UDC 620.92

WIND ENERGY DEVELOPMENT IN POLAND ON THE BACKGROUND OF THE EUROPEAN UNION

Skudlarski Ja., Zelazinski T.
Warsaw University of Life Sciences (SGGW)
Makarchuk O.G.
National University of Life and Environmental Sciences of Ukraine
Zając S.
State Higher Vocational School in Krosno, Poland

In the article is investigated the development of wind energy in Poland, comparing it with the European Union. There is analysed increases of wind turbines and production of electricity from wind. Features of law regulation of wind power in Poland and European Union countries are evaluated.
Keywords: wind power, renewable energy, development, Poland, the European Union.

Problem formulation. Wind energy is a booming sector of renewable energy in the world [1]. In 2013 the installed capacity in wind energy worldwide reached 318.6 GW. In 2013 in the world capacity of installed wind power plants came increased by 35.6 GW, of which European Union countries accounted for 11.3 GW [2]. The greatest interest in wind power exists in Asia, North America and Europe. The importance of Europe's wind power market has declined substantially. The share of European wind energy in terms of newly installed capacity in 2004 was 75%, while in 2009 only 25%. Currently the leading position in the wind energy sector is taken by China. According to the data of the World Wind Energy Council (GWEC) in the country there was increase of installed capacity of 13 GW in 2012 to 16.1 GW in 2013, resulting in total installed capacity in China is 91.4 GW [2].

In 2013 there was a decline in the rate of increase of new capacity in the United States. In 2013, 1.1 GW of new capacity was installed, while a year earlier it amounted to 13.1 GW. The reason for this disproportion is delayed extension of federal tax credits system, which expired on 31122012. This mechanism admitted tariff in the amount of $0.023/kWh for the first 10 years of production. In the absence of financial guarantees investors paused for new investments [2].

Slowdown in the wind energy market in 2013 was also recorded in the European Union. The European Union, already enlarged with Croatia, connected in 2013 to 11.2 GW of installed capacity in wind turbines, compared to 12.7 GW in 2012, which means a decrease in the growth rate of the size of 11.5%. The total installed capacity in the European Union (including switched off from use wind turbines) was 117.7 GW in late 2013.

Year 2014 saw an improvement in the market for wind power, after the slowdown in 2013. In the world more than 52 GW have been installed, 15 GW more than in 2013 (37 GW). The growth rate was 41.4% in 2014, reaching a total of 371 GW [4]. In the European Union increase of installed capacity amounted to 12.4 GW. At the end of 2014 total installed capacity in the EU exceeded 130 GW. The percentage of the global wind energy market in 2014 amounted to 36.5% [4]. In Europe there are significant disparities between the level of development of the wind energy market in each country of the European Union resulting from geographical and climatic diversity [3].

In Poland, wind power has developed since the early 90s. The first windmill in Poland was erected in 1991 at the previously existing hydropower plant in Żarnowiec. Currently, the site includes a wind farm of Lisewo. The industry's first wind farm in Poland was Barzowice wind farm. According to data from the Energy Regulatory Office at the beginning of October 2015 in Poland there were 981 wind turbines with a total capacity of 4,117.4 MW. In 2013, Poland was on the 9th place among the countries of the European Union in terms of installed capacity in wind energy [4].

Analysis of recent publications. Wind energy development opportunities in Poland are often addressed in the literature. The authors of the works in this subject are: P. Kacejko and M. Wydra, Z. Ząber, and Soliński et al., A. Chochowski, A. and P. Fajerska Dunal, Nalepa K. et al., A. Gielnik and R. Rosicki, G. Kalda, M. Kachel-Jakubowska and L. Karasek [5, 6, 7, 8, 9, 10, 11, 12, 13, 14].

A comprehensive publication on the development of wind energy in Poland is a collective work by G. Wisniewski, K. Micjhalowska-Klapand, S. Kocof Renewable Energy Institute [15]. It shows the potential of wind energy, economic and social benefits of wind energy in Poland and the impact of wind energy on the environment. The publication was made in 2012, and presented data covers the period up to 2011.

Unresolved parts of the general problem. Despite the great scientific and practical interest to the wind energy development, many questions remain open and unresolved. In the available literature no publications containing recent data are found. This paper is intended to complement the knowledges in the available literature.

