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The effect of energy transition on the labor market. A preliminary evaluation of Poland's wind-energy industry

ABSTRACT: Anthropoppression has become a factor of many negative environmental changes, including climate change. As a response to these changes, the European Union (EU) has already cut the GHG emission by 24% compared to 1990 levels. However, the goals are far greater since the Paris Agreement states that global warming should be kept down to near 2 degrees Celsius, ideally 1.5 degrees Celsius, compared to pre-industrial levels. By 2050, the proportion of global energy produced from coal must decline by between 73 and 97 percent to accomplish this objective. The global employment structure would definitely be affected by this decarbonization in the long run. In this paper, we concentrate on a preliminary evaluation of Poland's future job market. As Poland's economy is still driven by coal, energy conversion will have a significant influence on the country's economy. However, decarbonization is both an opportunity and a challenge for the future labor market. As per research findings, the transition to renewable power would be a net job creator with the potential for new quality workers in the renewable energy industry both directly in the construction and installation of renewable power plants and indirectly in the industry that supplies the

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items for the system. According to the preliminary investigation of Poland's future labor market, the future of Polish energy is the cohesion of clean energy sources and decentralized energy, while offshore wind energy in the Baltic Sea can play an important role in the national energy transition, as well as contributing to the country's energy security and reducing environmental pollution.

KEYWORDS: energy transformation, labor market, SDG, wind energy, renewable energy

Introduction

Changes in the Polish labor market relating to energy transformation are inevitable. The profound changes that follow the energy transition require substantial social and political support, at the same time, they present an opportunity and a challenge for the future labor market. On social, economic, and political levels, energy is the country's most important industry. This complex, as well as its economic constituent aspects, are essential to national security (Wasiuta 2018). As a result, finding the proper balance to create a carbon-neutral economy while maintaining cheap and adequate conditions for employment transition is critical. The seventh sustainable development goal (SDG) aims to give all people access to cheap, dependable, sustainable, and modern energy by 2030. The Paris Agreement was approved by 196 parties on December 12, 2015, at COP 21 in Paris; according to its aims, global warming should be kept to far below 2 degrees Celsius, ideally 1.5 degrees, over pre-industrial levels. To achieve the 1.5-degree Celsius target, the proportion of world energy production that comes from coal needs to fall to between 73% and 97% by 2050. As a result, the outcomes of the Paris Agreement have a long-term impact on the global job market. Since coal mining directly employs over seven million people and indirectly employs millions more, the shift to a low-carbon economy provides an opportunity for the growth of green jobs. "Just transition" was added to the 2015 Paris Agreement on climate change to guarantee that nobody is left behind in the energy transformation processes. Furthermore, the eighth sustainable development goal focuses on encouraging inclusive and sustainable economic development, jobs, and stable employment for all. Switching to renewable energy sources is both a way to mitigate climate change and a way to create new jobs. Despite the fact that coal production and use in the EU has been declining steadily in recent years, coal has long been one of the primary fuels in the European economy. Mine closures are planned in the future as a result of the Paris Agreement. Before 2025, the EU-27's emissions reductions is predicted to result in the loss of over 76,000 jobs in coal mines and plants; beyond that, the figure is likely to be double, with over 154,000 job losses forecast before 2030. Power generation from coal is strongly discouraged by rigorous post-2020 emission standards, high CO₂ emission allowance pricing, and anticipated limits on coal availability for future load-compensation methods due to the need to decrease carbon dioxide emissions (JRC 2020). A "just transition" for workers and communities as the world's economy adapts to climate change was included in the 2015 Paris

