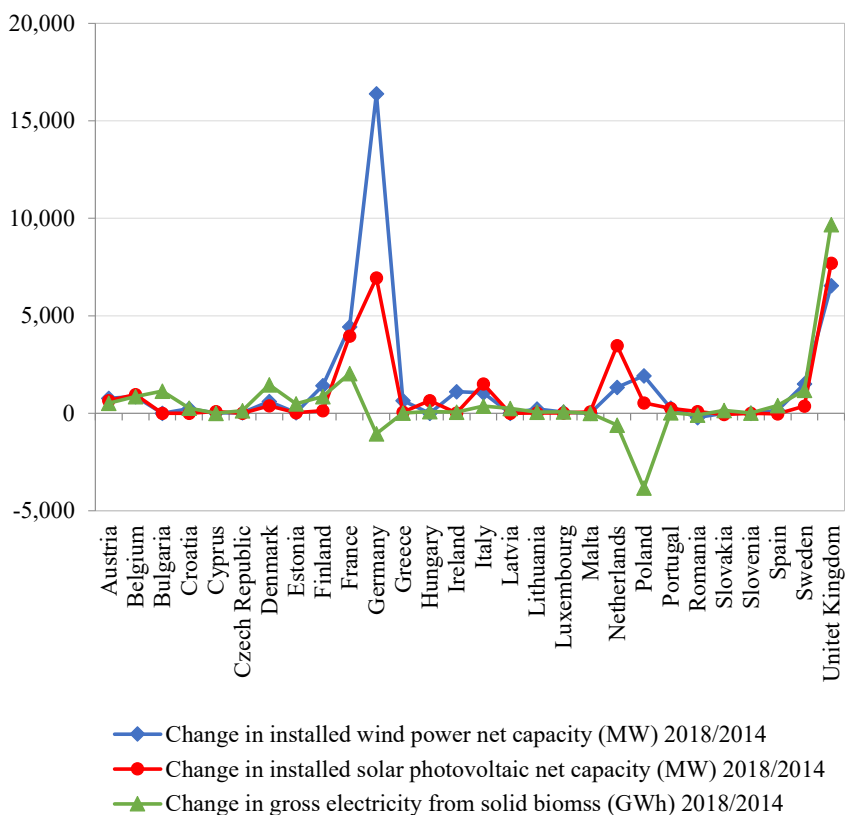


Figure 2. Changes in installed capacity in selected RES sectors in the EU in 2018 compared to 2014

Source: own study based on [EurObserv'ER 2015, 2019]

Table 2. Pearson's correlation between the number of employees and the installed capacity of wind energy, photovoltaics and solid biomass investments and the *p-value* in 2014 and 2018

	2014e_w	2018e_w	2014p_w	2018p_w	2014e_pv	2018e_pv
2014e_w	10.0000	0.8910	0.9057	0.9472	0.9226	0.9065
	p = ---	p = 0.000	p = 0.000	p = 0.000	p = 0.000	p = 0.000
2018e_w	0.8910	1.000	0.8683	0.9013	0.8634	0.7611
	p = 0.000	p = ---	p = 0.000	p = 0.000	p = 0.000	p = 0.000
2014p_w	0.9057	0.8683	1.000	0.9878	0.8882	0.8208
	p = 0.000	p = 0.000	p = ---	p = 0.000	p = 0.000	p = 0.000
2018p_w	0.9472	0.9013	0.9878	1.000	0.9333	0.8760
	p = 0.000	p = 0.000	p = 0.000	p = ---	p = 0.000	p = 0.000
2014e_pv	0.9226	0.8634	0.8882	0.9333	1.000	0.9444
	p = 0.000	p = 0.000	p = 0.000	p = 0.000	p = ---	p = 0.000
2018e_pv	0.9065	0.7611	0.8208	0.8760	0.9444	1.000
	p = 0.000	p = 0.000	p = 0.000	p = 0.000	p = 0.000	p = ---
2014p_pv	0.9326	0.7464	0.8531	0.8824	0.9040	0.9062
	p = 0.000	p = 0.000	p = 0.000	p = 0.000	p = 0.000	p = 0.000
2018p_pv	0.9469	0.8158	0.8679	0.9082	0.9521	0.9406
	p = 0.000	p = 0.000	p = 0.000	p = 0.000	p = 0.000	p = 0.000
2018p_pv	0.6858	0.5926	0.7060	0.7436	0.7868	0.7269
	p = 0.000	p = 0.001	p = 0.000	p = 0.000	p = 0.000	p = 0.000
2018e_sb	0.4918	0.3789	0.5055	0.5250	0.5211	0.5074
	p = 0.008	p = 0.047	p = 0.006	p = 0.004	p = 0.004	p = 0.006
2014p_sb	0.5831	0.6695	0.5739	0.6175	0.5421	0.4874
	p = 0.001	p = 0.000	p = 0.001	p = 0.000	p = 0.003	p = 0.009
2018p_sb	0.4930	0.7056	0.4953	0.5393	0.5168	0.3861
	p = 0.008	p = 0.000	p = 0.007	p = 0.003	p = 0.005	p = 0.042