Setting tasks. The aim of the study was to compare the state of and prospects for the development of wind energy in Poland compared to other European Union countries. The source of the data used in this study were available reports, year book sand statistical studies Polish and EU publications on issues of wind power development. Tabular and descriptive methods were used.

Statement of the main material of the study. An important in the development of renewable en-

ergy in the European Union countries was Directive 2001/77/EC on the promotion of the internal market in electricity from renewable sources. The document pointed out the main directions, providing great freedom in achieving the objectives. Poland, as a member of the European Community aligns its policies on renewable energy sources into EU policy. Since 2009, Poland applies Directive 2009/28/EC of the European Parliament on the promotion of energy from renewable sources. According to the Directive states commit to reduce greenhouse gas emissions, and increase the percentage of renewable energy in the overall energy balance [16].

The development of renewable energy sources in Poland, including wind power is one of the priorities listed in the document «Polish Energy Policy until 2030». The document was adopted by the Council of Ministers on 10 November 2009 and includes a strategy to implement solutions meeting the challenges of the Polish energy sector. It provides for mechanisms to encourage the development of renewable energy sources.

Energy Policy assumptions are summarized as adopted by the Council of Ministers on7 December 2010 the National Action Plan for energy from renewable sources («NAP»). In this document, the Council of Ministers stressed that assumes continued support for renewable sources of energy [17].

In 2005, Poland amended energy law. According to the new regulation electricity supplier is required to purchase energy generated from renewable sources (with facilities located in the area of seller's operations). The origin of energy from renewable sources is confirmed by so called 'A certificate of origin'. This document is issued by the Energy Regulatory Office at the request of energy producers [16].

It is required to obtain a license to sell electricity to the grid manufacturer. This is not applicable only the owners of small power plants, generating electricity for their own use.

In Poland the wind turbines are usually connected to the medium or high voltage. Connecting the wind power plant to the National Energy System is governed by the following legislation: the Energy Law, the Minister of Economy and Labour of 20 December 2004 (Journal of Laws of 2004 № 2, pos. 6). Operation and Maintenance Instruction of the Transmission System (...) and the Operation and Maintenance Manual of Distribution System (...) [16].

On 4 May 2015 Poland signed into law on renewable energy sources. In addition to administrative simplification the new law also defines the conditions of repurchase of the energy produced by micro installations with a capacity below 40 kW and small installations from 40 kW to 200 kW. For energy producers with domestic installations up to 10 kW, the Act introduces a preferred embodiment of a system called FIT (feed-in-tariff) that guarantees a fixed price of repurchase, for a period of 15 years from commissioning of such installations. Individuals, without establishing a business, and the company, without having to obtain a license can benefit from specified by law tariffs [18]. According to the adopted law on renewable energy sources, all new projects involving the construction of renewable energy sources, whose owners will want to use the support system in force after 2015, must be reported to the auction. In the auction, baskets auction for RES installations with a capacity of 1 MW and above 1 MW, will support investors who, in the case of projects submitted gathered permits necessary to start the production of energy, which is confirmed by the Energy Regulatory Office and offered the lowest prices for the sale of energy [19].

The development of wind energy in Poland against EU countries.

At the end of June 2015 the power of wind farms in Poland amounted to 4.1 GW. For comparison, the total installed capacity of the National Power System amounted to approx. 38.1 GW. Polish power industry increasingly reduces reliance on traditional fossil fuels, but still conventional power plants that use coal and lignite were responsible for producing 86% of electricity production in 2014.

At the end of 2014 installed capacity in wind farms in Poland amounted to 3.8 GW, an increase of 8% compared with the previous year. Throughout the European Union the installed capacity in wind energy reached 130.4 GW, an increase of 10% from a year earlier. In 2014 in European Union countries installed capacity came to 12.4 GW of. Most wind farms came in Germany, which is the leader in wind energy production in Europe. The total installed capacity in the country by the end of 2014 amounted to 40.4 GW. Further leaders in Europe are Spain (22.9 GW) and the UK (12.4 GW). Poland in terms of installed capacity in wind power plants in 2014 took the ninth position.

The installed capacity of wind farms in Poland and selected EU countries (as of 2014) are shown in Figure 1.