Agreement on climate change to ensure that nobody is left behind, taking into account the need of a “fair transition” of the workers, as well as the establishment of stable jobs and skilled jobs in accordance with national development goals (Paris Agreement 2015). Coal infrastructure is located in 108 EU areas, and the coal sector now employs 237,000 people, mostly in coal mining (185,000). Poland has the highest number of coal workers, followed by Germany, the Czech Republic, Romania, Bulgaria, Greece, and Spain. Twenty areas account for almost 200,000 jobs directly related to coal, with six in Poland (including the region of Silesia, which had an anticipated 82,500 employees in 2015) and five in Germany. The number of jobs indirectly relying on coal operations is up to 215,000 across the coal value chain, with four locations in Poland, Bulgaria, and the Czech Republic each providing over 10 000 jobs. Many of these jobs, both directly and indirectly related to coal operations, will become obsolete within the next few years (JRC 2020). Several places are anticipated to be particularly severely impacted by the shift. According to forecasts, one region in Poland may shed up to 41,000 jobs, while three more in the Czech Republic, Romania, and Bulgaria are expected to lose more than 10,000 jobs. Poland, the Czech Republic, Romania, Bulgaria, Germany, and Greece have the largest number of job losses.

1. Method and methodology

To begin, the review was performed using both the standard method of web-based literature research and a study of academic multidisciplinary databases such as Scopus and Google Scholar. The search terms were “energy transition”, “transition of the Polish labor market”, “renewable energy industry”, “green jobs” and “wind energy.” According to the findings, there is a significant link between energy transition and developments in the labor market. Climate change is one of the key effects of anthropopression, according to basic research, which has led to a revival of the notion of sustainable development. It should be stressed that while sustainable development is now the sole recognized model of development, failure to follow its suggestions would have severe consequences for mankind, because environmental destruction decreases profitability and welfare in the long run. “Green growth is getting popularity as a method to promote industrialization while limiting environmental deterioration, biodiversity loss, and unsustainable natural resource usage”, according to the OECD (OECD 2010). According to the World Bank, making energy policy a goal for the future is critical. “Climate policy cannot be defined in terms of a trade-off between growth and climate change”. Climate-smart policies, on the other hand, are those that promote development, decrease vulnerability, and fund the transition to low-carbon growth routes” (World Bank 2009). There is a good probability that the so-called technology revolution, which entails the conversion of the energy system to low-carbon development, will be a viable alternative to present energy production. Long-term, low-carbon growth can provide safer, greener, more biodiverse, and energy-secure energy production methods. Stern (Stern 2010). There remains a basic debate about the relationship between energy revolution and future

workforce sectors. According to UNEP projections, the process of transitioning to a green economy should be viewed as a development accelerator rather than a development drag (UNEP 2011). What should be emphasized is that the economic slump associated with the 2007/2008 economic crisis prompted several recommendations for “green” fiscal stimuli to stimulate growth and, in particular, employment (Pollin 2008). According to the OECD, there is a need to fund environmental initiatives since they create a bunch of works (OECD 2011). Still, some argue that the promise of green jobs is overstated, and that environmental regulations may have negative repercussions for the future labor market, making it less appealing (Morris 2009; Michaels and Murphy 2009; Alvarez 2010). Energy transition is undoubtedly associated with difficulties for future employment structures by the majority of researchers (Wasiuta 2018; Burchard-Dziubiska 2014; Deluga 2007; Deluga 2007; Lewandowski 2007). It has been demonstrated that hard coal’s importance in the Polish energy industry will eventually dwindle (Szpor et al. 2018). The next stage was to examine Poland’s energy policy for the coming years, as well as statistical information, to determine the number of jobs that will be lost in the coal-mining industry in future years. It was stated that the process of establishing green employment in Poland would be a fantastic chance for future green job development. During a thorough review of the literature, a study gap on the function of wind energy during the energy transition was discovered (Vogt-Schilb and Feng 2019). The study’s following section looked at the current state of wind energy in Poland.

