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# Challenges for the Polish energy policy in the field of offshore wind energy development

Abstract: Offshore wind power is a relatively new sector of the economy with a tremendous potential for development. Its main advantage is foreseeable production and a high capacity factor, estimated at 50% (with prospects to increase to 60%), which makes it the most efficient energy source of all renewable energy technologies. In the Baltic Sea Region, Poland has the largest potential for the development of offshore wind energy. This has been reflected in plans by investors interested in offshore investments within the Polish marine areas. European energy and climate strategies, which define principles and objectives for the transformation of the European energy sector in line with the principle of sustainable development, underline the importance of offshore wind in the effort to achieve climate neutrality of the EU economy and contribute to energy security in Europe. Decision-makers in Poland endeavor to create conditions favorable to the development of the offshore wind sector. The article presents European and Polish conditions for the development of the offshore wind energy. To assess threats and opportunities for the development of the technology in Poland, the article examines whether the offshore wind potential has been included in strategic policy papers related to the development of the Polish energy sector, as well as how the state intends to support the development of the technology. A particular emphasis has been put on the latest draft of the

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Energy Policy of Poland until 2040 due to the crucial role of the document, since it sets directions for the development of the Polish energy sector for the next 20 years.

Keywords: offshore wind energy, offshore wind farms, energy policy, renewable energy sources

## Introduction

In recent years, we have witnessed the transformation of the European energy sector, a process which requires Poland to diversify its energy sources, including renewable energy sources (RES). The underlying factor for these changes is the need to meet the growing demand for energy, the necessity to take concrete steps to reduce the harmful effects of the energy sector (especially power generation) on the environment and the desire to enhance energy security at the European level and local levels in each Member State.

According to research, until 2040, the demand for energy in Poland may increase by 50%, from the present 160 TWh to 240 TWh (Berkenkamp et al. 2016). Ensuring the stability and security of the energy supply will be a major challenge for the energy sector mainly due to the need to refurbish its aging, fossil fuel based generation assets and the need to develop the grid to connect further volatile renewable sources. In 2018–2032, the planned capacity decommissioning (mainly conventional units) is approximately 11.8 GW. In the same time, utilities plan to develop more than 11.9 GW of new generation capacity, of which almost 32% is in wind (for comparison – about 33% involves coal-based technologies). The main reason for capacity decommissioning is technical wear (URE 2019). In 2020 alone, it is expected that approximately 2.5 GW will be decommissioned in the case of unit modernization, which is not justified from the technical or the economic point of view (Draft PES 2019). The Polish Electricity Committee points to a threat of "missing capacity", which means a decrease in the production capacity resulting from the lack of investment in the new generation capacity (PKEE 2016). The situation threatens the stability of the power supply and may cause power shortages, which has already been encountered in the past.

Offshore wind energy fits perfectly into these trends, and no surprise, it is one of the fastest growing industries in the energy sector in Europe. The European offshore potential is estimated at 450 GW (until 2050), with some 93 GW on the Baltic Sea, of which Poland accounts for 28 GW (WindEurope 11/2019).

The enormous potential for possible energy production in Polish marine areas is accompanied by a very large capacity of the Polish steel and shipbuilding industry. Polish companies could ensure local content of 50% to offshore wind farm projects (PSEW 2019). Such favorable conditions in Poland for the development of the technology contribute not only to the sustainable development of the energy sector, but also boost the socio-economic development of the country.

The potential of offshore wind energy has been mentioned increasingly often in Polish strategy papers. The current draft of the Polish Energy Policy until 2040 points to the important role of offshore wind as a key technology in the further RES development in Poland. However, the net capacity forecast included in the document has been defined at a conservative level.

# 1. European and national conditions of offshore wind energy development

The offshore wind sector has been rapidly growing in Europe for several decades. The first offshore wind farm was established on the coast of Denmark 22 years ago. The Vindeby Farm of 4.95 MW consists of eleven turbines 0.45 MW each. Each year it has provided for the electricity demand of 3,506 households (WindEurope 11/2019).