Table 2. Cont.

	2014p_pv	2018p_pv	2018e_sb	2018e_sb	2014p_sb	2018p_sb
2014e_w	0.9326	0.9469	0.6858	0.4918	0.5831	0.4930
	p = 0.000	p = 0.000	p = 0.000	p = 0.008	p = 0.001	p = 0.008
2018e_w	0.7464	0.8158	0.5926	0.3789	0.6695	0.7056
	p = 0.000	p = 0.000	p = 0.001	p = 0.047	p = 0.000	p = 0.000
2014p_w	0.8531	0.8679	0.7060	0.5055	0.5739	0.4953
	p = 0.000	p = 0.000	p = 0.000	p = 0.006	p = 0.001	p = 0.007
2018p_w	0.8824	0.9082	0.7436	0.5250	0.6175	0.5393
	p = 0.000	p = 0.000	p = 0.000	p = 0.004	p = 0.000	p = 0.003
2014e_pv	0.9040	0.9521	0.7868	0.5211	0.5421	0.5168
	p = 0.000	p = 0.000	p = 0.000	p = 0.004	p = 0.003	p = 0.005
2018e_pv	0.9062	0.9406	0.7269	0.5074	0.4874	0.3861
	p = 0.000	p = 0.000	p = 0.000	p = 0.006	p = 0.009	p = 0.042
2014p_pv	1.000	0.9859	0.6536	0.5058	0.4544	0.3512
	p = ---	p = 00.00	p = 0.000	p = 0.006	p = 0.015	p = 0.067
2018p_pv	0.9859	1.000	0.6952	0.5125	0.5235	0.4532
	p = 00.00	p = ---	p = 0.000	p = 0.005	p = 0.004	p = 0.015
2018p_pv	0.6536	0.6952	1.000	0.7597	0.6801	0.5987
	p = 0.000	p = 0.000	p = ---	p = 0.000	p = 0.000	p = 0.001
2018e_sb	0.5058	0.5125	0.7597	1.000	0.5481	0.4381
	p = 0.006	p = 0.005	p = 0.000	p = ---	p = 0.003	p = 0.020
2014p_sb	0.4544	0.5235	0.6801	0.5481	1.000	0.9266
	p = 0.015	p = 0.004	p = 0.000	p = 0.003	p = ---	p = 0.000
2018p_sb	0.3512	0.4532	0.5987	0.4381	0.9266	1.000
	p = 0.067	p = 0.015	p = 0.001	p = 0.020	p = 0.000	p = ---

Source: own study based on [EurObserv'ER 2015, 2019]

Poland and Germany (3,828 GWh and 1,041 GWh, respectively) (Figure 2). The results of the statistical analysis indicated a significant relationship and *p-value* significance in 11 out of 12 variables accepted for correlation (the exception was the relationship between installed capacity in the photovoltaic sector in 2014 and installed capacity in the solid biomass sector in 2018) (Table 2). The results of the analysis confirm previous studies conducted in this area [e.g., Gradziuk 2017, P. Gradziuk, B. Gradziuk 2017, P. Gradziuk, B. Gradziuk 2018].