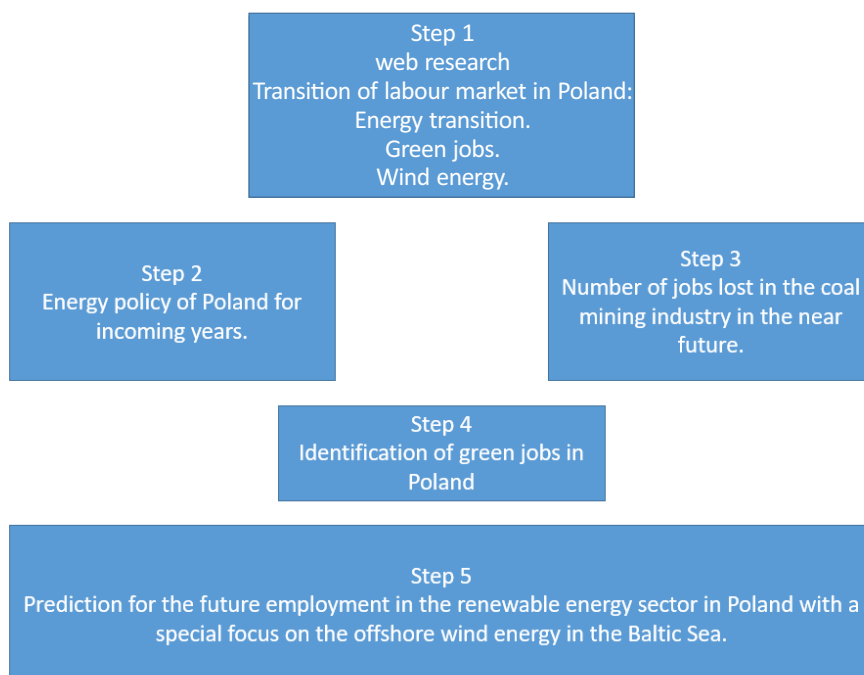


Fig. 1. Algorithm for detecting the future workforce market potential in the renewable energy industry

Rys. 1. Algorytm przyszłego potencjału rynku siły roboczej w branży energii odnawialnej

The final section of the study focused on forecasting future employment in Poland's renewable energy sector, with a particular focus on offshore wind energy in the Baltic Sea, which might be critical for the country's energy revolution.

2. Discussion

Hard coal's influence in the Polish energy sector will diminish and Poland will be confronted with not just energy conversion, but also changes in the labor market as a result of that transition. Poland's National Energy and Climate Plan for the Years 2021–2030 (NECP 2019) was presented in 2019, outlining the country's goals for improving energy efficiency and emission reductions. Within the time constraints for delivering the NECP, a thorough examination of the impact of energy transformation on mining regions (including society, jobs, and skills) was not achievable. This type of examination will be done in the context of the reorganization plan of hard coal and lignite mining areas, which is set to begin in 2020. In 2018, Poland approved a policy for the coal industry in the region through to 2030. The declared goal of the strategy is to establish environments that will enable the development of a lucrative, efficient, and modernized hard-coal mining sector due to higher collaboration, information exchange, and innovation. In 2019, the Ministry of Energy planned a proposal for Poland's Energy Policy up until 2040, which undertakes to minimizing coal use in electricity generation by 2030, boosting renewable energy in final gross energy usage, utilizing nuclear energy by 2033, increase energy efficiency, and minimizing Carbon footprints. The Strategy for Responsible Development through to 2020 (with a view to 2030) was approved in 2017. Concerning coal mining, the strategy will focus on enhanced mine performance, optimizing extraction to suit consumer demands, and where applicable, boost the number of higher value-added commodities in the extraction framework as well as guaranteeing sufficient levels of funding. The EU promotes economic diversity in the coal and carbon-intensive areas most affected by emission reductions, and the Just Transition Fund assists local workers in obtaining new credentials and capabilities. Three mining districts, Silesian, Wielkopolskie, and Dolnolskie, as well as the next three coal mining regions, Lubelskie, ódzkie, and Maopolskie, are formulating plans for such a transition. The employment multiplier influence, which quantifies the number of direct, indirect and inspired jobs generated or lost in the region should be recognized during the "just transition" (Pietrzyk-Sokulska et al. 2015). Due to the obvious mining multiplier influence of each loss of a mining job causes many additional employees to lose their positions. According to the Industrial Development Agency in Katowice, 83,297 employees were employed in hard coal mining in Poland at the end of December 2019, with 64,259 of them working underground. The mining facilities sector employs around 400 000 people. This creates over half a million jobs in total, proving the famous adage that "one job in mining creates three or four jobs in the surrounding area." Mining employment losses are linked to job losses in industries that provide goods and services to miners. The num-

