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Warsaw, 2013

Polish offshore wind energy and maritime industry development programme

Authors – Foundation for Sustainable Energy experts
Substantive Partner – EY

Draft of Polish offshore wind energy and maritime industry development programme

Team of authors supervised by Maciej Stryjecki

(Mariusz Wójcik, Jakub Sokołowski, Justyna Biegaj, Beata Bojanowska, Aleksander Gabryś)

Technical editor:

Magdalena Jankowska

Cover by:

Jerzy Opoka

Cover photo:

Zentilia – Dreamstime.com



Foundation for Sustainable Energy
Al. Wilanowska 208/4, 02-765 Warszawa
www.fnez.org, www.offshorepoland.eu

Warsaw, 2013

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Definitions and abbreviations

R&D – research and development

BIZ – direct foreign investments

CAGR – Compound Annual Growth Rate

CAPEX – capital expenditures

ULCIP Decision – the decision on establishing the location of the public purpose investment

DSU – decision on environmental conditions

The EIA Directive – Directive of the European Parliament and of the Council 2011/92/EU of December 13, 2011 on the assessment of the impact of certain public and private projects on the environment

EIB – European Investment Bank

EEZ – exclusive economic zone

ENTSO-E – European Network of Transmission System Operators for Electricity

WPP – wind power plant(s)

EWEA – European Wind Energy Association

FNEZ – Foundation for Sustainable Energy

GDOŚ – General Directorate for Environmental Protection

GPZ – Main Transformer Station

GW – gigawatt

HVAC – High Voltage Alternating Current

HVDC – High Voltage Direct Current

IEC – International Electrotechnical Commission

IPW – internal connection infrastructure

IPZ – external connection infrastructure

IRR – Internal Rate of Return

EGUC – energy generation unit cost

KfW – Reconstruction Credit Institute (*Kreditanstalt für Wiederaufbau*)

KIP – Project Information Sheet

KPA – Polish Code of Administrative Procedure

NREAP – National Renewable Energy Action Plan

NPS – National Power System

kV – kilovolt

kWh/m²a – unit of mean annual wind potential per given area

OWE – offshore wind energy

OWF – offshore wind farm(s)

MPZP – local development plan

MoU – Memorandum of Understanding

TS – territorial sea

MTBiGM – Ministry of Transport, Construction and Maritime Economy

MW – megawatt

MWh – megawatt hour

NSCOGI – North Seas Countries Offshore Grid Initiative

EIA – Environmental Impact Assessment

OPEX – operating expenditures

OPEXs – fixed operating expenditures

OPEXz – variable operating expenditures

RES – Renewable Energy Sources

CL – construction law

PWEA – Polish Wind Energy Association

PSZW – permit to erect and exploit artificial islands, installations and equipment within Polish maritime areas

EIA Report – report on the impact of the project on the environment

RDOŚ – regional directorate for environmental protection

EIA Regulation – ordinance of the Council of Ministers of November 9, 2010 on projects which may have a significant impact on the environment (Dz. U. [Journal of Laws] No. 257, item 2573, as amended)

CoO – certificate of origin

TWh – terawatt hour

TWh/a – terawatt hour per annum

EIA Act – the Act of October 3, 2008 on publishing information about the environment and its conservation, public participation in the

environmental protection and environmental impact assessment (Dz. U. [Journal of Laws] No 199, item 1227, as amended)

UPIZP – the Act on spatial development and planning

URE – Energy Regulatory Office

HV – high voltage

RCE – return on capital employed

ZSM – energy peak demand

Introduction

The discussion on the justness of the development of offshore wind energy (OWE) in Poland has been carried out for years. Decisions about the development of OWE are not easy due to the innovative nature of technology, high investment costs and long time and high risk involved in the execution of such investments. On the other hand, very high efficiency and stability of this low-emission renewable energy generation, considerably low operating costs and low social and environmental interference make this branch of industry one of the fastest growing in the European energy sector. **However, the most important reason for the development of offshore wind energy market is its direct connection with the offshore industry. Production of components for offshore wind power plants and vessels necessary for their construction and maintenance in shipyards and services provided by seaports are today a major stimulus driving the process of modernisation and growth of the European - and also the Polish - offshore industry.**

The development of Polish coastal regions depends strongly on the condition of the domestic offshore industry. Failure to develop offshore wind energy in Polish maritime areas would be detrimental to the economy and the societies of those regions. Especially, if the Polish shipyards have already taken the serious effort and invested in the preparation and development of production facilities for foundations, towers and transport and construction platforms for offshore wind power plants.

In 2009-2011 the Polish Government and Parliament successfully implemented a new system of issuing location decisions for offshore wind farms in the Polish exclusive economic zone, after recognising the justness of the development of offshore wind energy and industry in Poland. Thanks to that solution there are several projects already in the phase of development and their value exceeds PLN 30 billion. Those projects may supply the Polish energy system with 2.2 GW of installed capacity of emission-free, renewable energy sources.

Today, in the context of the economic crisis, the essential question must be asked: how to develop offshore wind energy in order to gain maximum economic benefits and to involve minimum social costs, in particular due to the increase of electric energy prices?

A possible answer to the question may be found in the "**Polish offshore wind energy and maritime industry development programme**", which was elaborated by the experts of the Foundation for Sustainable Energy in cooperation with EY.

The mentioned Programme demonstrates an optimum - from the economic, social and environmental perspectives - **scenario for the development of offshore wind energy and industry, assuming the installation of 6 GW of capacity in offshore wind farms up to 2030, out of which 1 GW should be installed up to 2020 and the following 2 GW up to 2025.**

Such a share of OWE in the national power system will not only increase in a sustainable manner the diversification of energy sources and also decrease the amount of emissions generated by our national economy, but it will become the driving force behind the development of the coastal regions.

Execution of the investments in OWF in Polish maritime areas may contribute to the development of Polish economy with an added value in the amount of PLN 81 billion up to 2030 and ca. 25,000 new jobs. The majority of new employment opportunities (ca. 85%) will be associated with the offshore industry.

The Programme assumes not only very ambitious investment plant, but also a strong regime in the reduction of investment and operating costs related to the development of offshore wind farms, what is compliant with the European tendency in creating the policy for this sector.

- **Investment costs (CAPEX) should be reduced by ca. 25%** in relation to the estimated data for 2012.
- **Operating costs (OPEX) should be reduced by ca. 24%** in relation to the values estimated in 2013.

This will allow for the reduction of a unit cost of energy generation by about 23%.

Hence, the value of the support for offshore wind farms would be reduced by 50% in the years 2014-2025. It should be also note that the system costs related to the support mechanism will occur only after 2020, when the first OWF are commissioned.

The development of the domestic production, logistics and service facilities, based on the national potential of our shipyards and ports will be the basic tool for the optimisation of costs. Major production and logistics centre should be located in Szczecin and Świnoujście. The operation and maintenance centres - in Darłowo and Ustka. The centres in Gdynia and Gdańsk will also play a vital role in terms of the production of components and vessels for the construction of offshore wind farms and the ports in Wejherowo and on the Hel Peninsula - in terms of maintenance and service.

A crucial factor for the optimisation of costs will also be the **construction of an offshore transmission grid**, connecting the Main Power Supply Station (*Główny Punkt Zasilania - „GPZ”*) in Słupsk-Wierzbęcino with GPZ Żarnowiec, what will allow for the creation of a connection point (hub) for OWF in maritime areas.