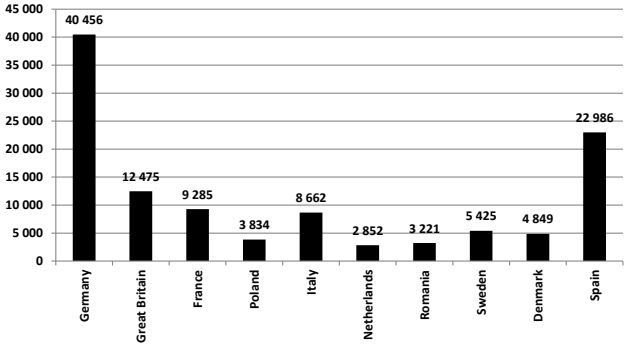

Fig. 1. The installed capacity of wind farms in selected EU countries in 2014 [MW]

Source: own study based on the EurObserv'ER Annual Report 2015

Over 60% of new wind power plants were established in Germany, the UK, France and Sweden. In terms of capacity growth of wind farms in 2014 Poland took the fifth position in the market in the European Union. In 2014 in Poland wind farms with a capacity of 444.5MW were started. Among the EU countries in terms of growth in capacity in the sector in 2014 the next places were taken by Romania (438 MW), Austria (411MW), Belgium (306), Ireland (222 MW) and Finland (184 MW) [4]. Capacity growth of wind farms in Poland and selected EU countries is shown in Figure 2.

The increase in installed capacity in the EU in naturally leads to increased production of wind

energy. From the data available to the EurObserv'ER consortium one may conclude that electricity production in 2014 rose only by 5.3% to 247 TWh/year. This is much less than last year, when wind conditions across southern Europe were much more favourable.

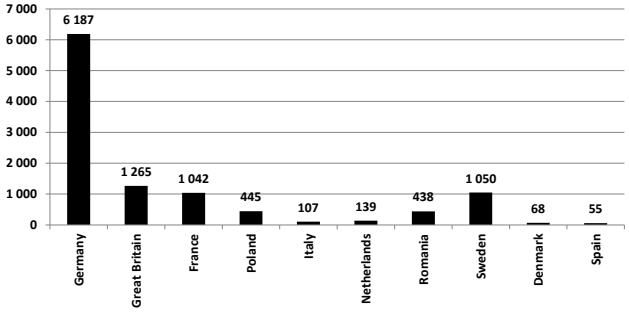

Fig. 2 Increase in wind farm capacity in selected EU countries in 2014 [MW]

Source: own study based on the EurObserv'ER Annual Report 2015

The share of wind in energy balance in the EU increased to 7.5% of electricity consumption compared to 7.1% in 2013. The leading producers of wind power are Germany (56 TWh), Spain (51.1 TWh) and the United Kingdom (31.5 TWh). Poland in terms of electricity production from wind turbines in 2014, took ninth place in Europe. Electricity production from wind power plants in Poland and selected EU countries in 2013-2014 is shown in Figure 3.

Poland is perceived by investors as a country with high potential for wind power energy development. According to the «National Action Plan» wind energy in Poland will play a crucial role in achieving the 15% target of renewables in energy consumption in 2020. Wind energy can be extracted from large wind farms as well as small wind turbines, called 'household' whose nominal power is approx. 100 kW [20].

Forecasts of wind energy sector expect installation of approx. 13 GW in 2020, while the increase in energy production from wind power is estimated to be approx. 24% in 2020, and almost 45% in 2030. The forecast also predicts an increase in employment in the sector wind power up to approx. 66,000 people in full-time equivalent jobs [21].

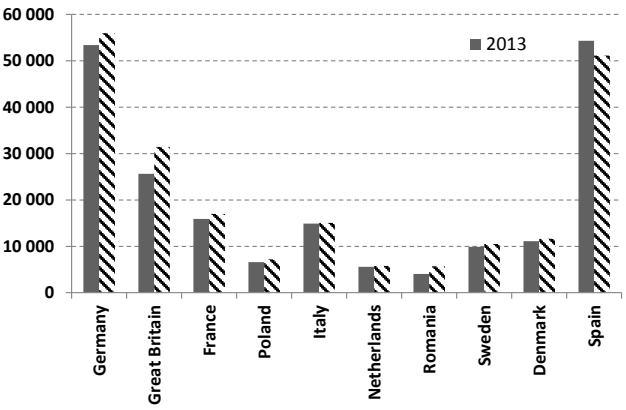

Fig. 3. Production of electricity from wind farms in selected EU countries in 2013 and 2014 [TWh]