ber of workers employed in the mining industry is 56,00, or roughly 0.4 percent of all workers in Poland (Kiewra et al 2018). Poland published its National Energy and Climate Plan (NECP) for the years 2021–2030 in 2019, outlining its goals for greater energy efficiency and emission reductions. The Ministry of Energy planned a proposal for Poland’s energy policy until 2040 in 2019, in which it undertakes to: minimize coal use in electricity generation by 2030; increase the proportion of renewable energy consumption in final gross energy consumption by 2033; increase energy efficiency; lower CO₂ emissions. In 2017, the Strategy for Responsible Development through to 2020 (with a view to 2030) was approved. In the case of coal mining, the strategy aimed to enhance mine productivity, adapt extraction to market demands, and, where feasible, boost the number of higher-value-added products in the extraction structure, as well as maintain adequate investment levels.

3. The green transformation in Poland

In Poland, the transition to green energy will undoubtedly make a large difference in the labor force. Green employment creation, which is considered as a credible alternative to a high-carbon economy, is viewed as both an opportunity and a burden for regional and national policymakers. It is critical that Polish government policy concentrates on the effective translation of both resources and capital to sectors that will ensure long-term sustainability.

Renewable energy sources are an opportunity to reduce climate change as well as mitigate the dependence on energy imports. The most important advantages of renewable energy sources are the reduction of pollutant emissions, use of commonly available and natural energy sources and the reduced consumption of non-renewable sources.

TABLE 1. Benefits of using renewable energy resources

TABELA 1. Korzyści z wykorzystania odnawialnych źródeł energii

Economic and social	Ecological and health
Implementation of inexhaustible and cheap energy sources	Reduction of the greenhouse effect
Creation of new jobs	Reduction of air pollutant emissions
Use of agricultural surpluses	Reduction of waste
Creation of conditions of competition between energy producers	Reduction of diseases resulting from environmental pollution
Reduction of the dependence on foreign energy sources	Regulation of water relations

Source: own study.

The green transformation in Poland, which can be seen more as an evolution than a revolution, is inevitable, what's more, it will increasingly affect the Polish labor market. According to the Institute of Renewable Energy's report, the growth of Poland's renewable energy industry could result in the establishment of 77,000 additional jobs. Green occupations are those that have a direct or indirect impact on environmental consequences. A green job, according to Eurostat's definition, is any job associated with environmental commodities (OECD 1999), which includes "operations that manufacture goods to evaluate, protect, restrict, reduce, or accurate harm to the environment to water, air, and soil, as well as waste, noise, and eco-systems." Green jobs, according to the United Nations Environmental Programme, are those in agriculture, production, administration, research and development, or service activities that are focused at significantly maintaining or recovering environmental quality (UNEP 2018).

Green employment, according to the International Labour Organization (ILO 2018), may assist in safeguarding the environment, avoiding climate crisis, enhancing energy and raw material efficiency, reducing greenhouse gases, and reducing waste and pollution (ILO 2018). Progress towards a sustainable economy, according to the International Labour Organization (ILO 2018), offers worldwide job opportunities. Impacts on energy generation have the potential to produce 18 million jobs globally. According to Eurostat, jobs in the EU-28's environmental economy increased from 2.8 million full-time equivalents (FTEs) in 2000 to 4.5 million FTEs in 2016. A move to sustainable energy sources is one of them. This net employment increase is the consequence of the establishment of around 24 million new jobs opportunities and the loss of approximately 6 million jobs by 2030 (ILO 2018). According to the ILO Deputy Director General, Deborah Greenfield, the green economy "can allow millions more people to escape poverty and provide better opportunities for this and coming generations. In a world with complicated options, this is a really good message and chance." In recent years, EU nations have debated "green growth" as a viable economic development strategy. New employment will be formed as a result of public and private sector initiatives in the green economy. The green economy has been included into the EU's Europe 2020 strategy. According to the strategy, the EU must concentrate and standardize its regulation convos, especially in new sectors such as climate and green growth, and expand our international influence where feasible by boosting equivalence, mutual recognition, and convergence on key regulatory requirements, including the implementation of regulations and principles (Europe 2020). The growing use of sustainable power is a major focus in the EU energy strategy. The use of sustainable power has the capability to increase employment opportunities. In order to produce the same quantity of energy output, renewable generation requires more labor than traditional power generation. Construction and operation jobs are available in the renewable energy (wind, solar, biomass) industry. There are three types of jobs in the RES field: installation, de-installation, maintenance.