Europe is the world leader in the development and operation of offshore wind farms – over 90% of the total offshore installed capacity is in Europe (WindEurope 2020). Many countries of the world included offshore wind targets in their national energy strategies. Some of them have already started the development of the technology (for example China – approximately 4,588 MW of installed capacity, South Korea 73 MW, Japan about 53 MW, and USA 30 MW) and certainly in the coming years we will witness a rapid development throughout the world (Statista 2020). Of course, this depends on a number of factors, including the technology. The capacity of wind turbines has been growing steadily, which provides for larger generation and investment outlays reduction. Although power generation from offshore wind farms accounts for only 0.3% of the global energy production (IEA 2019), its potential is enormous. The utilization of the potential on a larger scale depends, to a large extent, on policy makers and support schemes offered by individual Member States.

The tremendous interest in using the power generation capacity of offshore wind results from its characteristics. In comparison to onshore wind farms, offshore wind farms offer higher efficiency of turbines, improved generation and predictability, as well as stronger winds in marine areas and no technological restrictions, since turbines installed at sea can be larger and more efficient (in 2019, average capacity of offshore wind turbines was 7.8 MW, whereas in 2015 it was 4.2 MW), longer operation period for a project and fewer spatial conflicts. Additionally, the majority of the largest cities in the world are situated on the coast and offshore wind generation close to the main demand centers can meet the demand for energy without any need to develop long transmission lines. The technology undergoes continuous improvement, and statistics speak for themselves: turbines to shore distance has been growing (for example in 2019, average distance from shore was 59 km, whereas in 2015, 4.3 km), turbines are set at increasingly larger depths (average depth of turbine installed in 2019 was 33 m, whereas in 2015, it was 27 m) (WindEurope 2020).

In 2019, in Europe, a record new capacity was connected to the grid, namely 3,600 MW (502 new turbines in 10 wind farms). The average capacity of an offshore wind turbine was 7.8 MW (for example in 2015 it was 4.2 MW), while the average size of a wind farm was 621 MW (comparing with 337.9 MW in 2015). Now, Europe has 22 GW installed capacity in offshore wind, which corresponds to 5,047 turbines connected to the grid in 12 countries (approximately 77% of projects are on the North Sea, about 10% on the Baltic Sea, approximately 13% on the Irish Sea and the remaining part on the Atlantic Ocean) (WindEurope 2020).

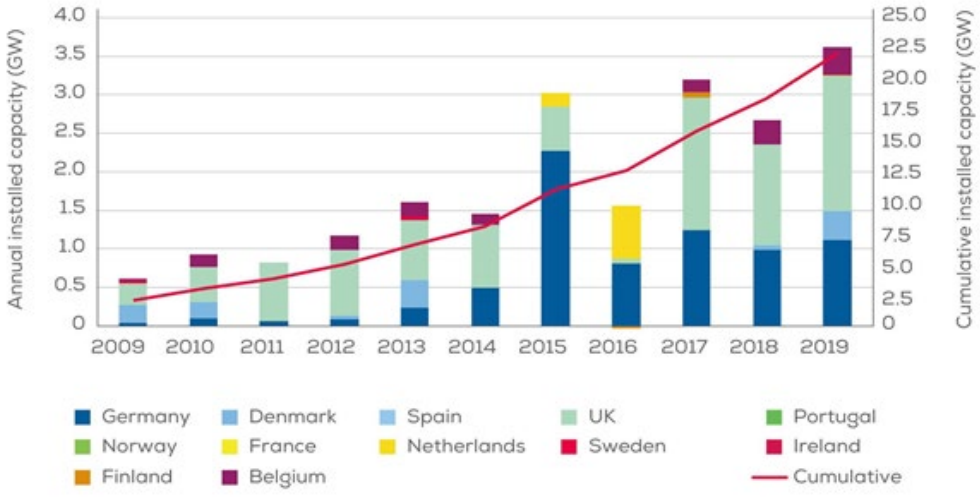


Fig. 1. Annual and cumulative installed capacity in offshore wind farms in Europe [MW]
Source: WindEurope 2020

Rys. 1. Roczna i skumulowana moc zainstalowana w morskich farmach wiatrowych w Europie [MW]

Figure 1 shows the annual cumulative installed capacity of offshore wind farms in Europe.