To sum up, we can state that the benefits associated with the development of offshore wind farms in Poland will several times exceed the costs related to the creation of appropriate conditions for their development. The scale of benefits (and the surplus over the costs) directly depends on the scale of development of the OWF sector in Poland. This results, in particular, from the fact that in case of the development of the sector up to the level of ca. 6 GW of installed capacity, the proportion of capital expenditures associated with the construction of OWF, which will be the revenue of Polish companies and it will contribute to the economic development of Poland, will be considerably larger. A smaller quantitative goal will make the investments in the production capacity of the Polish offshore industry unprofitable, and the delivery of components for OWF and the services related to the construction will be executed by foreign companies and on foreign markets - in particular in Germany, Sweden and Denmark, instead of Poland.

Therefore, from an economic point of view, it should be acknowledged that the support mechanism for offshore wind farms is an investment, which in the 2030 perspective will bring benefits to the Polish economy and may even contribute to the creation of a new economic sector in Poland, which will provide the increase of GDP and general employment, especially in the coastal regions.

This Programme was created due to the expectations of many political, business, scientific and non-governmental groups, what was explicitly stated during the conference: "Offshore wind energy - the driving force behind the development of maritime regions and industry" which took place in Słupsk, in January, 2013. This Programme will be subject to wide political, business and social consultations. Nevertheless, the implementation of this Programme will depend on certain political decisions.

Non-specialist summary

Chapter I

The potential of development of offshore wind farms in Polish maritime areas

In this chapter a thorough analysis of the potential of offshore wind energy in Polish maritime areas was carried out along with the analysis of the domestic offshore industry in terms of providing delivery, logistics, maintenance and service facilities for the offshore wind energy sector.

The **theoretical potential** was determined on the basis of the availability of locations for OWF projects, wind conditions and the maximum possible productivity of OWF. The said potential was estimated at the level of **12 GW of installed capacity and 48-56 TWh of energy per annum**.

The theoretical potential was then confronted with the following conditions: chances for the connection to the grid, national power system conditions, possibilities associated with the delivery and logistics facilities and available staff. On this basis the **technical potential** was determined, showing that there is a possibility to construct up to **7,4 GW by 2030**.

Technical potential was then verified in terms of the most important market conditions. The verification covered the limitations resulting from the optimisation of costs and organisational matters, both from the perspective of investors and the state. The analysis lead to the conclusion that the **market potential should reach the level of 6 GW in 2030**.

Chapter II

Programme objectives

In the second chapter the quantitative and qualitative objectives were determined in relation to both - the target capacity of offshore wind farms to be constructed in the Polish maritime areas and the production of construction elements by the Polish offshore industry.

Quantitative objectives:

I phase of market development - up to 2020: 1 GW of installed capacity and facilities providing:

- deliveries of supporting structures for the European market: 500-600 items and for the domestic market: 150-200 items,
- fixed area of ca. 30 ha for storage and assembly in seaports for the OWF components.

II phase - up to 2025: 3 GW of installed capacity and facilities providing:

- deliveries of supporting structures for the European market: 1000 items and for the domestic market: 300-400 items,
- delivery of 200 km of seabed cables,
- fixed area of ca. 50 ha for storage and assembly in seaports for the OWF components.

III phase - up to 2030: 6 GW of installed capacity and facilities providing:

- deliveries of supporting structures for the European market: 1500 items and for the domestic market: 500-600 items,
- deliveries of wind turbines for the domestic market: 500 items and for the European market: 500 items,
- delivery of 400 km of seabed cables,
- fixed area of ca. 80 ha for storage and assembly in seaports for the OWF components.

Cost optimisation objectives:

The economic conditions, which must be met in order to achieve the quantitative objectives, were also specified.

As an objective in terms of the **reduction of investment costs** ("CAPEX") in the **2025 perspective the reduction by ca. 25%** was assumed in relation to the unit costs in comparison to the costs valid for 2012 - from **PLN 14.7 million per MW to PLN 10.9 million per MW**.

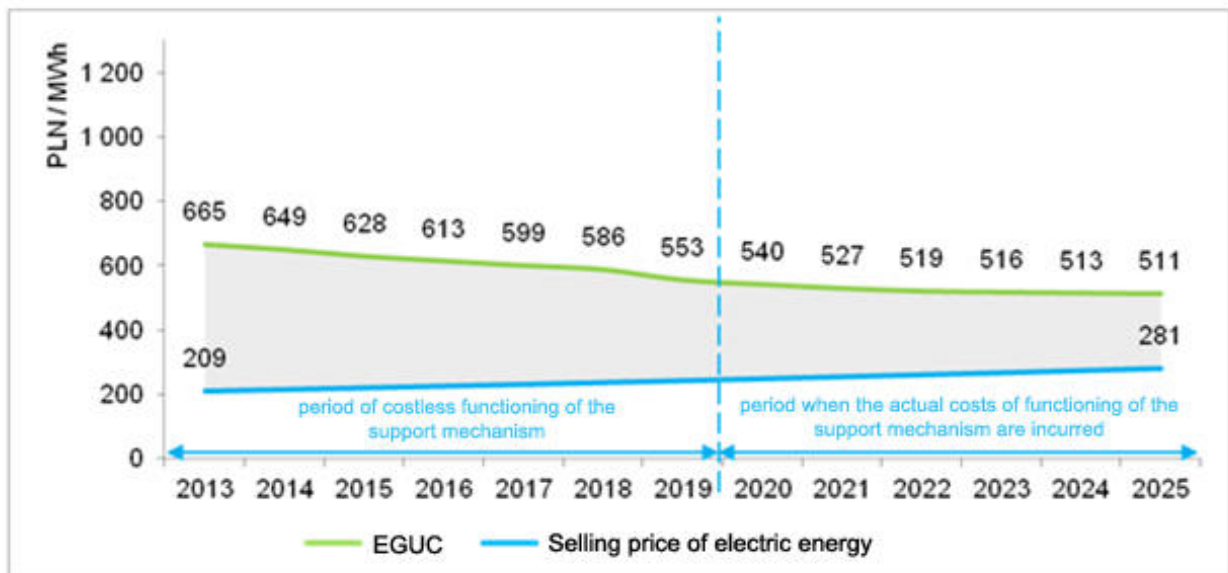
As for the **operating costs** ("OPEX") **the reduction should reach ca. 24%** in comparison to the estimated costs for 2013 in the 2025 perspective, *i.e.* from **250,000.00 PLN/MW to 190,000.00 PLN/MW**.

The reduction objective related to the **decrease of unit cost of energy generated** by OWF by 2025, in comparison to the estimated values for 2013, should reach 23% of costs, *i.e.* from **665.00 PLN/WWh to 511.00 PLN/WWh**.

