

OFFSHORE WIND FARMS IN EUROPE AND WORLDWIDE – THE POSSIBILITIES OF SELECTED COUNTRIES AND THE STATE OF DEVELOPMENT OF INSTALLATIONS IN POLAND

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Abstract

The offshore sector is one of the most dynamically developing branches of the economy. The countries with access to the sea in this sector see an opportunity to produce cheap clean energy. One of the countries which may become beneficiaries of the development of this technology is Poland, because the Baltic Sea has excellent conditions for generating energy by means of wind farms.

Key words: offshore, renewable energy sources, Baltic Sea

Introduction

The debate on the fundamentals of the development of offshore wind energy (OWE) in Poland has been going on for a decade. Offshore wind energy is one of the most dynamically developing technologies for the production of electricity, particularly in Europe. The development of this branch of the economy is supported above all by relatively low operating costs, the possibility of generating stable ecological energy and the negligible impact on the social and environmental conflict. The annual capacity increase is over 30% (WindEurope, 2016, 7-12). The installed capacity in Europe is more than 11.5 GW (McKinsey&Company, 2016, 4-22).

The main aim of the article is to present the situation of the offshore sector and installed capacities, including in selected countries, as well as the state of development of installations in Poland.

The following hypotheses have been verified in the article in relation to the set objective:

1. The world leader in the offshore sector is the United Kingdom, which produces about 1/3 of the world's power generated by offshore wind farms.
2. The main factor influencing the pace of development of the offshore sector in Poland is the lack of clearly defined legal norms.

In connection with the objective and hypotheses, the following research questions have been formulated: Which of the European countries utilise most in terms of offshore wind farm energy? Which country outside Europe is the most dynamically developing Offshore Wind Farms? What is the current status of offshore development in Poland? What are the estimates for electricity transfer from the Baltic Sea till 2030 in Poland?

The article mainly uses articles from industry portals, information available on investors' websites, and statements and interviews with specialists directly related to the sector, as source material.

Being aimed at a verification of hypotheses and constructed assumptions they made up their mind for using the analysis method of available information and documents. Using this method a situation and possibilities of chosen states will be presented in the sector offshore and state of Polish installations.

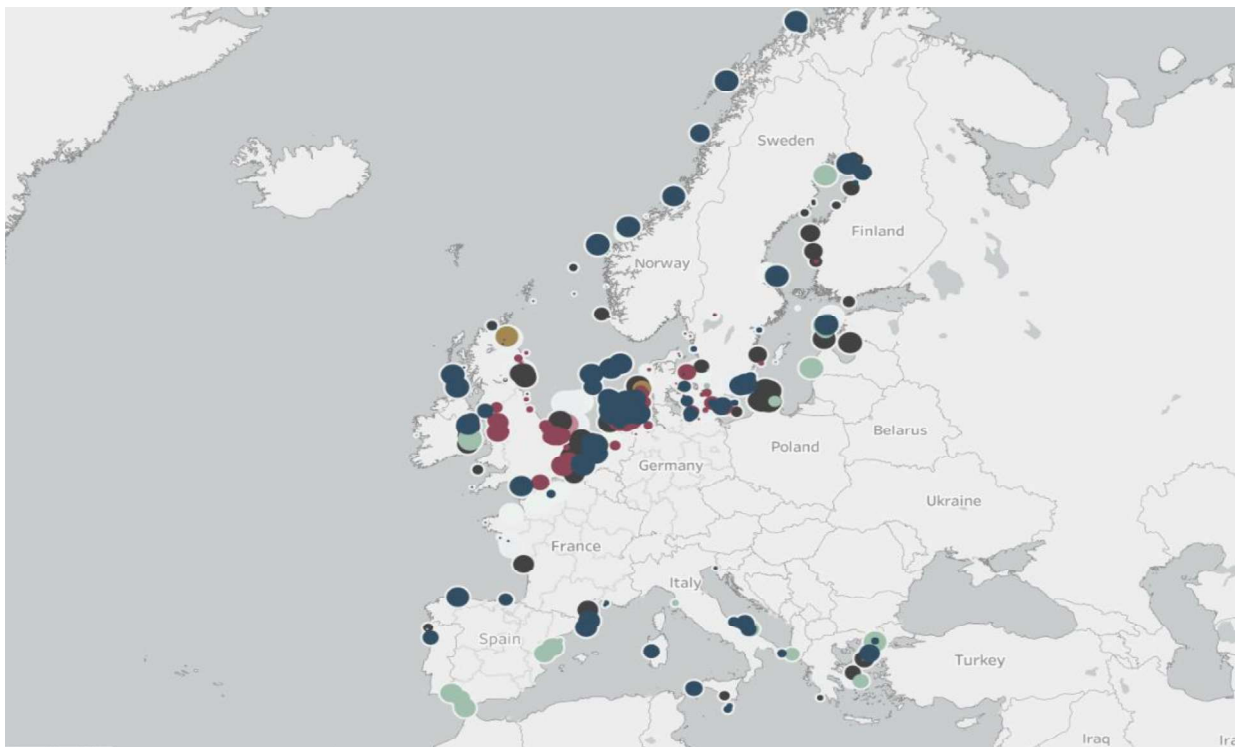
The first part is filing articles oneself from information concerning the state of the section of sea wind farms in Europe, with particular reference to of Great Britain and Germany. Additionally a state of the development was also presented Chinese of wind sea power stations.

