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## **TRENDS IN THE DEVELOPMENT OF THE GLOBAL RENEWABLE ENERGY MARKET**

*JEL Codes: Q 42*

**Summary:** Global development of renewable energy sources (RES) is a global and irreversible trend. The basic factor contributing to the development of the global renewable energy market are the objectives related to climate policy and environmental protection. Technological development and the potential of renewable sources mean that RES will be the most frequently installed source of energy in the world in the coming years. Renewable energy enables the diversification of energy sources. It promotes increased security and increased competitiveness. The creation of “clean-green” technologies also favors the creation of new industries and new jobs. They are conducive to economic growth, increased exports and the development of specialist knowledge. On the basis of renewable energy sources, new connections between science, investments in infrastructure, production and logistics as well as economic models that allow achieving goals are created. The aim of the article is to present the state of development of the global market for renewable energy sources, taking into account the share of individual technologies, dynamics of changes, employment in RES, investment and costs. The research material was the reports of international organizations analyzing the renewable energy market and Eurostat statistical materials. Research methods used in the work include the analysis and synthesis of reports, documents, and normative acts. These analyzes allowed to assess the development of the global RES market and the participation of individual regions and countries in it. They allowed to formulate trends, forecasts and trends in the development of the global RES market in the coming years. The analyzes and syntheses performed prove that the industries related to renewable energy sources have favorable development conditions in the future.

**Key words:** RES market, investments in RES, employment in RES, climate policy.

### **1. INTRODUCTION**

According to the findings included in the reports of the International Energy Agency (IEA), the development of renewable energy sources (RES) is a global and irreversible trend. The basic factors that contribute to the development of

the global renewable energy market are the objectives of the climate policy and environmental protection. Because of the technological development and the potential of renewable energy sources, RES are going to be the most frequently installed sources of energy in the world in the nearest future.

In the past, it was believed that only rich countries can afford to develop RES. However, the forecasts show that developing countries are going to dominate as regards renewable energy investments within the next few years, and are to account for two thirds of the global growth of the renewable energy potential, of which China is to account for 40% of the new capacity. The technological progress resulting in the reduction of costs worldwide causes the renewable energy market to change continuously. Therefore, it is important to understand the current and future trends, to notice opportunities, to minimise risks and to introduce business models, which are attractive to potential investors and make it possible to achieve the set goals with lower economic and social costs. The experiences of certain countries (Germany, Scandinavian countries) show that the replacement of fossil fuels with renewable energy requires an effective policy, which can be implemented with a high level of social acceptance. It is most often a combination of the following factors: a) social, environmental and economic ones; b) technological ones, and c) legislative ones (above all support schemes and legal stability).

Renewable energy allows diversification of energy sources. It fosters security enhancement and growth of competitiveness. The development of “clean and green” technologies also favours the creation of new branches of industry and new jobs. They, in turn, are conducive to economic growth, an increase of exports and the development of expertise. Renewable energy forms the grounds for new relations between science, investments in infrastructure, production, logistics, and economic models enabling the achievement of the set goals.

The global renewable energy market is becoming more and more complex because of, among other things, its mass nature and the abundance of technologies differing considerably in terms of their advancement, costs and results achieved. The overall profile of this market is influenced, *inter alia*, by the following qualities:

1. the amount, structure and dynamics of the installed capacity,
2. the amount and structure of the generated energy,
3. the efficiency of capacity utilization,
4. the share of renewable energy in total energy consumption,
5. the volume and structure of employment in the renewable energy sectors (direct and indirect),
6. the level of greenhouse gas emissions reduction,
7. the level of investment and exploitation prices, as well as the costs of energy,
8. the number and structure of renewable power plant manufacturers.

The aim of the article is to present the state of development of the global renewable energy market, taking into account the share of individual tech-

nologies, the dynamics of changes, the level of employment in the renewable energy sector, as well as investments and costs incurred. The research material was made up of the reports of international organisations analysing the renewable energy market and the statistical materials provided by Eurostat. The research methods applied in this study include analyses and syntheses of reports, documents and normative acts. These analyses made it possible to assess the development of the global renewable energy market and the share of individual regions and countries in this market. As a result, forecasts and trends in the development of the global renewable energy market for the next few years could be formulated. The presented materials constitute the basis for further and deepened analyses.