On the basis of investment and operating costs estimations for OWF constructed and exploited on foreign markets, in comparison to the Polish location and wind conditions and taking into account the reduction of CAPEX and OPEX assumed in the Programme and resulting from the accepted forecast of the development of OWF market and from the 'learning curve', it can be estimated that in order to provide the profitability of OWF in Polish maritime areas the **level of support for offshore wind farms could be reduced by 50% in 2014-2025** and it should be determined at the following levels in the new mechanism:

1. from **456 PLN/MWh** (with the productivity of 45%¹) up to 600 PLN/MWh (with the productivity of 35%) **in 2013,**
2. from **292 PLN/MWh** (with the productivity of 45%) up to 351 PLN/MWh (with the productivity of 35%) **in 2020,**
3. from **230 PLN/MWh** (with the productivity of 45%) up to 253 PLN/MWh (with the productivity of 35%) **in 2025.**

Diagram 1. Assumed gap in the revenues between the energy generation unit cost (EGUC) in OWF and an anticipated electric energy price in Poland in 2013-2025 - an optimistic scenario.



Source: own work

The costs of the support mechanism due to the surcharges to the sold energy, with an assumption that the parameters given in the previous draft Act on Renewable Energy Sources of October 2012 (specified guaranteed price of energy indexed with reference to the inflation value, certificate of origin with the coefficient guaranteeing

¹Productivity - the value determined as the relation between the number of working hours and the number of hours in a year in total (this indicator is expressed as a percentage value).

the coverage of the revenue gap so that the project can reach $IRR^2=12\%$) **in a mean annual perspective should not exceed PLN 1.1 billion for wind farms commissioned up to 2020 (1 GW) an additionally PLN 1.8 billion for wind farms commissioned up to 2025 (2 GW).**

Up to 2020 the support mechanism for OWF will not involve any costs.

Economic benefits

We estimated also the scale of economic benefits associated with the achievement of the objectives given in the Programme³:

- the total **added value for the Polish economy** up to 2030 should reach the amount of **PLN 81.8 billion** (aggregate value for the investment and operation phases),
- **mean annual added value** in the operation phase of OWF should reach the value of **PLN 13.7 billion**, out of which PLN 12.7 billion are the direct results,
- **the level of budget revenues up to 2030 should reach the value of PLN 16.4 billion**, where ca. 80% of this amount are the revenues from indirect taxation and CIT paid by the companies directly and indirectly associated with the offshore wind farm sector:
 - ca. 82% of the income (*i.e.* PLN 13.5 billion) will go to the central budget (the State Treasury),
 - ca. 18% of the income will go to the voivodeship, commune and poviats budgets,
- up to 2030, for a period of 20-25 years of operation, functioning OWF will provide mean annual income to the public finances sector in the amount of ca. PLN 3.1 billion,
- due to the payment of the location fee the income will reach the value of ca. PLN 0.9 billion up to 2030,
- in total the income to the Social Insurance Fund in 2012-2030, resulting from the development of OWF, will reach ca. PLN 5.1 billion,
- mean annual social insurance contributions associated with the development of OWF after 2030 will generate the income of ca. PLN 0.13 billion per year.

Impact on the labour market

On the basis of results from the comparative analysis of the impact of OWF on the labour market in the UK and in Germany we estimated that **in case of executing projects with the capacity of 6 GW at the investment and operation stage in total in 2012-2030 in the OWE sector there may be ca. 24,800 new jobs created**, and in case of 3 GW of installed capacity - ca. 12,400 new jobs and in case of 1 GW ca. 4,100 new job opportunities should occur.

In order to assess the scale of the impact of OWF on the development of the labour market in Poland it is necessary to take into account also the installation operation phase (2040-2045 perspective). On the basis of estimated data the mean annual employment resulting from the development of OWF should reach ca. 5,100 new jobs, with the assumption that the projects of 6 GW capacity will be executed (pursuant to data of 2013)⁴.

To sum up, we can state that the benefits associated with the development of offshore wind farms in Poland will several times exceed the costs related to the creation of appropriate conditions for their development. The scale of benefits (and the surplus over the costs) directly depends on the scale of development of the OWF sector in Poland. This results, in particular, from the fact that in case of the development of the sector up to the level of ca. 6 GW of installed capacity, the proportion of capital expenditures associated with the construction of OWF, which will become the revenue of Polish companies and it will contribute to the economic development of Poland, will be considerably larger. The development of OWE at a level lower than 6 GW will not result in exceeding the threshold necessary for further investment decisions related to the development of domestic production, delivery and logistics facilities for the provision of services for

² Internal Rate of Return.

³ On the basis of the Report: "Morska energetyka wiatrowa – analiza korzyści dla polskiej gospodarki oraz uwarunkowań rozwoju" (Offshore wind energy - analysis of benefits for the Polish economy and development conditions) prepared by EY in cooperation with the Polish Wind Energy Association (PWEA) and own analyses prepared by FNEZ.

⁴ Ibid.

offshore wind farm construction. The construction of OWF on a smaller scale may be efficiently supported by foreign markets, especially the German, Danish and Swedish markets.

Therefore, from an economic point of view, it should be recognised that the support mechanism for offshore wind farms, which should be established during the works on the new Act on RES, is an investment with the objective to provide maximum economic benefits in the 2030 perspective by creating a new economic sector, which will provide the increase of GDP and general employment, especially in the coastal regions. What matters here is that the investment will not trigger any costs due to the support for OWF before 2020, because the energy from the offshore wind farms located in Polish maritime areas will be first generated in 2020.

Chapter III

Analysis of the current situation

In the third chapter an analysis of the legal and market environment was carried out in terms of their influence on the possibility to achieve the assumed objectives. The following procedural conditions for the development, execution and exploitation of OWF were presented:

1. current stage of project development,
2. CAPEX,
3. energy reception and transmission conditions,
4. current condition of the delivery, service and labour markets.

Taking into account the organisational and procedural conditions, the development of an OWF project should take ca. 7 years, organisation of the construction site and the construction phase: 3-4 years, exploitation up to 25 years.

Table1.1 Planned offshore wind farm execution schedule

| Development stage | Time [Q ⁵] | I year | II year | III year | IV year | V year | VI year | VII year |
|--|------------------------|--------|---------|----------|---------|--------|---------|----------|
| Procedure for obtaining the permit to erect and exploit artificial islands, installations and equipment within Polish maritime areas for an offshore wind farm and a research and measurement station (PSZW) | 3 | | | | | | | |
| Procedure for obtaining the connection conditions and the connection agreement | 5 | | | | | | | |
| Environmental impact assessment procedure and the procedure for obtaining the decision on environmental conditions (including environmental research) | 12 | | | | | | | |
| Obtaining the permit to construct the research and measurement station and to carry out wind measurements | 10 | | | | | | | |
| Procedure for obtaining the permit to lay and maintain seabed cables and pipelines in internal waters and territorial sea (including the | 4 | | | | | | | |

⁵ Q - quarter

a serious interest of national and foreign investors in this subject, which resulted in the preparation of first OWF projects. On the basis of issued location permits, connection conditions and the initiated environmental procedures we can state that the quantitative objective for the I stage of OWE development in Poland - 1 GW up to 2020 - may be achieved without any substantial changes in the system, on condition that the support mechanism planned by the Government for renewable energy sources will be implemented. **It is worth highlighting that the failure to adopt the new support mechanism for renewable energy sources ("RES") in 2013-2014, providing a stable base for the development, execution and exploitation of pilot projects, i.e. those which may be constructed up to 2020, will block the development of the OWE market and will prevent the achievement of the assumed objectives.**

Also the national sector of offshore industry showed a serious interest and demonstrated the capacity to launch production for offshore wind farms, what resulted in the initiation of production of specialist vessels, towers and foundations for foreign OWF markets. The existing port facilities and infrastructure will allow for the support of offshore wind farm construction, provided that some part of the components will be delivered from foreign ports (*e.g.* wind turbines, seabed cables).