SUMMARY

Among the 10 RES sectors discussed, comparing 2018 to 2014, employment decreased in three sectors: wind energy, solar panels and geothermal. Employment growth, on the other hand, was recorded in the sectors: biofuels, heat pumps, small hydro, municipal waste, solid biomass, photovoltaics and biogas. The largest decreases in employment were observed among countries which are leaders in the RES market (e.g., Germany and France), while the largest increases were determined by the potential for development of the source in a given country, e.g., biofuels in Romania, Poland, Hungary or Lithuania.

After recognising the changes that occurred in the number of employed people in EU countries in the years analysed, there are several significant reasons. The increase in the number of jobs was influenced, inter alia, by: EU support programmes, which encouraged the development of photovoltaics (e.g., in the Netherlands and Poland); increased primary energy production in the renewable urban waste sector (e.g., in Germany); the development of new technologies, e.g., biomethane installations in Europe; and the development of the heat pump market, which not only contributes to lower emissions and reduces dependence on fossil fuel imports, but also promotes economic prosperity in the Member States. In contrast, job losses were due to, among others: plant closures or job cuts in the wind energy sector (e.g., in Germany); commissioning new solid biomass incinerators combined with energy efficiency improvements in existing production facilities (e.g., in the UK); high initial investment costs in the solar thermal sector; growing public resistance and strict regulations on the minimum distance between wind turbines.

The conducted pair-wise comparison analysis indicated that the relationship between the change in ranking position and the change in the number of employees is significant for EU countries whose ranking positions are both in the first (combination AA – I) and second ten (combination CC – II) in the RES sector. Moreover, the results of the statistical analysis indicated a significant relationship and *p-value* significance in 11 out of 12 variables adopted for correlation, covering the number of employed and installed capacity in selected RES sectors in 2014 and 2018.

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TENDENCJE W ZATRUDNIENIU W SEKTORZE ODNAWIALNYCH ŹRÓDEŁ ENERGII

Słowa kluczowe: zatrudnienie, odnawialne źródła energii, ranking, metoda porównawcza parami, Unia Europejska

ABSTRAKT

Celem artykułu jest rozpoznanie zmian, jakie zaszły w liczbie zatrudnionych w krajach Unii Europejskich (UE) w sektorze odnawialnych źródeł energii w roku 2018 w stosunku do roku 2014. Źródłem danych dotyczących zatrudnienia oraz mocy dla wybranych źródeł energii odnawialnej były roczniki EurObserv'ER. W artykule wykorzystano metodę opisową oraz porównawczą parami. Największe spadki w zatrudnieniu odnotowano wśród krajów, które są liderami na rynku OZE (np. Niemcy, Francja). Natomiast największe wzrosty zatrudnienia uwarunkowane były możliwością rozwoju źródła w danych kraju, np. biopaliw w Rumunii, w Polsce, na Węgrzech i na Litwie. W ramach przeprowadzonego porównania parami wskazano, że relacja zmiany pozycji w rankingu i zmiany liczby zatrudnionych była znacząca dla krajów UE, których pozycje w rankingu znajdują się zarówno w pierwszej (kombinacja AA – I), jak i w drugiej dziesiątce (kombinacja CC – II) w sektorze OZE. Ponadto, wyniki analizy statystycznej wskazały na znaczącą zależność oraz istotność *p-value* w 11 na 12 zmiennych przyjętych do korelacji, obejmujących liczbę zatrudnionych i zainstalowaną moc w wybranych sektorach OZE w latach 2014 i 2018.

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