## **2. RENEWABLE ENERGY MARKET**

The global energy transformation is taking place with a considerable share of renewable energy sources. The key stimuli to renewable energy growth are the politicians' commitments as regards decarbonisation, diversification of energy sources and new rules of financing. Thanks to the forecasted growth of the renewable energy production potential, its share in the global energy mix is to increase from 22% in 2013 to 26% in 2020 and 28% in 2021 (Renewable Energy Market Report 2015). In 2015, the production of RES electricity increased by 153 GW. This was possible because of the record growth of the onshore wind power market (63 GW) and the photovoltaics (PV) market (49 GW). For the first time, RES accounted for more than a half of annual net power grid connections. In 2016, the global renewable energy production increased by 161 GW, i.e. by 8.7%, and the global renewable energy generation capacity reached the level of 2,006 GW (2,195 GW in 2017) (Renewable Capacity Statistics 2018). In the medium term, solar and wind technologies account for 75% of the increase of renewable energy capacity share in electricity generation. The reports prepared by the Frankfurt School and Bloomberg New Energy Finance prove that investors are spending less and less money and receiving more and more energy. In 2016, investments in solar energy, wind power, biomass energy, geothermal energy, small hydroelectric power plants and energy from the sea soaked up 241.6 billion dollars, i.e. by 23% less in comparison with the year before. At the same time, the installed capacity was 138.5 GW, which was by 9% more than in the previous year. This prevented the emission of 1.7 gigaton of CO<sub>2</sub> in 2016 only.

In 2017, conventional sources of energy accounted for 73.5% and renewable sources for 26.5% of the global electricity production. Hydropower accounted for 16.4% of this share, wind power for 5.6%, biomass energy for 2.2%, photovoltaics for 1.9%, and other sources (CSP, tidal power, geothermal energy) for 0.4%.

**Table 1. Global installed capacity of renewable energy sources in 2015**

Specification	Installed capacity Amount [in MW]
Hydropower plants – in total	1,210,095
■ small ≤1 MW	30,942
■ medium 1- 10 MW	116,944
■ large ≥ 10 MW	907,119
Wind power – in total	416,072
■ onshore	404,791
■ offshore	11,281
Solar energy – in total	224,684
■ photovoltaics	219,868
■ CSP	4,816
Bioenergy – in total	98,170
■ solid biomass	81,380
■ municipal waste	12,060
■ liquid biofuels	2,048
■ biogas	14,741
Geothermal energy	11,757

Source: compiled on the basis of Renewable Energy Statistics 2017 and BP Statistical Review of World Energy 2017.

**Table 2. Total global renewable energy production capacity by technology in 2007-2017 [in MW]**

Year	Hydropower	Wind power	Solar energy	Biomass energy	Geothermal energy
2007	926,340	93,560	9,260	49,863	9,136
2008	960,233	119,571	15,306	53,897	9,454
2009	994,062	150,127	23,502	60,832	9,897
2010	1,027,030	182,860	40,405	67,039	10,118
2011	1,058,518	222,116	71,682	72,415	10,008
2012	1,091,609	271,983	102,199	78,858	10,468
2013	1,135,430	303,984	139,617	85,818	10,737
2014	1,170,772	350,637	177,210	91,768	11,189
2015	1,210,095	416,072	224,684	98,170	11,757
2016	1,245,708	467,091	295,933	106,940	12,647
2017	1,270,496	513,939	390,625	109,213	12,894

Source: compiled on the basis of Renewable Energy Statistics 2017 and Renewable Capacity Statistics 2018.

The structures of the installed capacity on the global renewable energy market differ from the production volume structures. This is connected with the productivity and number of operating hours in a year. In this respect, photovoltaic

plants operate for the smallest number of hours, i.e. around 1,000-1,500 hours in a year (excluding night and winter hours). Because of the wind speed limits, wind turbines generate electricity for 2,000-3,000 hours in a year. However, currently, the majority of generators are provided with continuously variable transmissions, and this makes it possible to make use of lower start-up speeds. As a result of these construction changes, new wind power plants generate electricity for 3,200-3,800 hours in a year. The trends related to the changes in technical parameters affect, and shall affect to a greater extent in the future, the process of reducing unit costs of electricity generation. The plant capacity is highly influenced by the size and location of the plants.