The United Kingdom has the largest offshore wind power capacity installed (more than 9,945 MW), followed by Germany (more than 7,445 MW) and Denmark (over 1,703 MW). Other countries developing this technology include: Belgium (1,556 MW), Netherlands (1,118 MW), Sweden (192 MW), Finland (70.7 MW), Ireland (25.2 MW), Portugal (8.4 MW), Spain (5 MW), Norway (2.3 MW) and France (2 MW) (WindEurope 2020).

An important incentive for the development of the offshore wind sector in Europe is provided by the support to renewable sources of energy offered by European institutions, including, in particular, the EU Climate and Energy Policy. In 2009, a package of regulations was adopted designating three main objectives to counteract climate changes by 2020 (3x20 package). The package defines mandatory targets for each Member State, depending on the specific nature of a country and the capacity of its economy. Objectives set out for Poland (EC):

- increase to 15% the share of RES in the final gross energy consumption by 2020;
- contribution to EU greenhouse gas emission targets of 20% (from levels of 1990) by 2020 (compared to 2005: –21% in EU ETS and –10% in non-ETS).

In 2014, the European Council maintained its commitment to counteract climate changes and endorsed four EU-wide objectives until 2030. The objectives were revised in 2018 as follows:

- contribution to EU greenhouse gas targets of 40% from levels of 1990 (compared to 2005: –43% in EU ETS and –30% in non-ETS);
- at least 32% share of RES in the final gross energy consumption;
- energy efficiency increased by 32.5%;
- completion of the internal EU energy market.

From the point of view of the EU climate and energy policy, global climate change agreements and EU objectives are also very important to meet the above targets. It is worth mentioning the Paris agreement of 2015 (the agreement signed during the 21 Conference of the Parties to the United Nations Framework Convention on Climate Change – COP21), which set an ambitious goal to stop the global average temperature increase below 2°C comparing with the pre-industrial level and try to keep it below 1.5°C. The "Clean energy for all Europeans" package, adopted in 2019, was a sort of manual to attain the agreed ambitious objectives and ultimately create the energy union and the single energy market in the EU.

At the end of 2019, the European Commission announced the so-called European Green Deal which commits Europe to become the first climate neutral continent by 2050. The European Green Deal is an ambitious package of measures that should enable European citizens and businesses to benefit from the sustainable green transformation. The Commission highlighted that the reduction of emission from the EU power generation systems is crucial for achieving our climate goals. Today, more than 75% of greenhouse gas emission in the EU comes from the production and energy consumption. Therefore, the Commission intends to revise existing objectives and provide more ambitious climate oriented goals for 2030. Based on those goals, Member States will update their national action plans in the field of energy and climate (Communication EC 2019).

## 2. References to the offshore wind sector in the Polish energy policy

The energy policy, one of nine strategic documents pertaining to the broad development in Poland, defines the vision for the energy sector, which is one of the most important infrastructure sectors. The existing two key policy documents, crucial from the point of view of the development of the sector, are the *Energy and Environmental Security* S*trategy – Until 2020* adopted in 2014, and the *Polish Energy Policy until 2030* adopted in 2009. The two policy

papers will soon be replaced by the Polish Energy Policy until 2040 (PEP2040). The authors of the draft PEP2040 indicate that the Policy "responds to the most important challenges facing the Polish energy sector in the coming decades and it sets directions for the development of the energy sector while taking targets to be achieved in the short-term period into consideration" (Draft PES 2019). We should remember, however, that changes in the energy sector are implemented over several years with long-term effects. The above has been reflected in the energy forecasts underlying the PEP.

In Poland, RES account for approximately 14% of the total power generation capacity installed in the national energy system. In 2019, wind turbines generated 1,664 GWh, which accounted for 12% of the total (Polskie Sieci Elektroenergetyczne SA). The Polish energy sector continues to depend on carbon, which has often been stressed by the draft PEP2040. At the same time, the document highlights the importance of the just energy transition, which means that countries with coal-based energy sectors should receive support for the transition toward a more sustainable, low carbon economy. This is based on the fact that those countries will have to invest more in new capacity (often more expensive new technologies), and the extension of the grid infrastructure. The above will also have its impact on the energy price for the end consumer (Draft PES 2019).

Of course, PEP objectives are consistent with European ones: energy security, while ensuring the competitiveness of the economy, energy efficiency and reduced impact of the energy sector on the environment, accompanied by optimum use of its energy resources, which highlights the important role of coal in the Polish energy sector.