II stage of market development - 2020-2025

Larger problems may be associated with the achievement of objectives of the II stage of development - 3 GW up to 2025. **The major barrier here are the connection capacity of the National Power System ("NPS").** In the opinion of the system operator, it is possible to connect ca. 2.2 GW from offshore wind farms up to 2025, *i.e.* 800 MW less than the Programme assumes. It seems, however, that the verification of currently issued connection conditions for the onshore wind energy and the verification of feasibility of the investment plans in the conventional and nuclear energy in the 2025 perspective may result in finding the expected connection potential for the additional OWF projects. The increase of the connection capacity may occur also as a result of the development of offshore transmission grids, transboundary connections or energy storage systems.

Another problem for the second group projects may be the financial aspects. The most intensive development of OWF on European markets will most probably fall on the years 2020-2025. This will naturally create a serious competition around the financing sources, especially in the context of quite high investment costs in that period. **This means that the Polish support mechanism must be competitive in comparison to the foreign systems, so that the investor would find it profitable to invest in Poland. Creating such a support mechanism requires a strategic approach and pre-emptive actions to create stable and long-lasting grounds for investment planning and constructing financial portfolios.**

Another problem for the projects of the II stage of market development may be the availability of delivery and logistics facilities. When the demand for devices and services on foreign markets is high, it seems inevitable to create own domestic potential, which will not only be competitive in comparison to other European markets, but will also provide maximum support for domestic investments.

III stage of market development - 2025-2030

The installation of 6 GW capacity in offshore wind farms up to 2030 in Polish maritime areas will require a strategic approach to the development of the OWE sector as a significant element of the energy and economic policy of the state for 2020-2050. Lack of strategic planning and shaping the legal system according to the needs of temporary interests and problems may constitute a serious barrier for the achievement of this ambitious objective. A substantial development of offshore wind energy in the next decade requires the making of critical political decisions right now, at the national and local level and the maintenance of those decisions for the next several years. **Such a responsible and strategic approach to the development of a new industry sector is fundamental also for the development of the offshore industry in Poland in order to make it the driving force behind the development of Polish coastal regions.**

In order to select projects, which could be executed after 2025, it would be necessary to introduce certain legal changes, which would guarantee the availability of locations along with the connection conditions for investors, guaranteeing the largest economic efficiency of their project.

The basic barrier for the achievement of the goal for 2030 will be the possibility to connect the additional 3 GW of capacity to the power grid and to provide the balance of evacuated energy. This problem may be solved by the investments in the offshore transmission systems, including

transboundary grids and energy storage systems. The current national energy mix will have a serious impact on the actual connection options for OWF. Unfortunately, due to the lack of a stable investment scenario it is very difficult to forecast the future energy mix.

The development of technology will be a substantial condition for the development of OWE after 2020. As the technologies applied in OWF will become more common, the domestic production, logistics and service facilities will develop and the experience in executing OWF will increase, leading to the reduction of investment costs and an optimisation of investment schedules.

Chapter VI

Programme for executive actions

The achievement of objectives stated in the Programme requires preparations and implementation of actions in various fields and at various organisational levels - national, local and private.

In the sixth chapter of the Programme we present a series of executive actions divided into three complimentary executive programmes. The purpose of each of those programmes will be the creation of stable foundations for the development of offshore wind energy and industry in Poland.

I. "Investment facilities" - executive programme

Programme objective:

creating political, system and legal frames in order to provide the attractiveness of the Polish offshore wind energy market for future investors.

Major Programme actions:

1. Provide strategic and political bases for the objectives related to the development of offshore wind energy and industry by adopting the Polish offshore wind energy and maritime industry development programme by competent state and local authorities or by including in appropriate strategies and programmes the objectives and tasks specified in the Programme:
 - a. Energy Policy of Poland
 - b. Seaports development strategy
 - c. Regional development strategies
 - d. Power Grid development strategy
2. Elaboration and adoption of a package of legislative changes providing a stable and competitive - in comparison to foreign markets - bases for the development, execution and exploitation of offshore wind farms:
 - a. the Act on Renewable Energy Sources
 - b. the Act on Energy Law
 - c. the Act on transmission corridors
 - d. the Act on maritime areas of the Republic of Poland and maritime administration
3. Preparation and implementation of operational programmes allowing for the support of investments associated with the execution of offshore wind farms, offshore power grids and the production and logistics facilities using the EU funds in the 2014-2020 perspective and the national and regional special-purpose funds.

Schedule:

Actions should be carried out in 2013-2014.

Authorities responsible for the performance of those tasks: Minister of the Economy, Minister of Regional Development, Minister of Transport, Construction and Maritime Economy, Marshals of the Pomeranian and West Pomeranian Voivodeships.

II. "Investment facilities" - executive programme

Programme objective:

Creation of conditions for the development of the offshore industry and the infrastructure facilities at a scale and within a scope guaranteeing a full support for the domestic offshore wind energy market.

Major Programme actions:

1. Preparation and implementation of the strategy for the development of production, logistics, operation and maintenance centres, covering:
 - a. the creation and development of special economic zones around the national port centres,
 - b. investments in the modernisation of ports and accompanying communication and storage infrastructure,
 - c. extension of the existing and the construction of new plants involved in the production of structural components of offshore wind farms,
 - d. creation of scientific, research and implementation centres combining the national and international scientific and industrial potential.
2. Elaboration and implementation of the "offshore transmission grid" project connecting the Słupsk-Wierzbęcino GPZ with Żarnowiec GPZ with an onshore-offshore DC cable, with an offshore transformer station, which is the connection point for OWF executed within the region of the Słupsk Bank and Middle Bank. The target grid should be connected with a seabed cable with the transboundary grids connecting the Baltic States, as the part of the so called Baltic Supergrid. The project could be executed in accordance with the public-private partnership, in cooperation with investors and the transmission grid operator.
3. Preparation and implementation of the marine environment monitoring programme, based on the construction and exploitation of 2 or 3 permanent offshore research and measurement stations. This programme would allow for the creating of an independent, objective source of knowledge on the condition of the marine environment and the impact of OWF on that environment.

Schedule:

Preparation of particular projects should be carried out in 2013-2014.

Actions should be carried out in 2015-2019.

Authorities responsible for the performance of those tasks:

- Task 1: Minister of the Economy, Minister of State Treasury, Minister of Science and Higher Education, appropriate local government authorities,
- Task 2: Minister of the Economy, operator of the transmission system,
- Task 3: Minister of the Environment, Minister in charge of maritime economy, General Inspector for Environmental Protection.

III. "Investment facilities" - executive programme

Programme objective:

Creation of system conditions for a reasonable and efficient performance of development, execution and exploitation actions associated with the offshore wind farm projects.