**Table 3. Economic, technological and location parameters characterising renewable energy sources**

Specification	Typical investment costs of the system [USD 2015/kW]	Number of operating hours in a year	Operating period (economically justified [in years])
Biomass (plants dedicated to electricity generation)	800 – 4,500	7,000	20
Hydropower plants			
Small	1,300 – 2,500	2,200 – 6,600	35
Large	2,030 – 3,500	2,200 – 6,600	35
Geothermal power plants			
Small	2,000 – 5,000	7,450	35
Binary	2,400 – 5,600	7,450	35
Offshore wind power			
China	3,500 – 3,800	2,950	25
Germany	4,300 – 5,000	3,850	25
USA	4,400 – 4,900	3,850	25
Onshore wind power			
China	1,125 – 1,250	1,900	25
Germany	1,600 – 1,900	2,000	25
Japan	2,300 – 2,600	2,200	25
USA	1,650 – 1,850	2,950	25
PV – commercial			
China	1,250 – 1,500	1,050	20
Germany	1,300 – 1,500	1,050	20
Japan	2,400 – 2,700	1,075	20
USA	3,000 – 3,400	1,300	20
PV – residential			
China	1,500 – 1,700	1,050	20
Germany	1,650 – 1,900	1,050	20
Japan	2,900 – 3,200	1,075	20
USA	3,900 – 4,200	1,300	20

Source: compiled on the basis of Renewable Energy Market Report 2016.

The regional diversity as regards the costs and environmental conditions has an influence on uneven development of RES in individual countries and regions. In 2016, the highest installed capacity of renewable power plants was in the following countries: 1. China – 545,916 MW, 2. the USA – 214,766 MW, 3. Brasil – 122,951 MW, 4. Germany – 104,704 MW and 5. India – 90,748 MW. The countries with the highest installed capacity of hydropower plants were: 1. China – 333,650 MW, 2. the USA – 102,719 MW, 3. Brasil – 98,009 MW, 4. Canada – 80,960 MW and 5. India – 47,587 MW. In comparison with other technologies, this technology recorded the lowest growth of the installed capacity in 2007-2016. The countries with the highest installed capacity of wind power plants were as follows: 1. China – 148,983 MW, 2. the USA – 81,312 MW, 3. Germany – 49,747 MW, 4. India – 28,875 MW, and 5. Spain – 22,992 MW. A considerable part of the installed wind power capacity is the capacity of onshore wind farms, but the next few years are going to be characterised by a dynamic growth of offshore wind power plants. They are definitely larger and show a higher efficiency of installed capacity utilization. Over the recent years, the highest growth dynamics of the installed capacity was recorded for solar power plants. In 2016, the countries with the highest installed capacity of solar power plants included: 1. China – 77,802 MW, 2. Japan – 41,600 MW, 3. Germany – 40,988 MW, 4. the USA – 34,711 MW and 5. Italy – 19,251 MW. The ranking of countries is different when it comes to the structure of installed bioenergy capacity. It is as follows: 1. Brasil – 14,179 MW, 2. the USA – 12,458 MW, 3. China – 12,140 MW, 4. Germany – 8,201 MW, 5. Great Britain – 4,965 MW and 6. Sweden – 4,935 MW. Because of natural conditions, the list of countries with geothermal power plants is relatively short. Here, the ranking is as follows: 1. the USA – 2,512 MW, 2. Thailand – 1,916 MW, 3. Indonesia – 1534 MW, 4. New Zealand – 986 MW, and 5. Mexico – 909 MW.

For years now, the leading producers of renewable energy have been the European countries, and, in particular, the member states of the European Union. In 2016, Europe accounted for 485,465 MW (24%), with the European Union accounting for 421,220 MW (21%), of the global installed capacity of renewable energy sources amounting to 2,011,332 MW. As regards hydropower, Europe accounts for 26.9% of the installed capacity, with the EU accounting for 12.4%. In the case of wind power, Europe accounts for 33.3% of the installed capacity, with the EU's share of 32.9%. Europe dominates the global offshore wind power market. Here, the total installed capacity was 14,085 MW, of which Europe and the member states of the European Union accounted for 12,476 MW (88.6% of the global capacity). In the case of solar energy (291,064 MW), Europe's share was 35.1% (102,282 MW), and the EU's share was 34.3%. Europe's share in the installed capacity of bioenergy plants was 33.2%, i.e. 35,515 MW (the EU – 32.8%). Moreover, Europe has a high share in the installed capacity of biogas plants. The global installed capacity of this technology amounts to 15,752 MW, of which Europe accounts for 67.5%, i.e. 10,640 MW, including the European Union's share of 66.9% (10,533 MW). In the next few years, the EU is going