The second part of the text constitutes presentations of the situation offshore in Poland. She is presenting plans, projects, the current state and future possibilities of the development of this sector in Poland. Also statistical data concerning future, possible powers for getting produced are given.

The state of offshore wind farms in the world on the example of selected countries

Europe is a clear leader in the construction of offshore wind farms. In 2017, the total power output of OWE in Europe amounted to 15.8 GW. Compared to 2016, this is an increase of 25% (WindEurope, 2017). The result was due to the launch of 13 new offshore wind farms, including the first offshore wind farm in Hywind Scotland. More than 4,000 offshore wind turbines operate in 11 countries on the Old Continent (Leonardo Energy, 2018). According to data from the Global Wind Energy Council (GWEC), 51.3 GW turbines were installed worldwide in 2018. From 2014 onwards, in each subsequent year, the growth rate will be at least 50 GW (Shipbuilding Portal, 2019). This potential is constantly being developed and new installations are being systematically implemented in successive countries. After analysing power generation from traditional and offshore wind farms, the results show that offshore wind farms account for only 1/10 of the total capacity. However, the Global Wind Energy Council predicts that by 2023 it will already have reached a quarter of its capacity. The major players in this area are the United Kingdom, Germany and China (World Economic Forum, 2019). The deployment of offshore wind farms (OWF) in Europe is shown in Figure 1.

Figure 1: Map of European wind farms



Source: WindEurope, 2019

It is worth noting that almost 98% of offshore wind farms in Europe are concentrated around a few countries, namely, the United Kingdom, Germany, Denmark, the Netherlands, and Belgium. The data showing the production capacity in Europe are presented in Table 1.

Table 1: Installed capacity of offshore wind farms in Europe (MW)