Major Programme actions:

1. Determination of locations for the OWF projects in the II round - 3 GW to be executed in 2025-2030 by:
 - a. preparing and adopting the spatial development plan for the maritime areas, including the exclusive economic zone, in order to indicate the areas for the second round of OWF location selection and for the infrastructure corridors for the offshore grids,

- b. carrying out the strategic environmental impact assessment of the spatial development plan for the maritime areas.
2. Associating the locations available for the OWF from the II round with the grid connection conditions by:
 - a. verifying, on the basis of previously adopted amendments to the Energy Law, the already issued connection conditions, cancelling the connection conditions for the projects without any chances for execution,
 - b. determining the connection capacity available for the OWF on the basis of the NREAP or the energy policy,
 - c. specifying the connection conditions for wind farms, which may be executed within the locations of the II round.
3. Tender procedures for location decisions and grid connection conditions for the OWF from the II round, which aim at selecting investors guaranteeing the optimum economic conditions for the execution of the investments within the given locations.

Schedule:

- Action 1 should be carried out in 2013-2014. Authority responsible for the performance of this action: Minister in charge of maritime economy.
- Action 2 should be carried out in 2014-2015. Authority responsible for the performance of this action: Minister of the Economy and the transmission system operator.
- Action 3 should be carried out in 2016-2017. Authority responsible for the performance of this action: Minister in charge of maritime economy.

Chapter VII

Managing the implementation of the Programme

In the seventh chapter we recommended the principles of managing the Programme.

Preparing a programme and implementing the development of a new branch of industry, *i.e.* the offshore wind energy and the offshore industry associated with it, requires a coherent management system. Unfortunately, the scope of actions necessary to be taken is very wide and it covers the competence of numerous state and local administrative bodies and their subordinate institutions. Therefore, all actions associated with managing the Programme should be carried out at various levels of administration.

Management at the national level

We suggest to appoint an interministerial group for the implementation of the Programme for the Development of Offshore Wind Energy and Industry, which would consist of the representative of the following Ministries and institutions:

1. Ministry of the Economy - chairman of the team, Government representative for the programme implementation issues,
2. Ministry of Transport, Construction and Maritime Economy - vice-chairman of the team,
3. Ministry of State Treasury,
4. Ministry of Regional Development,
5. Ministry of the Environment,
6. Pomeranian Voivodeship Office in Gdańsk,
7. West Pomeranian Voivodeship Office in Szczecin,
8. Pomeranian Voivodeship Marshall Office,
9. West Pomeranian Voivodeship Marshall Office,

10. Polish Agency for Enterprise Development,
11. Polish Information and Foreign Investment Agency,
12. Industrial Development Agency,
13. National Fund for Environmental Protection and Water Management,
14. transmission system operator.

The Group would be involved in the approval of the scope of major executive actions, the methods and schedule of their performance and in the coordination of those executive actions.

Management at the regional levels

At the regional levels we recommend the appointment of Voivodeship Marshal's representatives to be responsible for the management over the executive actions included in the competence of the regional self-governments. The Marshals could appoint working groups, which could consist of the representatives of the following institutions:

1. Marshal Office,
2. Voivodeship Office,
3. Maritime Offices,
4. port management,
5. commune self-government,
6. regional directorates for environmental protection,
7. offshore industry,
8. investors.

The Group would be involved in the approval of the scope of major executive actions, the methods and schedule of their performance and in the coordination of those executive actions.

Monitoring and reporting

Monitoring the implementation of the Programme should be carried out by the interministerial group that would prepare a report on the progress every half a year. The report should be presented at the Government meeting and at the meetings of appropriate parliamentary committees. The report should be prepared on the basis of information presented by representatives of particular institutions (members of the group) and by the representatives of the Voivodeship Marshals.

Further works on the Programme

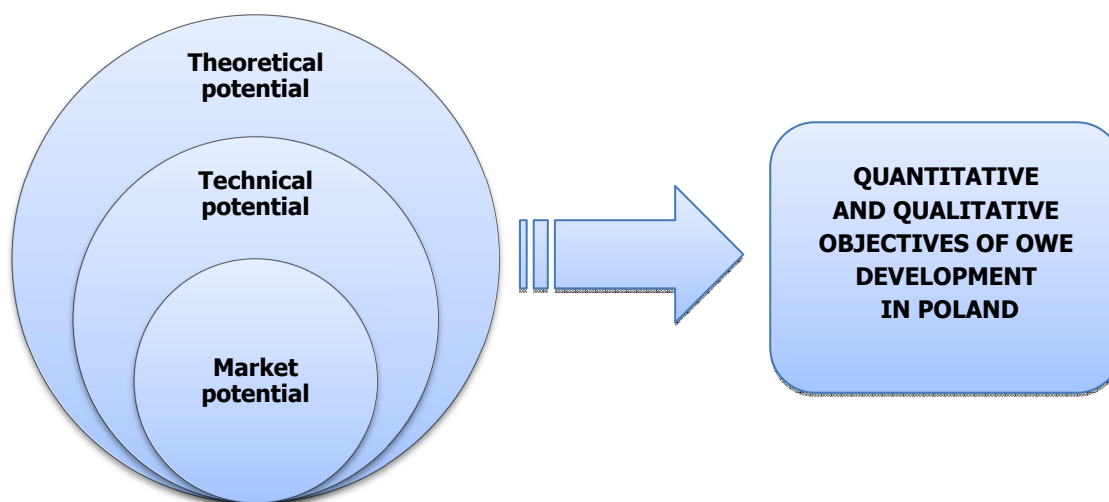
The Programme will be discussed internally, by FNEZ experts, partners and representatives of the sector. Then the presentations and political consultations will take place at the national and regional level along with social consultations.

After considering and approving the remarks and proposals submitted during the consultations, the Programme will be delivered by FNEZ to the government representatives and to the Marshals of involved voivodeships along with the request for the formal acceptance and use as an aid in their current activities.

1. The potential of development of offshore wind farms in Polish maritime areas

The assessment of the potential of a given sector requires a multi-criteria analysis and the consideration of various factors. Further in this chapter a thorough analysis of the offshore wind energy in Polish maritime areas was carried out along with the analysis of the domestic offshore industry in terms of providing delivery, logistics, maintenance and service facilities for the offshore wind energy. As a result of the analysis the theoretical, technical and market potential for the development of offshore wind farms were determined and hence the real goals for the sector could have been specified for the 2030 perspective.

Fig.1. Diagram for the method of determining the objectives of the Programme.



1.1. Theoretical potential

1.1.1. Location availability

Pursuant to the Act of March 21, 1991 on the maritime areas of the Republic of Poland and maritime administration (Dz. U. [Journal of Laws] of 2003, No. 153, item 1502, as amended) amended in 2011, the OWF may be located only within the exclusive economic zone of the Polish maritime areas. This means that the minimum distance from shore is 12 nautical miles (ca. 22 km).