to focus on solar and wind technologies, and, in particular, on offshore farms. In the case of these two technologies, the annual percentage growth of production exceeds the installed capacity growth. This means that the efficiency of the wind and solar technologies increases every year. For this reason, the majority of countries have adopted an auction system, in which the reference prices and planned auctions favour the said technologies. Economic reasons are also of great importance. The continuous technological progress causes the wind and solar energy to be competitive to conventional energy. For example, in Germany, there are days (when there are good wind and solar conditions) when all the electricity consumed comes from renewable sources.

**Table 4. Changes in the share of renewable energy in the global energy production**

Specification	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Change in the renewable energy capacity as % of the global generation capacity change (net) [%]	20	27	42	32	40	49	39	41	47	57	61
Renewable energy as % of the global energy capacity [%]	7.5	8.2	9.2	10.2	11.4	11.9	13.0	14.3	15.7	17.3	19.0
Renewable energy as % of the global energy production [%]	5.2	5.3	5.9	6.1	6.9	8.0	8.6	9.2	10.0	11.0	12.1

Source: compiled on the basis of Global Trends In Renewable Energy Investment (2018).

The increasing share of renewable energy is influenced mainly by wind and solar technologies. They are characterised by a high annual growth of capacity resulting from the current structure of funds invested in RES. Moreover, solar power plants are the most popular source of consumer renewable energy.

**Table 5. Annual capacity growth of solar and wind power plants in 2007-2017**

Year	Solar PV		Solar thermal		Wind power	
	Annual growth [GW]	Year-to-year growth [GW]	Annual growth [GW]	Year-to-year growth [GW]	Annual growth [GW]	Year-to-year growth [GW]
2007	8	25	145	20	94	20
2008	15	66	170	25	121	27
2009	23	8	203	33	159	38
2010	40	17	242	39	198	39
2011	70	31	285	43	238	41
2012	100	29	330	45	283	45

cd. Table 5.

Year	Solar PV		Solar thermal		Wind power	
	Annual growth [GW]	Year-to-year growth [GW]	Annual growth [GW]	Year-to-year growth [GW]	Annual growth [GW]	Year-to-year growth [GW]
2013	137	38	374	44	319	36
2014	177	40	409	35	370	52
2015	228	51	435	26	433	64
2016	303	76	456	21	487	55
2017	402	98	472	16	539	52

Source: compiled on the basis of Renewables 2018.

The further capacity growth of renewable energy sources shall be a derivative of the amount of funds at the disposal of private investors (including prosumers) and the opportunity to provide public support for such investments. An important factor powering the economy in the RES sector is the state of development of industries involved in the manufacture of renewable power plants. Due to the current high level of this development, renewable power plants are becoming more and more important for the global exports and imports.

### 3. EMPLOYMENT

Activities related to renewable energy production are among the relatively new spheres of business activity, which has resulted in the creation of a new labour market. The knowledge about employment in the renewable energy sector is provided in the reports of the International Renewable Energy Agency (IRENA), which analyse the situation in individual countries and different branches of the renewable energy sector. In 2017, there were 10.3 million people employed in the renewable energy sector worldwide, which denotes an increase by 5.3% in comparison with 2016, when the employment level was 9.8 million.

Table 6. Global employment in renewable energy sectors in 2012-2016 [in million people]

RES sector	2012	2013	2014	2015	2016
Photovoltaics (PV)	1.36	2.27	2.49	2.77	3.09
Biomass	2.40	2.50	2.99	2.88	2.74
Wind power	0.75	0.83	1.03	1.08	1.16
Solar thermal energy	0.89	0.50	0.76	0.94	0.83
Large hydropower plants	1.41	1.74	1.66	1.63	1.52
Other renewable energy technologies	0.33	0.38	0.40	0.40	0.45
Total	7.14	8.22	9.33	9.70	9.78

Source: compiled on the basis of Renewable Energy and Jobs (2017), Annual Review, IRENA.