Nevertheless, the development of RES has been recognized as one of the objectives of the Polish Energy Policy until 2040, which in practice means the reduction of emissions from the energy sector and the diversification of energy generation. The objective of 23% RES in the total energy consumption in 2030 will translate into approximately 32% RES in the total net power generation. According to the PEP2040, a key role in achieving the objectives for the energy sector will be played by photovoltaics and offshore wind due to an increase in their efficiency and the expected improvement of market flexibility. They are necessary for the development of RES in general and the two technologies in particular. Consequently, the two technologies are expected to account for the largest volume of power generated from RES in 2040 (Fig. 2) (Draft PES 2019).

At present, the development of the offshore wind sector is the 6$^{th}$ strategic objective of the PEP2040 with a designation that the new technology is not be able to develop fully in the current legal framework. Therefore, the Policy foresees dedicated regulations to be adopted in the first quarter of 2020 (draft bill on promotion of energy generation from offshore wind farms has been consulted by the Ministry of State Assets). At the same time, the PEP2040 provides for the establishing of the first Polish offshore wind farm in 2025. The analysis of the situation on the Polish offshore market shows that the goal is very realistic.

It should be emphasized that the previous policy document, i.e. the Polish Energy Policy until 2030, also pointed to the important role of the offshore wind sector. The same applies to supporting documents which referred to its potential at a far higher level than the level specified

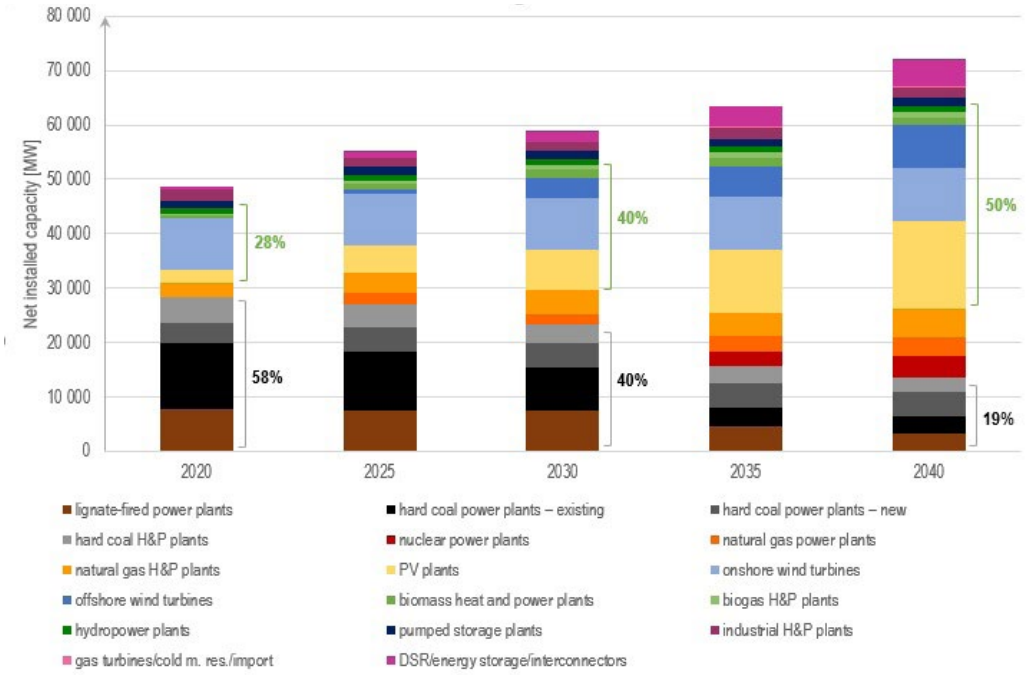


Fig. 2. Installed capacity forecast in the power sector in 2020–2040
Source: Draft PEP2040

Rys. 2. Prognoza mocy zainstalowanej w sektorze wytwórczym energii elektrycznej w latach 2020–2040

in the draft PEP2040. However, at that time, the development of the sector was not considered a priority.