From the economic and technical points of view the best locations for OWF are shallow areas (due to the costs of foundations) and near the shoreline (due to the costs of installation, maintenance and the construction of connection infrastructure). When selecting a location for an OWF the previous methods of exploiting particular maritime areas should be taken into account along with the restrictions associated with such previous exploitation, *i.e.*:

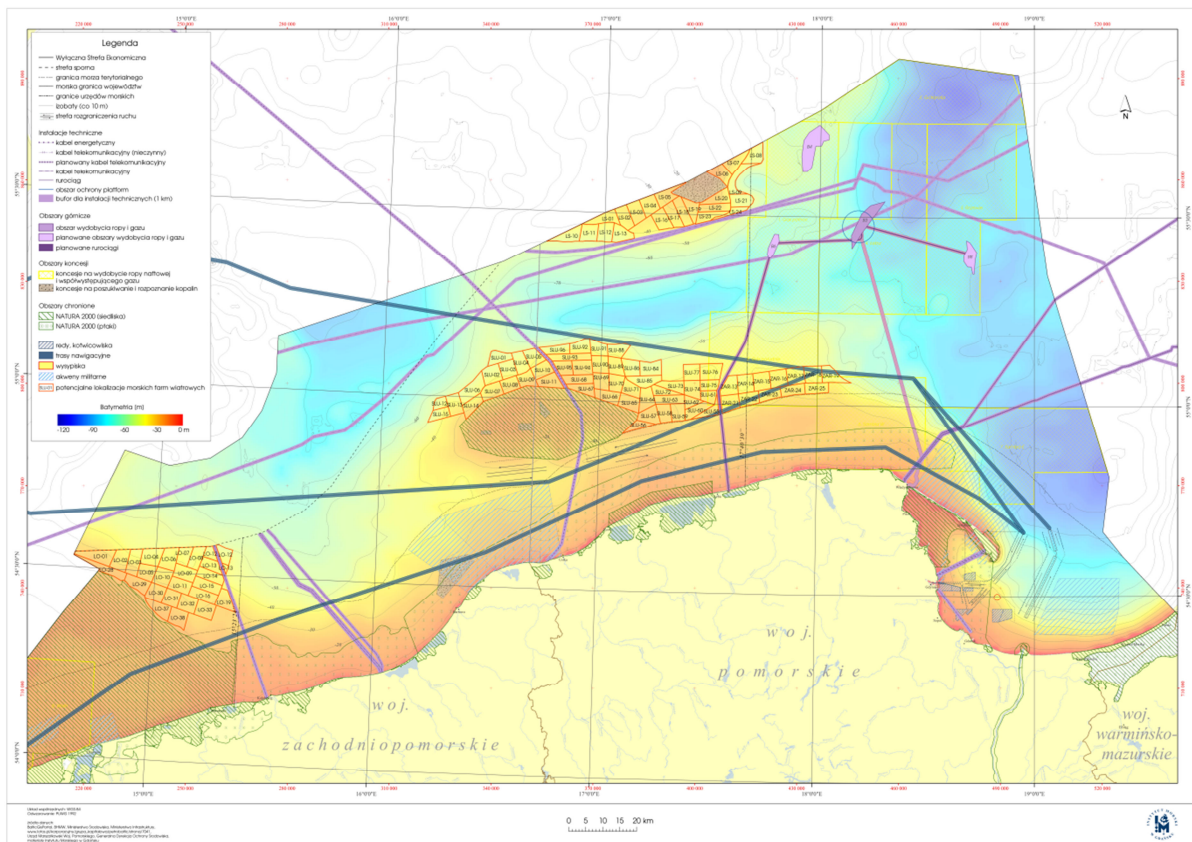
- common marine routes and potential navigation obstacles,
- military areas,
- areas under special environmental protection (NATURA 2000),
- areas significant for the fisheries.

According to the calculations of the Maritime Institute in Gdańsk the entire surface of the maritime areas, where the OWF can be located, is 3,590 km², however, after taking into account the economic conditions (*e.g.* depth and distance from shore) it must be limited to ca. 2,000 km² up to

2030. The other areas may be used in a future perspective, depending on the development of new technologies for foundations and the decrease of investment costs^{6,7}.

The Minister in charge of the maritime Economy (Ministry of Transport, Construction and Maritime Economy) published in 2012 a map of potential locations for OWF projects prepared by the Maritime Institute in Gdańsk⁸. It should be pointed out here that the above presented map is not binding for the authorities issuing and expressing opinions on the location permits for OWF. On the basis of the map we can distinguish 4 basic areas for potential locations of offshore wind farms: northern slope of the Oderbank, northern slope of the Słupsk Bank, eastern slope of the Słupsk Bank and south-western slope of the Middle Bank. Taking into account the conditions in each of those regions, in particular the depth, distance from shore and the potential interference with other methods of exploiting the maritime areas, the eastern and northern regions of the Middle Bank have the largest potential for a rapid development of offshore wind energy, with the Oderbank the Middle Bank as the second best locations.

Map 1. Map of potential areas intended for the location of wind farms in the exclusive economic zone.



Source: Ministry of Transport, Construction and Maritime Economy

1.1.2. Wind conditions, productivity

One of the major factors affecting the productivity of OWF and therefore the justness of their construction and profitability are the wind resources. A preliminary assessment of wind conditions shows that the area of the Polish economic zone has one of the largest wind potentials within the area of the Baltic Sea. Analyses carried out by

⁶ Institute for Renewable Energy (IEO). 2012. Energetyka wiatrowa – stan aktualny i perspektywy rozwoju w Polsce. (*Wind energy - current condition and the development perspectives in Poland*). Warsaw.

⁷ B. Gutkowski. 2012. Perspektywy rozwoju morskiej energetyki wiatrowej w Polsce. (*Offshore wind energy development perspectives in Poland*). Presentation for the conference: "Inwestycje w morskie farmy wiatrowe" (*Investments in offshore wind farms*). Polish Offshore Wind Energy Society (POWES).

⁸ MTBiGM website <http://www.transport.gov.pl/2-4e393a7f7308f.htm>, accessed on [March 26, 2013].

the Maritime Institute in Gdańsk indicate that the productivity of 1 MW of capacity in the Polish economic zone may be even higher than the average productivity for the Baltic Sea⁹.

There are, however, insufficient measuring instruments within the Polish maritime areas which would allow for a precise specification of the wind conditions and the productivity of the planned OWF as up till today there has not been any professional met-masts installed within the region yet. For the purpose of this publication a study was carried out on the "Potential of wind and the productivity of selected offshore wind farms in Polish maritime areas"¹⁰ based on the wind measurement data from the Offshore FINO 2 measurement platform located within the German EEZ and from the onshore met-mast located 10 km from the city of Łeba, in 2008-2009. Using professional mathematical models extrapolating the FINO 2 data the calculations were made for three projects representing the groups of potential OWF locations near: Słupsk Bank, Middle Bank and Oderbank.

FINO 2 platform is used for the meteorological, hydrological, technical and ecological measurements. It was erected in June 2007 in "Kriegers Flak" and since August 2007 it has been providing measurement data on the western part of the Baltic Sea. Apart from the data from FINO 2 there are no other data regarding the Baltic Sea, which would be precise enough and collected at the height of the offshore wind turbine rotors.

The major wind direction in the Polish Maritime Areas is determined to be in the western sector (from 255° to 285°) of the compass rose (windrose) and its share is ca. 17%. For the three locations the mean annual wind speed at the height of 100 m is 9.9-10 m/s and the mean annual wind energy potential at the height of 100 m is 8,657-8,763 kWh/m²a.

Wind conditions in the North Sea are characterised by an average wind speed of 8.5-11.5 m/s (at the height of 90 m). It should be noted here that currently the highest class of wind turbines according to the IEC standards (International Electrotechnical Commission) assumes the average wind speed equal to 10 m/s for wind turbines with the service life of 20 years. Installation of the turbines of this highest class within the areas with higher average wind speed is possible, however, it could cause the reduction of the service life of the construction¹¹.