Definitely, the sector accounting for the largest number of jobs on the global renewable energy market is photovoltaics, with the employment level of 3.09 million people in 2016. This number keeps on increasing thanks to the rapid pace of the global photovoltaic market development. In the biomass sector, which covers solid biomass, liquid biofuels and biogas, the level of employment was 2.74 million people. A sector with high growth dynamics of employment is the wind power sector, in which, in 2016, the rate of employment was 1.16 million people, with China accounting for nearly a half of this number. China is becoming an increasingly more important manufacturer of wind power plants, and the Chinese Goldwind has become the major provider of such plants regarding the potential of orders completed.

**Table 7. Direct and indirect employment on the global renewable energy market by technology and country in 2016 [million people]**

Type of technology	World-wide	China	Brasil	USA	India	Japan	Germany	France	Other EU member states
Photovoltaics (PV)	3.095	1.962	0.004	0.242	0.121	0.302	0.032	0.016	0.067
Liquid biofuels	1.724	0.051	0.783	0.284	0.035	0.003	0.023	0.022	0.048
Large hydropower plants	1.519	0.312	0.183	0.028	0.236	0.018	0.006	0.009	0.046
Wind power	1.155	0.509	0.032	0.103	0.061	0.005	0.143	0.022	0.165
Solar energy (heating/cooling)	0.828	0.690	0.043	0.013	0.014	0.007	0.010	0.055	0.20
Solid biomass	0.723	0.180	-	0.080	0.058	-	0.045	0.050	0.238
Biogas	0.333	0.145	-	0.007	0.085	-	0.045	0.004	0.015
Small hydropower plants	0.211	0.095	0.012	0.009	0.012	-	0.007	0.004	0.035
Geothermal energy	0.182	-	-	0.035	-	0.002	0.017	0.038	0.062
CSP	0.023	0.011	-	0.005			0.001		0.003
Total	9.823	3.955	1.058	0.806	0.621	0.330	0.340	0.171	0.714

Source: compiled on the basis of Renewable Energy and Jobs (2017), Annual Review, IRENA.

The top employer in the renewable energy sector worldwide is China. This country accounts for 43% of the global labour market in the renewable energy sector. This is the result of, above all, direct and indirect employment in the

photovoltaics branch, in which China is an important exporter. In Brasil, which is ranked second in terms of employment in the renewable energy sector, the highest level of employment is recorded for the production of sugarcane-based liquid biofuels. In the European Union, for many years now, the leader in employment in the renewable energy sector has been Germany. Great Britain is ranked second, and France third. The next largest employers are respectively Poland, Spain and Italy. In the European Union, the highest level of employment in the renewable energy sector is recorded in the case of biomass acquisition and processing, as well as wind power production. This is respectively 389 thousand and 344 thousand jobs. Moreover, in 2016, these branches recorded a growth in comparison with the previous year. By contrast, the number of jobs in the EU's photovoltaics sector dropped from 108.5 thousand in 2015 to 99.6 thousand in 2016. The changes in the employment structure resulted from the changes in political and economic support, as well as the decline in conventional fuel prices. The systematic growth of employment in the renewable energy sector is in contradiction to the trends in other sectors of energy production, where employment is on the decrease. This is clearly visible in the case of coal-fired energy production in Poland, in which, in the 1980s, the level of employment was more than 200 thousand people, including the coal mines, and, currently, it is around 65 thousand. According to the IRENA reports, it is estimated that, under the signed climate agreements and the planned double share of RES in the global energy mix by 2030, the level of employment in the global renewable energy sector shall increase to reach 24 million people.

#### 4. INVESTMENTS IN RENEWABLE ENERGY

Before 2016, there was a permanent upward trend in renewable energy technology investments. The total investment expenditures in 2013 amounted to USD 239 billion, in 2014 they were USD 289 billion, and USD 330 billion in 2015. In 2016, the value of investment fell to the level of USD 263 billion, with a simultaneous growth of the installed capacity. The technologies with the highest share in the investment value are two electricity generation technologies, i.e. photovoltaics (PV) and wind power.