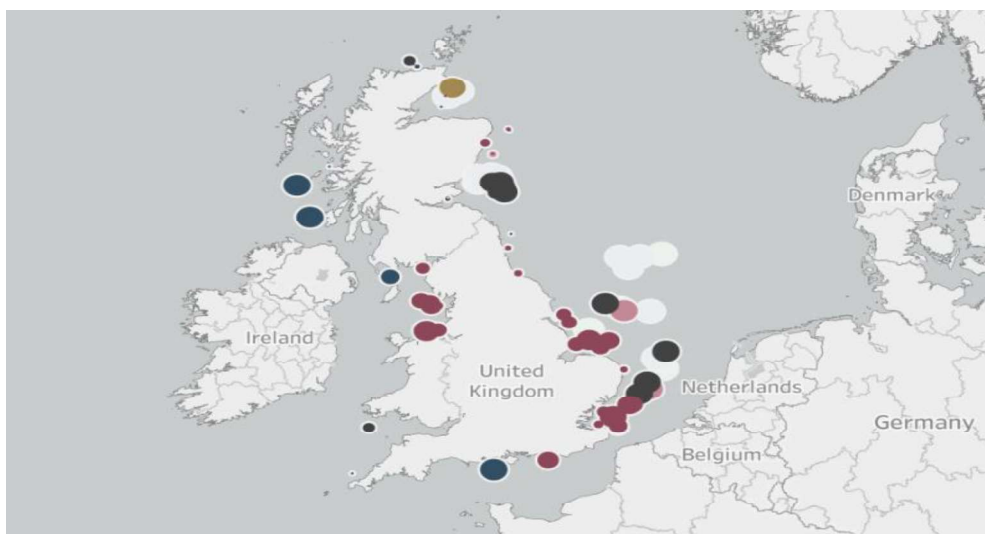
No.	Country	Installed capacities of OWE
1.	United Kingdom	8,183
2.	Germany	6,380
3.	Denmark	1,329
4.	Belgium	1,186
5.	Netherlands	1,118
6.	Sweden	192
7.	Finland	71
8.	Ireland	25
9.	Spain	10
10.	Norway	2
11.	France	2

Sound: WindEurope, 2019

The world leader in OWE is the United Kingdom. The British have 34% of the installed power. It is estimated that by 2030 1/3 of the UK's energy mix will be covered by offshore generation. The UK has been sector leader since 2008, when it overtook Denmark. *RenewableUK* estimates that the cost of new offshore energy fell by 50% in 2015 (World Economic Forum, 2019). This has been aided by factors such as:

- government policy encouraging investment in offshore and discouraging investment in on-shore wind farms,
- geographical conditions favourable to the creation of offshore wind farms (Fig. 2).