In their position to the draft Polish Energy Policy until 2040 of November 29, 2019, the Polish Wind Energy Association stresses that from the point of view of the development of the offshore wind sector it is important to identify its potential of at least 10 GW (now, it is 3.8 GW). According to the Association, "setting ambitious goals is particularly important for suppliers and subcontractors for offshore wind farms, since they need a precise time framework for projects to investment in their production facilities. The reduction of the target would sent a negative and worrying signal to investors and suppliers in the supply chain" (PSEW 2019).

## 3. The Baltic Sea as offshore wind exploration area

As mentioned earlier, approximately 10% of existing offshore wind farms are in the Baltic Sea area. The current status of the offshore wind sector does not reflect its potential (the exami-

nation of the potential has taken wind conditions, depth, icing, and spatial planning and environmental requirements into account) which the European Commission estimated at up to 93 GW (achievable in 2050). Based on wind measurements, it has been defined that offshore wind farms could produce 325 TWh/year (for comparison, in 2016, total consumption of electricity in Baltic Sea Region was 913 TWh) (EC 2019).

Of the 22 GW total installed capacity of offshore wind farms in Europe, slightly over 2 GW are located on the Baltic Sea (Denmark – 872 MW, Finland – 68 MW, Germany – 1,074 MW and Sweden – 192 MW) (WindEurope 11/2019). To achieve the goal for 2050, every year Baltic countries should develop wind farms of at least 3 GW. Considering the above, this objective seems very ambitious. To achieve it, all states in the Baltic Sea Region should have clear climate and energy targets, develop incentives in the form of a dedicated, carefully designed support system, and initiate cooperation to integrate their energy markets and develop interconnectors at an unprecedented level. The European Commission also added that Member States would have to provide access to their marine areas to guarantee long-term income and develop long-term schedules for auction or other support schemes (for example contracts for difference) for offshore wind farms (EC 2019).

Cross-border cooperation in the Baltic Sea Region is often mentioned as one of key factors necessary to release the potential of the offshore wind sector in the area. An integrated market could help to address the problem differences in energy prices, models and technical standards. It seems evident that the second key factor is the development of the grid to enable to connect such a high capacity, as well as ensure the functioning of the new energy market. This can guarantee the stability of the power supply and balancing of the grid with highly volatile wind energy sources (we need to remember that apart from offshore wind farms, PEP2040 also provides for development of other RES). Crucial cooperation areas include: spatial planning on marine areas, planning and development of the grid both offshore and onshore, financial framework and technical standards (WindEurope 11/2019).

So far, several initiatives have been established to promote cooperation in the Baltic Sea region. One of them is the BEMIP (Baltic Energy Market Interconnection Plan), coordinated by the European Commission and involving 8 Baltic countries (Denmark, Germany, Estonia, Lithuania, Latvia, Poland, Finland and Sweden). The BEMIP led to the implementation of infrastructure projects which focused on the development of the grid, for example: Estlink, Nordbalt and LitPol Link, which provide interconnections between Finland, Sweden and Poland (EC 2019).

It is also worth mentioning the joint initiative of WindEurope (European Wind Energy Association) and industry associations from Estonia, Denmark, Finland, Sweden, Lithuania, Latvia, Poland and Germany to support regional energy transformation. The initiative aims to develop a single energy market model, regional cooperation in the planning and development of the grid, and the system of support for offshore wind projects (Basof 2020).

As yet, no comprehensive spatial development plan has been created for the Baltic Sea area. Moreover, the majority of the marine area is not covered by any plan at all. The European Union requires Member States to develop such plans which should be submitted until March 2021. Poland has already completed a draft plan and the development of cross-border environmental

impact assessment papers is in progress (expected completion within 6 months). From the point of view of the offshore wind sector, the plan is important, since investors who have already obtained planning permits (details in further part of article) may continue their work and seek to obtain further permits (environmental and building permits). The process of granting permits has been brought to a halt until the spatial plan is adopted (Maritime office in Słupsk).

## 4. Opportunities and threats to investment in offshore wind energy

No offshore wind farm project has been implemented in Poland as of yet. There are, however, several investors interested in the sector in Poland and several projects are already advanced in their preparatory phase. Table 1 summarizes Polish offshore wind projects. In Poland, the pioneers in the offshore wind sector include Polenergia (now paired with Equinor) and PGE, and their projects are actually the most advanced. Other parties considering investment in the future are PKN Orlen and Tauron.