**Table 8. Global investment value and capacity growth of photovoltaic and wind power technologies in 2013-2016**

Specification	Unit	2013	2014	2015	2016
Annual investment value	USD billion	178	232	278	229
Annual capacity growth	GW	71	83	113	122

*Source:* compiled on the basis of Renewable Energy Finance (2018).

In 2016, the total value of investments in solar PV and solar thermal technologies amounted to USD 138 billion, and in onshore and offshore wind power technologies USD 107 billion. The investments in other renewable energy technologies (geothermal energy, biomass, hydropower, biofuels) amounted to USD 27 billion only. The development of solar and wind power technologies is primarily connected with a steady and progressive decrease in the costs of electricity generation per kilowatt hour.

**Table 9. Changes in the global costs of energy in renewable energy technologies in 2010-2017 (in USD/kWh)**

Renewable energy technology	2010	2017
Biomass	0.07	0.07
Geothermal energy	0.05	0.07
Hydropower	0.04	0.05
Photovoltaics PV	0.36	0.10
CSP (Concentrating Solar Power)	0.33	0.22
Offshore wind power	0.17	0.14
Onshore wind power	0.08	0.06

Source: compiled on the basis of Renewable Power Generation Cost (2018).

The presented values are average values for all the countries, and they do not take account of the installed capacity. In practice, the higher the capacity of photovoltaic and wind power plants, the considerably lower the costs, which makes it possible to compete with conventional energy on a commercial basis. According to the reports of the International Energy Agency, the costs of electricity production shall fall by subsequent 15% and by 25% in the case of photovoltaic electricity by 2021. It is forecasted that, after 2025, the wind and photovoltaic technologies shall generate electricity at costs lower than those of the currently dominating electricity from coal. The reduction of energy costs is influenced by the increasingly lower investments costs per kW. For example, the total investment costs of the photovoltaic PV technology decreased from 4,394 USD/kW in 2010 to 1,388 USD/kW in 2017, and in the case of wind power these costs were respectively 1,843 and 1,472 USD/kW (Renewable Power Generation Cost 2018).

A region with the highest level of investments in renewable energy is East Asia and the region of the Pacific Ocean. The value of these investments was USD 64 billion in 2013, USD 81 billion in 2014, USD 114 billion in 2015 and USD 88 billion in 2016. The majority of these investment were made in China and Japan. The dominant technology as regards investments in this region is photovoltaics. Investments in solar energy amounted to USD 28 billion in 2013, USD 56 billion in 2015 and USD 49 billion in 2016. As regards this technology, the major investor is China, which earmarked for solar PV technologies USD 24 billion in 2013, USD 41 billion in 2014, USD 53 billion in 2015 and USD 51 billion in

2016. In Western Europe, investments in renewable energy reached their climax in 2015, with a value of USD 73 billion. In 2013, the investments amounted to USD 53 billion, USD 58 billion in 2014 and USD 53 billion in 2016. In 2015, in Western Europe, USD 21 billion were invested in offshore wind farms, USD 26 billion in onshore wind farms, and USD 10 billion in solar PV (Renewable Energy Finance 2018).

According to the figures included in the report *Global Trends In Renewable Energy Investment 2018*, prepared by the Frankfurt School of Finance & Management in cooperation with Bloomberg New Energy Finance, the first ten countries in the world in terms of renewable energy investments in 2017 were as follows (in USD billion):

China – 126.6, the USA – 40.5, Japan – 13.4, India – 10.9, Germany – 10.4, Australia – 8.5, Great Britain – 7.6, Brasil – 6.0, Mexico – 6.0, and Sweden – 3.7. According to these data, Europe's share in investment expenditures of all the countries in the world on renewable energy technologies decreases systematically. In 2011, Europe accounted for 45% of investments in renewable energy, and, in 2017, they were only 15% (with the investment level of USD 40.9 billion).

## 5. SUMMARY

Currently, the use of renewable energy resources is not only looking for new sources, but a new trend in economic development, which shall influence the following decades. To a large extent, this situation is the consequence of the Paris Agreements adopted in December 2014. The long-term plans related to the climate policy shall result in limiting the exploitation and consumption of high-emissions fossil fuels. Alternative for these fuels are renewable sources, with their enormous and virtually inexhaustible global potential. The increasingly wider use of renewable energy sources forces the pace of technological progress, which allows the long-awaited cost balance in comparison with traditional sources of energy.