Figure 2: Distribution of offshore wind farms in the UK

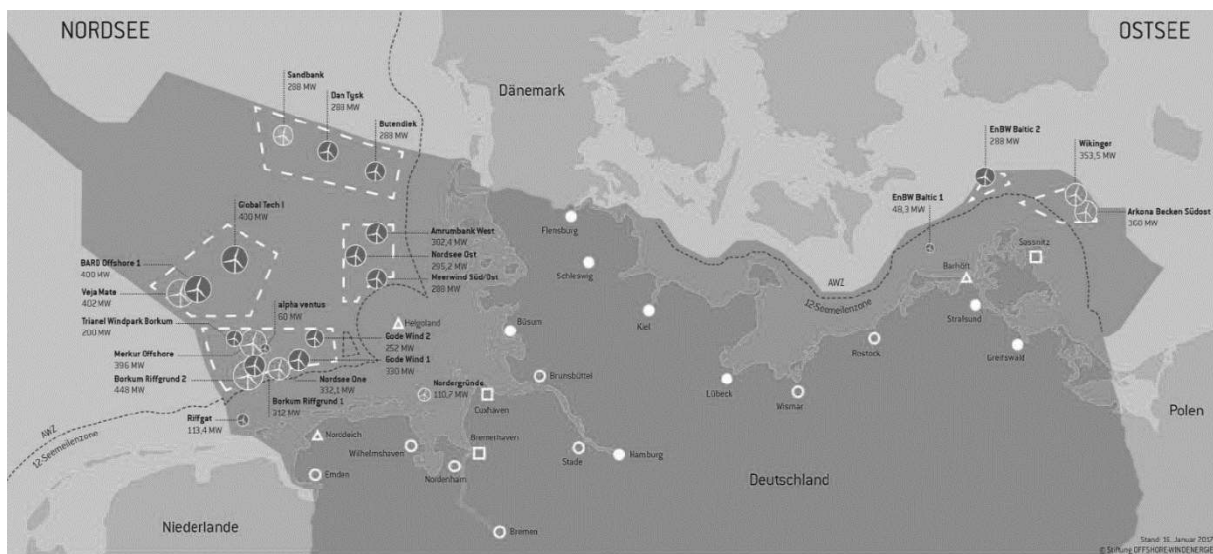


Source: WindEurope, 2019

China is experiencing dynamic growth in the offshore sector. The Chinese are leaders in investments in both onshore and offshore wind energy. In 2018, China launched 1.8 GW of OWE, which gave it a leading position in this period (Shipbuilding Portal, 2019). The Chinese plan is to double the rate of increasing their capacity by 2025. (World Economic Forum 2019). The development of the offshore sector is determined mainly by growing demand. According to the International Energy Agency, China's energy consumption increased by 3.5% or 1/3 of global demand (IEA, 2018). In the Chinese province of Jiangsu, 24 offshore development projects were approved. Their cost will be 18 billion dollars and will supply 6.7 GW (World Economic Forum, 2019).

German offshore wind turbines account for 28% of all offshore installations, and in 2018 they installed 136 new turbines. There are 6.4 GW of power installed in the maritime zones. Germany's first offshore wind farm was started by Alpha Ventus, the first offshore wind farm to start producing electricity, relatively late, in 2009. (World Economic Forum, 2019). The Federal Ministry of Economy and Energy has said that since 2013 investments amounting to 15 billion EUR have been made in the offshore industry. However, stakeholders in the sector, such as the German Wind Energy Association (BWE), the Association of German Mechanical Engineers and Equipment Builders (VDMA) and the Windenergie Agentur (WAB), are concerned that the current political situation in the country is not conducive to the long-term development of the sector (Renewable Energy World, 2019). The location of German wind turbines offshore is shown in Figure 3.

Figure 3: Distribution of offshore wind turbines in Germany



Source: Renewable Energy World, 2019

German offshore wind farms are located mainly within the North Sea. This is largely due to the increased location capacity, as the German part of the Baltic Sea is much smaller than the areas in the North Sea. Nevertheless, Germany is also planning to construct an installation in the Baltic Sea. By creating appropriate legislative conditions, it has become possible to separate the zone at a distance of 10 km from the coast and place up to 12 turbines in the Baltic Sea. Turbines of 13-15 MW unit capacity will be tested there (Gram w Zielone, 2019).

Offshore in the Polish Baltic Sea Region – current status

Offshore wind farms (OWFs) are in the government's strategic plans. The Polish offshore sector will eventually provide around 10 GW in 2040. In 2025, according to the National Energy and Climate Plan, the first installations are to be launched (State Energy Policy until 2040, 2018).

In the Polish economic zone in the Baltic Sea there are designated areas to be used in the energy sector. The area designated for this sector is approximately 2,000 km² (Rączka 2018, 12). The areas made available for use are presented in Table 2.

Table 2: Area of the Polish Economic Zone in the Baltic Sea to be used in the energy sector

No.	Terrain	Area (km ²)
1.	Odrzańska Sandbank	380
2.	Słupska Sandbank	1210
3.	Środkowa Sandbank	390

Source: Rączka 2018 p.14

It is estimated that wind turbines with a capacity of 4 to 5 MW can be installed per 1 km². This means that the production potential in the designated areas is in the range of 8-10 GW (Rączka 2018, 13). The expected time of completion of the first developments is estimated at 12-14 years. Projects implemented after this period are likely to be implemented much faster due to the experience gained and improvements in individual processes.

In the Polish economic zone of the Baltic Sea, 9 location decisions have already been issued for the following companies (Table 3) with a capacity of approximately 10 GW.