Table 1. Polish offshore wind projects

Tabela 1. Polskie projekty morskich farm wiatrowych

| No. | Project | Area [km$^2$] | Grid connection conditions [MW] |
|---|---|---|---|
| 1. | Polenergia – Bałtyk I | 128 | 1,560 (grid connection conditions – GCC) |
| 2. | Polenergia/Equinor – Bałtyk II | 122 | 600 (grid connection agreement GCA) + 240 MW (GCC) |
| 3. | Polenergia/Equinor – Bałtyk III | 116 | 1,200 (GCA) |
| 4. | PGE Baltica 2 | 189 | 1,498 (GCC) |
| 5. | PGE Baltica 3 | 131 | 1,045 (GCA) |
| 6. | PGE Baltica 1 | 108 | |
| 7. | Baltic Trade Invest | 42 | 350 (GCC) |
| 8. | PKN Orlen – Baltic Power | 131 | 1,200 (GCC) |
| 9. | EDPR – B-Wind | 42 | |
| 10. | EDPR – C-Wind | 49 | |
| 11. | Grupa BALTEX – Baltex-2 | 66 | |
| 12. | Grupa BALTEX – Baltex-5 | 111 | |
| Total | | 1,261 | 7,693 |

Source: PSEW 2019.

To define opportunities and threats to the investment processes in the sector, one should analyze milestones in the implementation of this type of project in Poland.

Firstly, the project should obtain a planning permit (building permit and the use of artificial islands, structures and equipment in Polish marine areas) issued by the minister responsible for the maritime economy (after the adoption of a marine area master plan, the director of the relevant maritime office). The planning permit provides for the right to use Polish marine areas (in the case of offshore wind farms, within exclusive economic zones, since such investments may only be located in this area) for 35 years with a possibility to extend the period under certain conditions. The validity of the permit, however, expires after 8 years, if the investor fails to obtain a building permit, 3 years after the building permit if the investor does not start construction, of 5 years after the completion of the investments, if the investor does not start its operation. Additionally, an annual fee is charged for the permit at the level of 1% of the project value (payable in installments prescribed by law) (MMA 1991).

Then, the project must undergo an environmental impact assessment (EIA) and obtain an administrative decision on environmental requirements from the Regional Directorate for Environmental Protection.

Yet another step is to apply for a building permit (issued by Governor), as well as a permit for placement and operation of submarine cables within the Polish exclusive economic zone from the minister responsible for the maritime economy and the Director of the Maritime Office relevant for the cable within the internal waters and territorial sea. Of course, the investor needs to obtain conditions to connect to the grid and sign an agreement with the transmission system operator (PSE SA), as well as perform a number of tests and analyses, chiefly wind measurements and environmental, location and other surveys.

In conclusion, the implementation of offshore wind farms is an intensive, lengthy and costly process, every stage of which has impact on the overall investment cost. In Poland, planning, development and construction may take up to 9 years.

In this context, we can define major needs of the offshore wind sector, the fulfillment of which determines the development of the sector in Poland (PSEW 2019):

1. To ensure sufficient area for offshore wind farms and technical infrastructure in the master spatial plan for Polish marine areas.
2. Preparation of the national grid (investment in transmission infrastructure) to connect offshore wind farms at the capacity level corresponding to the potential for 2050.
3. Preparation and development of port and inshore infrastructure to export generation from offshore wind farms.
4. The government should offer an attractive and stable support system for offshore wind farms, including a guarantee of power purchase from offshore wind farms at a relevant price.
5. Ambitious targets should be defined for the development of the offshore wind sector in strategic energy policy papers.

At the same time, we should be aware of the tremendous opportunities related to the development of the offshore wind sector. The Polish Wind Energy Association highlights that by 2030 the offshore wind sector can generate additional PLN 60 bn to the Poland's GDP, and charges and

taxes on wind farms can contribute to local and central government budgets with the amount of PLN 15 bn by 2030. Moreover, by 2030, the development of the industry can create as many as 77 thousand new jobs (PSEW 2019). A typical tower of a wind turbine comprises 300–400 tons of steel and its foundation structure adds another 750–1200 tons. The construction of offshore wind farms of 6 GW will require one million tons of steel, which alone is a huge opportunity for the Polish steel and shipbuilding industries (McKinsey&Company 2016).