- 1) manufacturing, operation, fuel extraction and processing,
- 2) biomass energy-related areas.

According to EurObservER, by the end of 2014, renewable energy in Poland had created about 33 800 jobs. The following industries had the largest shares in employment in the RES sector in Poland: biomass (60%), biofuels (16%) and solar collectors (8%). In comparison with

TABLE 2. Renewable energy sources

TABELA 2. Źródła energii odnawialnej

Type of energy source	Energy generators
Solar technologies	Solar photovoltaic Solar panels
Wind energy	Onshore wind energy Offshore wind energy
Hydro	Micro hydro, small hydro, large hydro
Biomass	Solid biomass fuels Liquid biomass resources Landfill gas and municipal solid waste Liquid biofuels
Geothermal energy	For electricity or heat

Source: own study.

statistical data for the entire EU, the national industries with the highest share in employment in the European RES sector, i.e. over 5% of the respective industries in the EU, are biomass and solar collectors. Industries with relatively the smallest employment (less than 1% share in the EU) are wind energy, biogas with waste and photovoltaics (EurObservER 2020). The sectors of biomass (60%), biofuels (16%) and solar collectors (8%) had the largest employment share in the RES sector in Poland. In comparison with statistical data for the entire EU, the national industries with the highest share in employment in the European RES sector, i.e. over 5% of the respective industries in the EU, are biomass and solar collectors. Industries with the relatively smallest scale of employment (less than 1% of the EU share) are wind energy, biogas with waste and photovoltaics.

In Poland, there is an increasing demand for specialists in the field of renewable energy sources, ranging from engineers, managers and people related to the construction market to solar panel fitters. New employees will be needed by, among others, the automotive industry, which must make a revolution by departing from the traditional drive. There is also a growing demand for green financiers, i.e. people who can account for green investments, not only as part of projects implemented with EU funds. New employment will be needed in the waste management business, bioeconomy and biotechnology, the chemical industry, and public transportation. Furthermore, roles of sustainability managers and so-called green officers, i.e. managers responsible for the company's compliance with eco-standards at every step of its operation, are becoming increasingly common in the construction and energy sectors.

4. Results

The combination of renewable sources and distributed energy is the future of Polish energy, and offshore wind energy in the Baltic Sea can play a significant part in the country's energy transition, and also assist in energy security and pollutant reduction. Wind energy has the potential to be a driving factor in the growth of Poland's economy and marine industry. The Baltic Sea has a lot of promise in this area, and its use may result in more electricity and more employment. Offshore wind energy could account for up to three-quarters of future work opportunities. It is important to note that we see the so-called multiplier effect in the case of wind farms, which implies that operating a current 10 MW wind farm creates two direct and three indirect jobs. As a result, wind energy creates jobs in a variety of industries at varying levels of development. Wind farm renovation and installation are complex processes involving a wide range of industries, from construction to processing, services, programmers, engineers, electricians, manual workers, trainers, sales representatives, developers, meteorologists, lawyers, security specialists and project coordinators. Wind energy is a renewable energy resource that has a positive impact on both established and emerging economies. Wind energy does not just allow countries to fulfill their energy demands, it also opens up new economic opportunities for young people in developing countries. Project developers, service technicians, data analysts, and electrical, computer, mechanical and construction engineers all have market opportunities. Companies in the industry will be searching for workers with varied degrees of expertise and competencies as wind energy develops rapidly in Poland and throughout the world. When compared to 2007, direct and indirect employment among individual developers of wind turbines, manufacturers, and business managers grew to 270,000 in the European Region in 2010 (IRENA 2013). There are several offshore wind farms scheduled for implementation in the future, as indicated below in Table 8 (Sari et al. 2015).