According to the study, the wind conditions in Polish maritime areas allow for the production of energy in OWF equal to 4,000-4,700 hours/year with full load, what means 45-54% of productivity¹² (according to the formula for the productivity rate, with the assumption of 100% of technical availability and without taking into account the power losses). Projects already executed in the North Sea show that the productivity OWF is in fact 41% and due to the technological development the growth of productivity to ca. 42.5% in 2025 is anticipated¹³. In case of onshore wind energy the values are significantly lower - 2,200 hours/year (ca. 25%)¹⁴.

The study was carried out for three levels of rated power in terms of the area (4, 6 and 8 MW/km²). On the basis of the results the option with **6 MW/km² was selected as an optimum option for Polish maritime areas** due to the costs of installation with the currently available technology, losses due to the aerodynamic shadow of the turbine and the energy output on the area.

To sum up, when taking into account the available area of the Polish EEZ (2000 km² in the 2030 perspective), wind conditions, OWF productivity and the distribution of rated power over the area (6 MW/km²) the theoretical potential can be determined at the level of ca. 12 GW, with the productivity potential at the level of 48-56% TWh/a¹⁵.

⁹ Maritime Institute in Gdańsk. 2011. The possibility to use Polish maritime areas for the development of offshore wind energy.

¹⁰ Windhunter-prognoza sp. z o. o. and WIND-consult Ingenieurgesellschaft für umweltschonende Energiewandlung mbH. 2012. Study of the wind potential and the productivity of selected offshore wind farms in Polish maritime areas. FNEZ – unpublished data.

¹¹ Beldock N., Jacquemin J. 2011. Inventory of wind potential based on sea depth, wind speed, distance from shore. Garrad Hassan. Part of the WINDSPEED project no. EIE/07/759/S12.499460.

¹² The rate is determined as the relation between the number of hours of operation with full load and the total number of hours in a year (it is expressed as a percentage value).

¹³ EY. 2013. Morska energetyka wiatrowa – analiza korzyści dla polskiej gospodarki oraz uwarunkowań rozwoju. (*Offshore wind energy - analysis of benefits for the Polish economy and development conditions*). PWEA.

¹⁴ IEO. 2009. Wizja rozwoju energetyki wiatrowej w Polsce do 2020 r. (*Vision of the offshore wind energy development in Poland up to 2020*).

¹⁵ Terawatt hours per year.

1.2. Technical potential

1.2.1. Grid connection possibilities

One of the most significant factors affecting the development potential of offshore wind energy is the possibility to evacuate power from the maritime areas and the transmission of generated energy to the power system. In Polish conditions this problem is one of the most basic factors limiting the theoretical potential of offshore wind energy due to the following parameters of the National Power System ("NPS"):

- low elasticity of NPS due to the domination of power generating units based on coal,
- low level of demand for energy in the off-peak time at night at the level of 15.5 GW with technical minimum resulting from the regulating possibilities of coal-based units, which is 12 GW,
- small share of pumped-storage hydroelectricity in the system - 1.5 GW,
- poor development of the transmission grid in the northern parts of Poland, both in the west-east and north-south directions,
- small number of energy consumers in the northern regions,
- weak transboundary connections, which reduce the possibility to balance the system with the international energy transfer.

The assessment of the actual (real) connection potential of OWF is hindered also by the fact of blocking the connection capacity by a large number of issued connection conditions, especially for the onshore wind energy projects (over 17 GW), most of them are planned for the northern parts of Poland. It is commonly known that such a large number of onshore wind farm projects will not be executed in the long run, however the existence of the issued connection conditions prevents the proper verification of the actual power grid load with wind generation in the 2020-2030 perspective. The investment plans related to the nuclear, gaseous and coal-based generating units are also difficult to verify and these energy sources may load the transmission grid in the northern and central parts of Poland.

Nevertheless, the assessment of the OWF connection potential should not be based on the present state of NPS, but must take into account the factors, which will shape the condition of the system in 2020-2030, *i.e.* in particular:

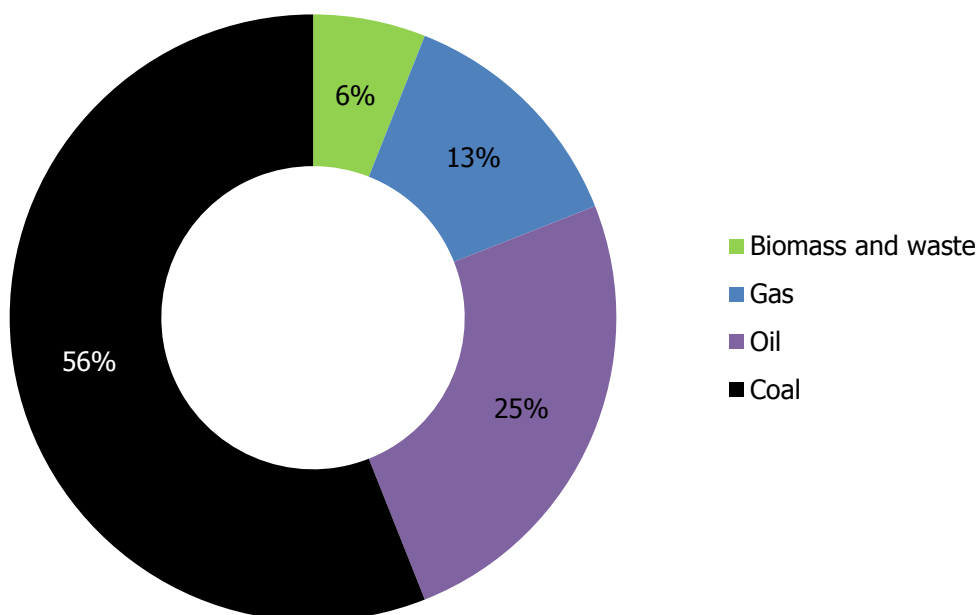
- anticipated increase of power demand due to economic growth,
- power losses in the system due to the withdrawal of old generating units,
- significant delays in the implementation of the investment plan in energy in terms of new capacities,
- investment plans in new transmission grids,
- anticipated increase of the share of flexible gaseous generation in the system,
- development of energy storage technologies,
- development of offshore transmission systems within the Baltic Sea.

1.2.2. System conditions

According to the historical data of the Ministry of the Economy¹⁶ when the currently valid Energy Policy for Poland up to 2030 was being adopted, almost 90% of energy in Poland was generated by coal-fired (lignite and bituminous coal) power plants. Most of the coal-fired power plants in Poland will have to be systematically shut down due to their age.