The auction method is becoming more and more effective way of developing renewable energy production. Over the last decade, the number of countries which decided to adopt the auction method increased elevenfold, from 6 in 2005 to at least 67 in November 2016. The auction system, which is introduced in numerous countries, proves that competition forces continuous reductions of renewable energy production costs. This is proved by the increase in the amount of renewable energy generated with a simultaneous decrease in the value of installed capacity investments. Particularly promising technologies in terms of efficiency improvement are wind and photovoltaic power plants. They allow you to obtain an increasingly higher capacity and, at the same time, satisfy the growing energy needs of societies. Moreover, the arguments of coal-fired energy production supporters that coal is the cheapest source of energy are of less and less value. The said assumption may be valid in the case of old and depreciated mines only. In the case of new mines, built from the ground up, with all the external costs be-

ing taken into account, investment expenditures are repeatedly higher than when building a new renewable power plant. Since January 1<sup>st</sup>, 2016, the member states of the European Union are bound by a new directive on industrial emissions, which imposes an obligation of actual measurement and monitoring of emissions. The costs of adjusting Poland's power industry to the new limits are estimated to amount to PLN 12.2 billion. Therefore, it is worth reflecting on whether it is better to spend this money on zero-emission renewable energy technologies.

Renewable energy sources are becoming more and more stable and flexible. Therefore, they can be incorporated into the national power system and ensure the country's energy security. There is an increasing number of global companies which become convinced of this, and which begin to participate in renewable energy production and create autonomous energy regions. Moreover, a lot of companies begin to build their strategies based on clean energy. The examples are Google, which generated 3,186.4 MW of clean energy in 2017, Amazon with 1,218.9 of energy produced, Microsoft Corp. with a generation of 759.0 MW, and Facebook, which generated 725.8 MW of energy. These corporations are being followed by more and more enterprises, which shows that this a durable trend. The renewable energy market is going to gradually reach the developing regions. This is proved by the Chinese domination on the global renewable energy market.

The analyses conducted and the syntheses performed show that, in the future, there are going to be favourable conditions for the development of branches related to renewable energy sources.

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## TENDENCJE W ROZWOJU GLOBALNEGO RYNKU OZE

**Streszczenie:** Globalny rozwój odnawialnych źródeł energii (OZE) to trend ogólnoswiatowy i nieodwracalny. Podstawowym czynnikiem przyczyniającym się do rozwoju globalnego rynku OZE to cele związane z polityką klimatyczną i ochroną środowiska. Rozwój technologiczny oraz potencjał źródeł odnawialnych sprawia, że w najbliższych latach OZE będą najczęściej

instalowanym źródłem energii na świecie. Energia odnawialna umożliwia dywersyfikację źródeł energii. Sprzyja ona zwiększeniu bezpieczeństwa i wzrostowi konkurencyjności. Tworzenie „czystych – zielonych” technologii sprzyja również tworzeniu nowych branż przemysłu i nowych miejsc pracy. Sprzyjają one wzrostowi gospodarczemu, wzrostowi eksportu i rozwojowi specjalistycznej wiedzy. Na bazie OZE powstają nowe powiązania pomiędzy nauką, inwestycjami w infrastrukturę, produkcję i logistykę oraz modelami ekonomicznymi pozwalającymi osiągać zamierzone cele.

Celem artykułu jest przedstawienie stanu rozwoju globalnego rynku odnawialnych źródeł energii, uwzględniającego udział poszczególnych technologii, dynamiki zmian, zatrudnienia w OZE, inwestycji i kosztów. Materiałem badawczym były raporty organizacji międzynarodowych analizujących rynek OZE i materiały statystyczne Eurostatu. Metody badawcze wykorzystane w pracy to analizy i syntezy raportów, dokumentów, aktów normatywnych. Analizy te pozwoliły ocenić rozwój globalnego rynku OZE oraz udziału w nim poszczególnych regionów i krajów. Pozwoliły one sformułować tendencje, prognozy, trendy rozwoju globalnego rynku OZE w najbliższych latach. Przeprowadzone analizy i dokonane syntezy świadczą, że branże związane z odnawialnymi źródłami energii mają w przyszłości korzystne warunki rozwoju.

**Słowa kluczowe:** rynek OZE, inwestycje w OZE, zatrudnienie w OZE, polityka klimatyczna.

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