## Conclusions

Offshore wind energy enhances the security of energy supply in Europe, eliminates dependence on prices of oil, gas and coal, and reduces risk related to fuel import from other countries (including Russia). It has supports growth and generates significant socio-economic advantages.

In 2016, industry related to the wind energy contributed 36.1 bn euros to the EU GDP, of which 22 bn was directly from the wind industry, including developers, manufacturers of turbines and components, service providers and suppliers of foundations for offshore wind farms.

The development of the offshore energy sector also affects the labor market. In the last 10 years, in Germany alone, the offshore wind sector created 25 thousand new jobs. The building of offshore wind farms of 32 GW in the Baltic Sea Region by 2050 would create about ten thousand new jobs every year during planning and construction and even 29 thousand new jobs a year during Operation & Maintenance (EC 2019).

Poland has one of the largest potentials for offshore wind farms development in the Baltic Sea Region and once utilized it would stimulate economic growth and the social development of our country. As emphasized by EU bodies, and scientists and experts from the industry, the use of the potential will not be possible without a firm position of the government regarding their will to support the sector. This should be reflected in long-term objectives and strategies, and in the national law providing a framework for the functioning of the sector in Poland.

Positive changes in the perception of the sector can already be seen, and the evidence of that is the recognition of the development of the offshore wind sector as one of strategic goals in Poland Energy Policy until 2040. Another positive signal for the sector is the dedicated act of law (drafted) providing support of offshore wind farms. Considering wind to be a fairly new technology that necessitates major investment, the offshore wind sector needs dedicated solutions. Despite a higher support in relation to other power generation technologies, experts are in agreement that the cost per unit of energy produced by offshore wind farms will rapidly decrease, and the technology will be able to compete with conventional technologies as well (which is already the case in Denmark). We should remember that the offshore wind sector stands out among other technologies in terms of the total cost balance because of significant benefits for the economy and the environment. Thus, it fits perfectly into the idea of sustainable development.

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# Wyzwania polskiej polityki energetycznej w zakresie rozwoju morskiej energetyki wiatrowej

## Streszczenie

Morska energetyka wiatrowa jest stosunkowo nowym sektorem gospodarki o ogromnym potencjale. Jej główną zaletą jest przewidywalna produkcja i wysoki współczynnik wykorzystania mocy, szacowany na poziomie 50% (w przyszłości nawet 60%), co czyni ją najbardziej efektywnym źródłem energii spośród wszystkich technologii odnawialnych. Polska posiada największy potencjał rozwoju morskiej energetyki wiatrowej w regionie Morza Bałtyckiego, co odzwierciedlają plany inwestorów przygotowujących się do realizacji inwestycji w polskich obszarach morskich. Europejskie strategie energetyczne i klimatyczne, kształtujące zasady i główne założenia transformacji europejskiego sektora energetycznego zgodnie z zasadą zrównoważonego rozwoju, podkreślają znaczenie morskiej energetyki wiatrowej w dążeniu do osiągnięcia neutralności klimatycznej gospodarki Unii Europejskie oraz jej wkładu dla zapewnienia bezpieczeństwa energetycznego Europy. Również w Polsce decydenci starają się stworzyć warunki sprzyjające rozwojowi morskiej energetyki wiatrowej. Celem artykułu jest przedstawienie europejskich i polskich uwarunkowań rozwoju morskiej energetyki wiatrowej. Na potrzeby dokonania oceny szans i zagrożeń rozwoju tej technologii w Polsce przeanalizowano, czy potencjał morskiej energetyki wiatrowej został uwzględniony w kluczowych dokumentach strategicznych związanych z rozwojem polskiego sektora energetycznego, a także, w jaki sposób państwo planuje wspierać rozwój tej technologii. Szczególny nacisk położono na obecnie procedowany projekt Polityki Energetycznej Polski do roku 2040, z uwagi na nadrzędny charakter tego dokumentu, wyznaczającego kierunki rozwoju polskiej energetyki na kolejne 20 lat.

Słowa kluczowe: morska energetyka wiatrowa, morskie farmy wiatrowe, polityka energetyczna, odnawialne źródła energii