Source: own study based on the EurObserv'ER 2015

The development of wind energy is determined by the wind energy resources in the country. The greatest potential for wind energy development is located in northern Poland where the average wind speed ranges from 5 m/s to 7.5 m/s at a height of 50 m. The most favorable conditions occur in the Baltic Sea, and especially its eastern regions, on the north – eastern part of the Poland comprising around Suwalki and Goldap and differentiated open regions of Warmia, Mazury and Pomerania and the southern Polish foothills. Unfavourable wind conditions prevail throughout most of the highlands of the country. Calculations carried out by the Institute of Meteorology and Water Management (IMGW) show that on 30% of the country there are good wind conditions, while very favourable conditions are on 5% of area. Unfortunately, the investment is the construction of a wind farm meets certain environmental and economic barriers [22].

According to data of the Energy Regulatory Office (ERO) in mid-2015. Poland had 981 wind turbines (in 2014, there were 890), and their installed capacity amounted to 4117.4 MW (in 2014 – 3 668 MW). The majority of installed capacity currently comprises approx. 50 largest wind farms, located mainly in northern Poland. Wind power dominates in Western Pomerania (1,154 GW), Pomeranian (459.8 MW) and Greater (454.2 MW) [23]. Most wind turbines are located in Kujawsko-Pomorskie (237), and the least in the region of Lublin (5). Installed capacity in wind farms in Poland in the years 2005-2014 are shown in Figure 4.

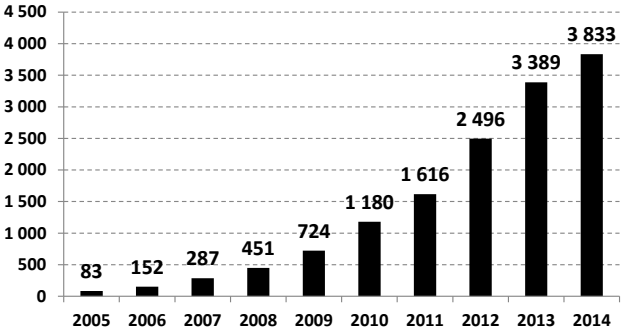

Fig. 4. The installed capacity of wind farms in Poland in the years 2005-2014 [MW]

Source: own study based on ERA

Since 2005, the share of wind energy in total energy production from renewable sources has been steadily increased – now it is already approximately 20%. In 2011 for the first time wind power produced more electricity than water power sector. More «green» energy technologies came only from co-firing, which, however, is decadent and in the coming years will cease to play a dominant role [15].

The share of wind power in the energy balance of electricity acquired from renewable sources in 2013was 35%. Despite the development, wind energy represents only 6% of total obtaining energy from renewable sources [24].

Since 2004 Poland has noted a significant increase in electricity production from wind power plants. Intensive growth took place from 2010. In 2014wind power plants produced 7624 GWh of electricity. To 30.09.2014, the wind power plants

achieved 5352 GWh of electricity [data ERO]. Electricity production from wind power in Poland in the years 2004-2014 is shown in Figure 5.

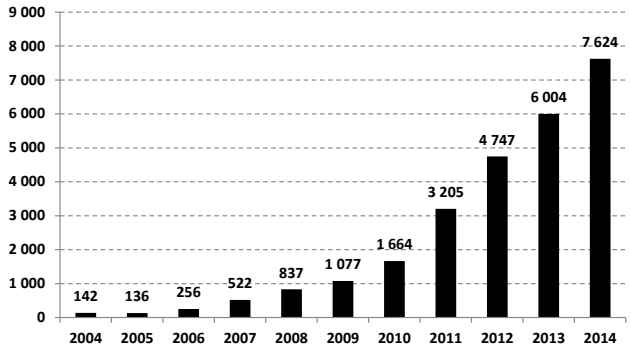

Fig. 5. Production of electricity from wind energy in Poland in the years 2004-2014 [GWh]

Source: own study based on CSO and the Energy Regulatory Office

National Action Plan for the promotion of renewable energy sources (KPD) also includes the development of small wind energy (less than 100 kW). It was assumed that in Poland by 2020 there will be 550 MW in total installed power from small wind turbines, which is equivalent to about one hundred thousand installations [25].