Occupations were divided into direct and indirect jobs. The International Renewable Energy Agency not only gives a precise and practical explanation of these words, but it also goes into detail about major differences in their application among research it has looked at. Manufacturing of critical elements, power plant building, and operation and maintenance (O&M) are all common opportunities for direct jobs. The definitions of direct and indirect (and, in some cases, induced) occupations vary widely between research, which is a concern. Planning and project management, as well as research and development, energy businesses, utilities, banks, and other services, may be included in some circumstances. Indirect jobs are even more unclear, as some writers assess the indirect impacts of materials (e.g. cast iron and steel) and services used on the supply chain process using input-output analysis. These are secondary-level occupations connected to the supply and support of the wind-power sector. The examination of consultation and other small components not directly connected to the industry is a further expansion. Some research distinguishes between indirect jobs, such as those mentioned above, and induced jobs, which arise as a result of expenditure generated by both direct and indirect employment. Some research incorporates these induced effects, although the majority of studies do not. Estima-

ting generated jobs is difficult, but visualizing them is simpler. Consider the following scenario involving a wind-power sector employee who is staying at a hotel during building projects: this housing structure helps the growth of the service sector's workforce. In reality, determining the precise number of generated jobs can be difficult since separating spill over employment impacts from the deployment might be difficult. It is predicted that Poland's wind-energy labor market will grow rapidly in the coming years. It is important to note that the industry's development is heavily influenced by political and economic situations. Wind energy jobs in Poland are expected to increase from 5,000 to 42,000 by 2030. It is worth noting that the number of employment opportunities in wind energy is directly proportional to the quantity of generated megawatts of electricity, thus it fluctuates substantially from year to year. In Poland, wind energy produced just 300 direct jobs in 2005, whereas 4,400 people worked for direct component suppliers in 2012. According to WISE and PWEA statistics, 8,400 Poles were employed in wind energy in 2014, including 2,800 in industries ([Impact of wind energy on the Polish labor market 2015](#)). In total installed, it was just 83 MW in 2005, whereas 3.8 GW in 2014. It must be noted that throughout the investment phase, 1 MW of additional wind-energy capacity generates 11.4 direct and indirect jobs. Keeping them will necessitate ongoing expenditure in the years ahead, but this is a means to create longer employment opportunities. We see the so-called multiplier effect in the case of wind farms, which implies that maintaining a current 10 MW wind farm creates two direct and three indirect jobs. The largest wind farms in Poland are presented in Table 3.

TABLE 3. The largest wind farms in Poland

TABELA 3. Największe farmy wiatrowe w Polsce

Name of the farm	Specification
Potęgowo wind farm	The plant, with an output of 219 MW, became operational in December 2020. It is located in the Supsk and Sawno poviats. It is made up of 81 General Electric turbines with capacities ranging from 2.5 MW to 2.75 MW.
Margonin wind farm	The farm is made up of 60 wind turbines with a combined capacity of 120 MW, allowing it to satisfy the energy demands of 90,000 homes.
Banie wind farm	The farm is made up of 53 turbines with a combined generation capacity of 106 MW. It is located in the voivodship of West Pomerania.
Marszewo wind farm	The farm has 50 wind turbines with a total power output of 100 MW. The farm is located in the voivodship of West Pomerania.
Lotnisko wind farm	The farm is made up of 30 turbines, each of which has a nominal output of 3,150 MW, for a cumulative installed capacity of 94.50 MW. This farm produces 195,000 MWh of power per year on a gross basis. The Pomeranian voivodship is where the farm is located.
Karścino wind farm	The farm is comprised of 60 turbines, each with a rated output of 1.5 MW, and spans an 11-kilometer square area. There is a total installed capacity of 90 MW.