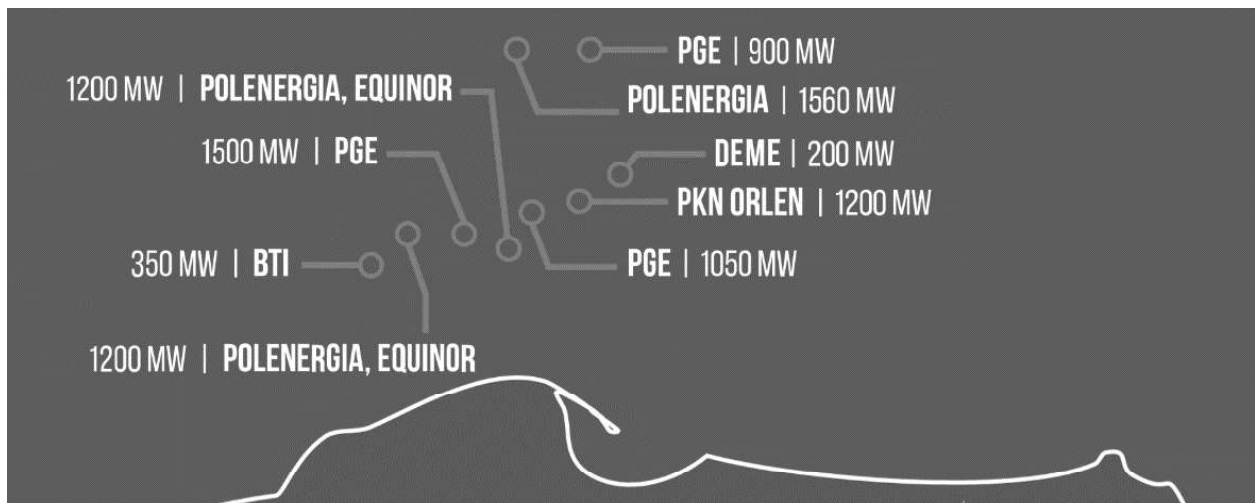
Table 1. Number of decisions for individual enterprises in the Polish maritime economic zone

No.	Investor	Number of decisions	Projected power (GW)
1.	Polenergia	1	No data
2.	Polenergia z Equinor	2	2.4
3.	Polska Grupa Energetyczna	3	2.55
4.	PKN ORLEN	1	1.2
5.	Baltic Trade & Invest	1	0.35
6.	DEME NV	1	No data

Source: Rączka 2018, p.15

It should be noted that the projects are at different stages of development. Some companies have already obtained the environmental decision and have already signed the connection agreements (Polenergia with Equinor). However, most investors are still applying for environmental decisions. Planned deployment of offshore wind farm projects in the Baltic Sea (Figure 4).

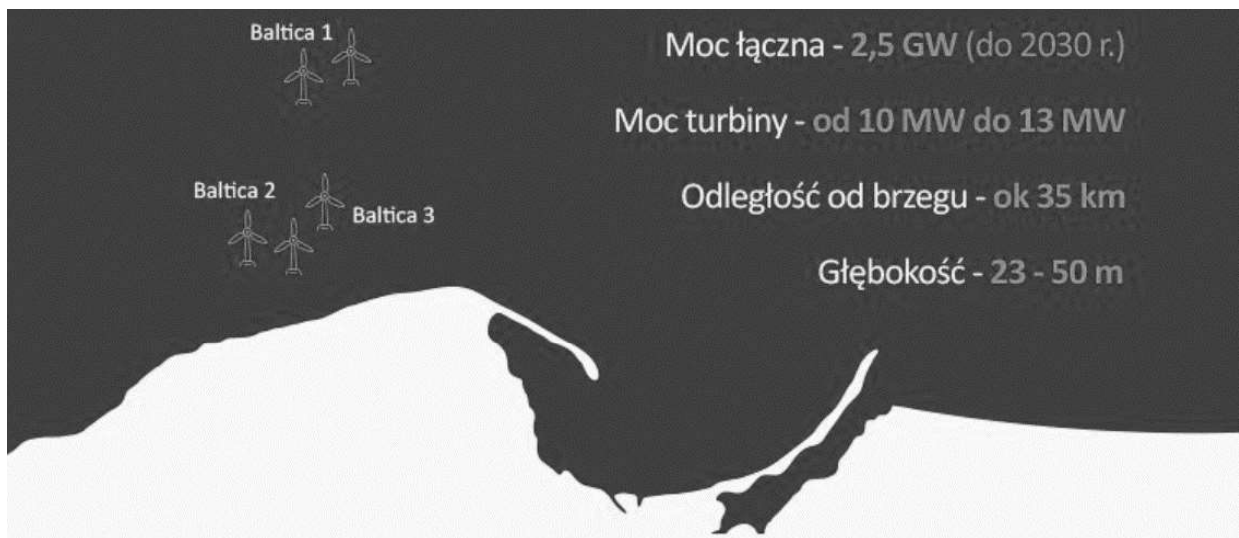
Figure 4. Distribution of OWF projects in the Baltic Sea