Conclusions and proposals. In Poland there is significant growth in electricity production from renewable sources. Wind power is an intensively developing area of renewable energy in Poland. Since 2004 Poland has recorded a significant increase in electricity production from wind, which in 2014 reached 7.6 TWh. Poland's participation in the production of electricity from wind energy installations in the European Union in 2014 amounted to about 3%. Poland's participation in the installed capacity of wind energy in the EU in 2014 reached 2%. In terms of installed capacity and electricity generated Poland takes 9th position in Europe. In 2014 Poland recorded a significant increase in installed capacity of wind energy (444.5 MW). It was higher than in Spain (increase of 55 MW), and Italy (107 MW), the countries that are leaders in the production of electricity from wind.

The development of renewable energy sources in Poland, including wind power is one of the priorities listed in the document «Polish Energy Policy until 2030». Wind power development is to be encouraged by law on renewable energy sources, enacted in 2015.

References:

1. Raport PSEW (Polskie Stowarzyszenie Energetyki Wiatrowej) 2010: Raport «Wizja rozwoju energetyki wiatrowej w Polsce do 2020 r. Źrydło dostępu: http://www.consus.eu/pliki/raport_ieo_psew__wizja_rozwoju_energetyki_wiatrowej_w_polsce_do_2020_r._-_podsumowanie.pdf (stan z 10.11.2015).
2. EurObserv'ER 2014, Biuletyn energii odnawialnej. Energetyka wiatrowa. Źrydło dostępu: http://www.energies-renouvelables.org/observ-er/stat_baro/observ/baro-jde14_po.pdf (stan z 10.11.2015).
3. Mazur-Wierzbicka E., 2013: Stan i perspektywy rozwoju energetyki wiatrowej na świecie. Ekonomia = Economics, № 1 (22), s. 86-96.
4. EurObserv'ER 2015, Biuletyn energii odnawialnej. Energetyka wiatrowa. Źrydło dostępu: http://www.eurobserv-er.org/biuletyn-energii-odnawialnej-energetyka-wiatrowa-2015/ (stan z 22.11.2015)
5. Kacejko P., Wydra M., 2001: Energetyka wiatrowa w Polsce − analiza potencjalnych ograniczeń bilansowych i oddziaływania na warunki pracy jednostek konwencjonalnych, Rynek Energii № 2, s. 30.
6. Soliński I., Soliński B., Solińska M., 2008: Rola i znaczenie energetyki wiatrowej w sektorze energetyki odnawialnej, Polityka Energetyczna № 1 (Tom 11), s. 451−456.
7. Chochowski A., Energetyka wiatrowa, w: F. Krawiec (red.),Odnawialne źrydła energii w świetle globalnego kryzysu energetycznego. Wybrane problemy, Difin, Warszawa 2010, s. 125−128.
8. Fajerska A., Dunal P., Możliwości rozwoju energetyki wiatrowej w Polsce i jej wpływ na zagospodarowanie przestrzenne kraju. Źrydło dostępu: http://pbc. up.krakow.pl/Content/5231/20150630_mu_ra_mozliwosci_rozwoju_energetyki_a_fajerska.pdf (stan z 21.11.2015)
9. Nalepa K. (red.), Miąskowski W., Pietkiewicz P., Piechocki J., Bogacz P., 2011: Poradnik małej energetyki wiatrowej. Olsztyn.
10. Gielnik A., Rosicki R. Energetyka wiatrowa w Polsce − możliwości rozwoju i zagrożenia. Źrydło dostępu: https://repozytorium.amu.edu.pl/bitstream/10593/6064/1/Energetyka%20wiatrowa%20w%20Polsce%20%E2%80%93%20mo%C5%BCliwo%C5%9Bci%20rozwoju%20i%20zagro%C5%BCenia.pdf (stan z 21.11.2015).
11. Kachel−Jakubowska M., Karasek Ł., 2012: Zasoby i możliwości wykorzystania energii wiatru na terenie wojewydztwa lubelskiego. Journal of Research and Applications in Agricultural Engineering: 2012, vol. 57, № 2, s. 99-102.
12. Barzyk G., 2010: Rozwyj krajowej energetyki wiatrowej w trzech aktach. Czysta Energia, № 4, s. 30-33.
13. Ząber Z., 2002: Możliwości wykorzystania energii wiatru w małych siłowniach wiatrowych oraz potencjału wody w małych elektrowniach wodnych. Czysta Energia, № 10, s. 30-31.
14. Kalda G., 2013: Perspektywy rozwoju energetyki wiatrowej w Polsce do 2020 roku. Czasopismo Inżynierii Lądowej, Środowiska i Architektury. Z 60, № 4, s. 45-56.
15. Wiśniewski G., Michałowska-Klap K., Koć S. 2012: Energetyka wiatrowa − stan aktualny i perspektywy rozwoju w Polsce. Instytut Energetyki Odnawialnej (EC BREC IEO), Warszawa.
16. Aspekty prawne związane z energetyką wiatrową. Źrydło dostępu: http://www.zielonaenergia.eco.pl/index.php?option=com_content&view=article&id=198:aspekty-prawne-zwizane-z-energetyk-wiatrow&catid=48:wiatr&Itemid=205 (stan z 23.11.2015).
17. Ramy prawne projektyw związanych z odnawialnymi źrydłami energii w Polsce. [Źrydło dostępu]: http://www.paiz.gov.pl/prawo/odnawialne_zrodla_energii (stan z 23.11.2015).
18. Ustawa o OZE wchodzi w życie 4 maja 2015 roku [Źrydło dostępu]: http://www.odnawialnezrodlaenergii.pl/oze-aktualnosci/item/1665-ustawa-o-oze-wchodzi-w-zycie-4-maja-2015-roku (stan z 23.11.2015).
19. Ceny referencyjne dla aukcji OZE na 2016 r. [Źrydło dostępu]: http://gramwzielone.pl/trendy/18093/ceny-referencyjne-dla-aukcji-oze-na-2016-r (stan z 23.11.2015).