Source: own study.

5. The future of wind energy in Poland – possible development scenarios

After a period of stagnation from 2015 to 2019, wind-energy growth increased. By 2023, it is expected that the number of windmills would have increased by 50%. According to the report “Participation of local production to the growth of onshore wind energy and its impact on the Polish labor market until 2040,” there are two basic improvement scenarios: stagnation, which assumes no capacity increases after 2025; development, which assumes capacity increases after 2030 (2040). By 2040, 42,000 people might be employed in Polish onshore wind energy, according to the best scenario. According to forecasts, the numbers are much greater in the presence of offshore wind energy. The planned construction of 6 GW at sea in the present decade will hire tens of thousands of people; we can also speak of a multiplier effect, in which the growth of offshore wind energy will create additional jobs across the entire energy industry, including construction, finance, transportation and services (PSEW 2019). According to the publication “Baltic Sea Vision”. A plan for Poland. Offshore wind-energy expansion in the Baltic Sea basin in the fundraising process – that is, about 34,000 workers will be required for infrastructure building and development. Approximately 29,000 jobs will be created throughout the operational phase (servicing built wind farms) (PSEW 2020). The majority of people are engaged throughout the production and building stages of wind farms, particularly while wind energy in each nation is in its early stages of growth and the volume of wind farms needing servicing is minimal. The targeted professional groups for different stages of ind farms life cycle are presented in Table 4.

TABLE 4. Target professional groups for a different stages of life cycle of wind farms

TABELA 4. Docelowe grupy zawodowe w różnych etapach cyklu życia farm wiatrowych

Stage	Targeted Professional Groups
Construction stage	Lawyers, environmental engineers, civil engineers, meteorologists, project managers
Exploitation stage	Electronics, electro mechanics, plumbers, builders, service technicians, trainers

Source: own study.

It is important to note that in terms of wind farms, we see the so-called multiplier impact, which implies that supporting a current 10 MW wind farm requires two direct jobs and three indirect jobs. Therefore, wind energy, at various levels of investment, creates jobs in a variety of sectors of the economy. Wind farm construction and installation are complex processes that require the participation of many industrial sectors, including construction, processing, services, programmers, engineers, electricians, manual workers, trainers, sales representatives, developers, meteorologists, lawyers, security specialists and project coordinators.



Fig. 2. Possible jobs in the wind sector with division into construction and exploration stages
 Source: own study

Rys. 2. Możliwe miejsca pracy w branży wiatrowej z podziałem na etap budowy i eksploracji

TABLE 5. Scenarios for wind farms in Poland

TABELA 5. Scenariusze rozwoju farm wiatrowych w Polsce

Low scenario	Central scenario	High scenario
In an unfavorable regulatory environment, the development impulse for wind energy may be extinguished. In this scenario, approximately 200 MW of new capacity will be generated annually.	Maintaining employment at the current level.	Acceleration of wind energy development with the production of 600 MW of new power each year. By the end of the decade, employment could increase in the range of 5,000 to 42,000 jobs in 2030.

Source: own study based on the report “Contribution of domestic suppliers to the development of onshore wind energy and its impact on the Polish labour market until 2040”.

Among the future development scenarios indicated by renewable energy experts, the following options are listed for the development of wind farms in Poland.