Source: *Wysokie Napięcie*, 2018

The National Energy Policy until 2040 provides that by 2030 Poland will hold 4.6 GW of OWE capacity. It is estimated that in the Polish offshore zone, the wind turbines will be commissioned after 2025. Then, Polenergia with Equiron and the Polish Energy Group projects will be commencing operations. In 2030, PGE want to have the power of 2500 MW and the turbines are to have the power of 10 to 13 MW (Fig. 5) (CIS, 2019).

Figure 5: Location and OWF technical data of PGE Baltica



Source: *WNP*, 2019

If Poland implements the assumptions of the State Energy Policy by 2040 and installs capacities in the Polish economic zone in the Baltic Sea amounting to approximately 10 GW, it will become a significant player in the European sector of the OWE (State Energy Policy to 2040, 2018).

Analysing the pace of work and preparations for the implementation and development of the offshore sector in Poland, one can assume optimistic scenarios for this branch of the economy. Nevertheless, specialists point out some problems that may hamper the work. One of

the barriers is the institutional (political) uncertainty about the future directions of the country's energy policy development. Stakeholders claim that the basic condition for the dynamisation of the sector in Poland is the political decision to include offshore wind farms in the energy mix (Institute for Structural Research, 2018). Many experts emphasise that in Poland, specific legislative steps should be taken to regulate the issues related to offshore wind farms (Portalmorski, 2019). However, specialists point out that offshore in Poland is a great opportunity that should be used (Energetyka24, 2019). They also add that from 2023/2024, 1 GW of electrical power should be installed annually in the Baltic Sea on a cyclical basis. The first electricity supply from the Baltic Sea should be shipped in 2027 and by 2030, Poland should have energy of about 6 GW at its disposal (YouTube 2019).

Summary

Offshore Wind Energy is a young sector, but it is developing very dynamically. Offshore is an excellent alternative for countries that have access to the sea and who want to develop renewable energy sources. Offshore wind farms are an opportunity for development for countries without minerals and enables clean energy to be produced.

By analysing the market and the current state of offshore development in Europe and the world, the first hypothesis was confirmed, which assumed that the OWF sector is one of the most dynamically developing in the world. This is confirmed by the fact that it is a relatively young branch of the economy, in which numerous investments are constantly made. Countries with access to the sea are trying to maximise its potential. One of the biggest advantages of offshore wind energy is the production of clean energy far from inhabited places, which are not always in favour of the changes taking place.

The first hypothesis related to the statement that the United Kingdom is the world leader in offshore wind power generation. The statistics clearly confirm this hypothesis. The UK currently has the greatest potential for offshore energy generation. The potential of this country is also constantly being developed, so that the share of this energy carrier in the energy mix can be even greater.

The second hypothesis assumed that the main factor influencing the pace of offshore development in Poland is the lack of clearly defined legal norms. Opinions and statements by experts clearly confirm that offshore in Poland needs set legal standards in order to function properly. The introduction of specific regulations will lead to the concretisation and systematisation of the implementation of OWF in the Polish Baltic Sea area.

Offshore is a great opportunity for Poland in terms of development and continuity of electricity supply. The vast majority of power plants in Poland are located in the south of the country. It is very important to create an appropriate infrastructure also in the north of Poland, as this will contribute to increasing Poland's energy security.

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