20. Wiśniewski G., Böll-Stiftung H., 2012: Kolektory słoneczne, systemy fotowoltaiczne, małe elektrownie wiatrowe; Instytut Energetyki Odnawialnej (EC BREC IEO), Warszawa.
21. Raport IEO (Instytut Energetyki Odnawialnej), 2010: Wizja energetyki wiatrowej w Polsce do 2020 roku – raport. Szczecin.
22. IEO (Instytut Energetyki Odnawialnej), 2007: Możliwości Wykorzystania Odnawialnych Źrydeł Energii w Polsce do 2020. Warszawa.
23. Raport: Energetyka wiatrowa w Polsce 2015. Źrydło dostępu: http://www.odnawialnezrodlaenergii.pl/energia-wiatrowa-aktualnosci/item/2331-raport-energetyka-wiatrowa-w-polsce-2015 (stan z 10.01.2015).
24. GUS Energia ze źrydeł odnawialnych w 2014 r., Warszawa. Źrydło dostępu: http://stat.gov.pl/obszary-tematyczne/srodowisko-energia/energia/energia-ze-zrodel-odnawialnych-w-2013-r-,3,8.html (stan z 27.11.2015).
25. Raport IEO (Instytut Energetyki Odnawialnej), 2011: Rynek małych elektrowni wiatrowych w Polsce. Warszawa.

Скудларскі Я., Желазінскі Т.
Варшавський університет природничих наук «SGGW»
Макарчук О.Г.
Національний університет біоресурсів та природокористування України
Заєць С.
Державна вища професійна школа в м. Кросно, Польща

РОЗВИТОК ВІТРОВОЇ ЕНЕРГІЇ В ПОЛЬЩІ НА ФОНІ ЄРОПЕЙСЬКОГО СОЮЗУ

Анотація
У статті досліджується розвиток вітрової енергетики в Польщі у порівнянні з Європейським Союзом. Проаналізовано зростання вітрових турбін та виробництва електроенергії з вітру. Розглянуто особливості законодавчого регулювання вітрової енергії в Польщі та Європейському Союзі.
Ключові слова: вітрова енергетика, відновлювані джерела енергії, розвиток, Польща, Європейський Союз.

Скудларски Я., Желазински Т.
Варшавский университет естественных наук «SGGW»
Макарчук О.Г.
Национальный университет биоресурсов и природопользования Украины
Заец С.
Государственная высшая профессиональная школа в г. Кросно, Польша

РАЗВИТИЕ ВЕТРОВОЙ ЭНЕРГИИ В ПОЛЬШЕ НА ФОНЕ ЕВРОПЕЙСКОГО СОЮЗА

Аннотация
В статье исследуется развитие ветровой энергетики в Польше по сравнению с Европейским Союзом. Проанализировано увеличение ветровых турбин и производства электроэнергии из ветра. Рассмотрены особенности законодательного регулирования ветровой энергии в Польше и Европейском Союзе.
Ключевые слова: ветровая энергетика, возобновляемые источники энергии, развитие, Польша, Европейский Союз.