Conclusions

Changes in the Polish labor market as a result of the energy transition are unavoidable and represent one of the country's most pressing issues in terms of social and economic policy. Although renewable energy sources account for a modest percentage of the total energy output, they will offer tremendous future prospects for the country. The Warmisko-Mazurskie Voivodeship in Poland is an example of a location where virtually all of both the local residents and enterprises have shifted to renewable sources. According to the ministry's predictions, offshore wind farms will grow rapidly after 2035. It should be highlighted that the growth of the renewable energy industry has the potential to have a beneficial influence on the employment market, particularly in construction, the manufacture of energy-related technology, and the upgrading of existing devices. The future of Poland's transition to green jobs will be largely determined by the growth of offshore wind energy, which will eventually become the industry's largest employer. According to predictions, the shift in the national economy into renewable energy would benefit both entrepreneurship and the Polish economy's performance. This will be linked to an increase in consumption for novel gadgets and infrastructure. It is also predicted that foreign investments would boost inflow into the Polish economy, which would help to strengthen our country's balance of payments. Aside from financial considerations, the environmental and health advantages of energy conversion, such as reduced air pollutants, are also critical. Renewable energy assumptions have a significant benefit in terms of dispersion, which means that the power sources are spread out across the country and are close to the recipients, which is critical in terms of energy distribution and storage. However, it is important to keep in mind that energy transformation is a long-term process the effects of which will be felt most acutely in the so-called carbon anchor regions. The following voivodships in Poland may face the largest social and economic costs: Silesia, Wielkopolskie, Dolnolskie Lubelskie, ódzkie, and Maopolskie. According to estimates, Silesia will face the largest transition charges since it mines the majority of Polish coal. The hard coal mining sector employs 74,500 people, mostly males, and generates 7% of the region's value added. It is anticipated that the mining facilities industry employs four times as many people, or 280,000 people. As a result, action plans of restructuring and the relocation of personnel who formerly worked in the coal sector should be implemented to promote the shift of the labor force forward into renewable energy. Instead, it may reduce unemployment, which may result in major unemployment, leading to a negative impact on the national economy. The future of Poland's transition to green jobs will be heavily reliant upon the growth of offshore wind energy, the industry's largest employer. Nevertheless, one should be cautiously optimistic in this regard; the future possibilities provided in the paper suggest that in the event of an unfavorable regulatory

environment, the development drive for wind energy may be eliminated. The optimistic variation, on the other hand, estimates that wind energy alone will create 42,000,000 additional jobs in the future. The energy transition is now underway, and it appears that the most essential thing at this point is to make every effort to turn it into an opportunity rather than a threat to Poland's future labor market. The most significant benefits of renewable energy sources include lower pollutant emissions, the use of readily available and natural energy sources, and the reduced use of non-renewable sources.

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Wpływ transformacji energetycznej na rynek pracy. Wstępna ocena potencjału sektora energii wiatrowej w Polsce

Streszczenie

Antropopresja stała się czynnikiem wielu negatywnych zmian środowiskowych, w tym zmian klimatycznych. W odpowiedzi na te zmiany Unia Europejska (UE) już obniżyła emisję gazów cieplarnianych o 24% w porównaniu z poziomami z 1990 roku. Jednak cele są znacznie bardziej ambitne, Porozumienie Paryskie zakłada, ograniczenie średniego wzrostu temperatury na Ziemi znacznie poniżej 2 s.c. Aby osiągnąć ten cel do 2050 r., udział globalnej energii produkowanej z węgla musi spaść o 73–97%. Ponieważ gospodarka Polski w dużej mierze opiera się na węglu, transformacja energetyczna będzie miała istotny wpływ na gospodarkę kraju. Tym samym dekarbonizacja może postrzegana być zarówno jako szansa, jak i znaczące wyzwaniem dla przyszłego rynku pracy. W dłuższej perspektywie dekarbonizacja z pewnością wpłynie na globalną strukturę zatrudnienia. Artykuł koncentruje się na wstępnej ocenie potencjału sektora energii wiatrowej w Polsce. Według wstępnej oceny przyszłego rynku pracy w Polsce, morską energetyką wiatrową na Morzu Bałtyckim może odegrać ważną rolę w krajowej transformacji energetycznej, stać się ważnym elementem rynku pracy, a także przyczynić się do bezpieczeństwa energetycznego kraju i zmniejszenia zanieczyszczenia środowiska.

SŁOWA KLUCZOWE: transformacja energetyczna, rynek pracy, SDG, energetyka wiatrowa, energia odnawialna