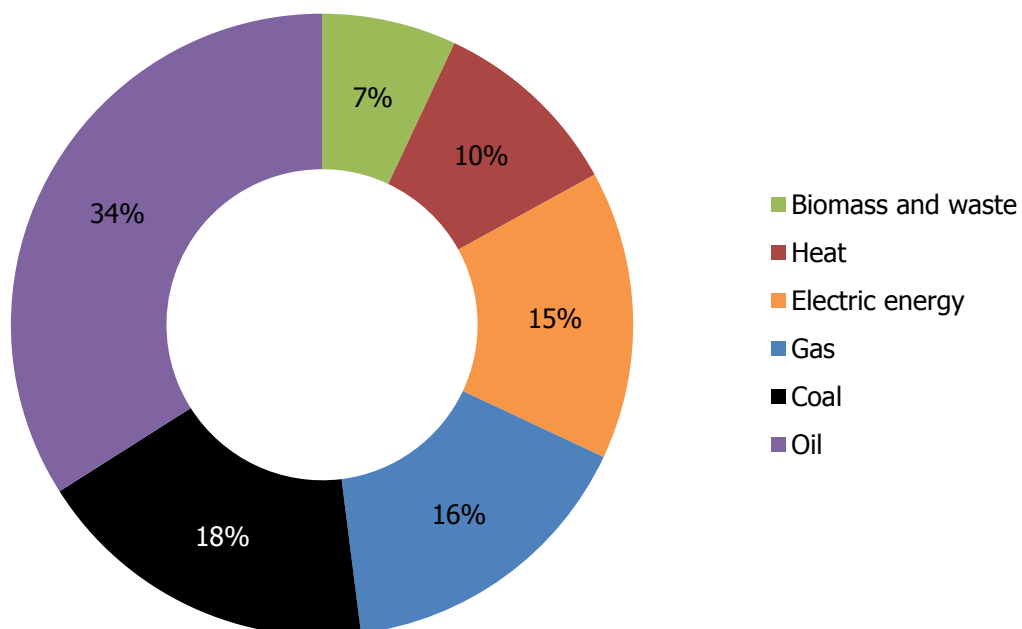
¹⁶ Ministry of the Economy. 2011. 2050 Energy Mix. Warsaw.

Diagram 2. Demand for primary energy by sources



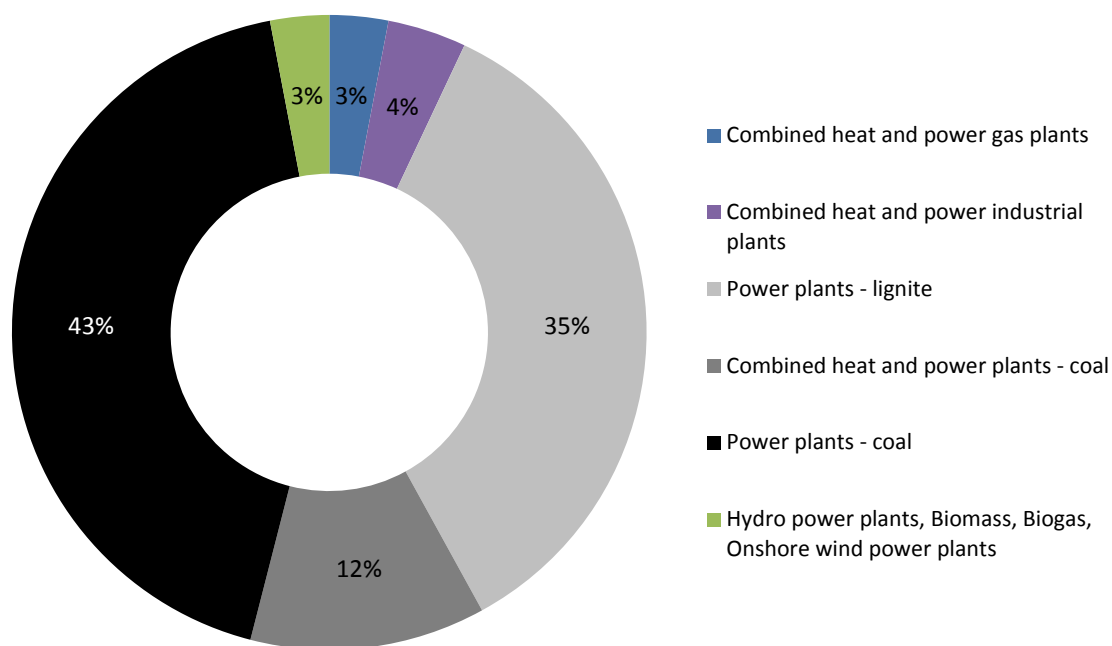
Source: Ministry of the Economy, 2050 Energy Mix, Warsaw 2011

Diagram 3. Final energy consumption by carriers



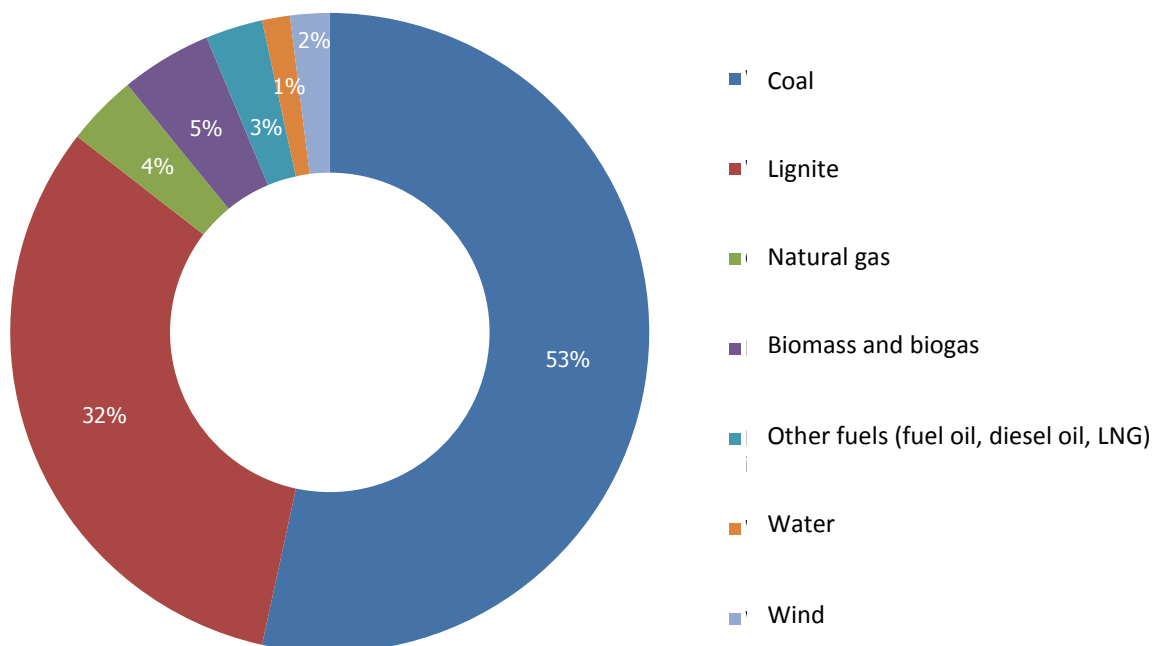
Source: Ministry of the Economy, 2050 Energy Mix, Warsaw 2011

Diagram 4. Power production by technologies



Source: Ministry of the Economy, 2050 Energy Mix, Warsaw 2011

Diagram 5. Power production by carriers in Poland in 2011



Source: Agencja Rynku Energii S.A.

Major conclusion, which can be drawn from the above presented diagrams, is the necessity to implement in Poland a gradual modernisation process related to the Polish energy sector within the next 3 decades. Such a modernisation should aim at increasing the diversification of sources and a more balanced use of the coal resources. Today, the major driving force behind the changes is the European energy and climate policy, which requires the member states to decrease emissions, increase the energy efficiency and to extend the share of renewable sources ("3x20 climate package"). However, in a long-term perspective, regardless of the future of the European and world energy policy, it will be necessary to gradually substitute the limited coal resources with other conventional and non-conventional sources of energy.

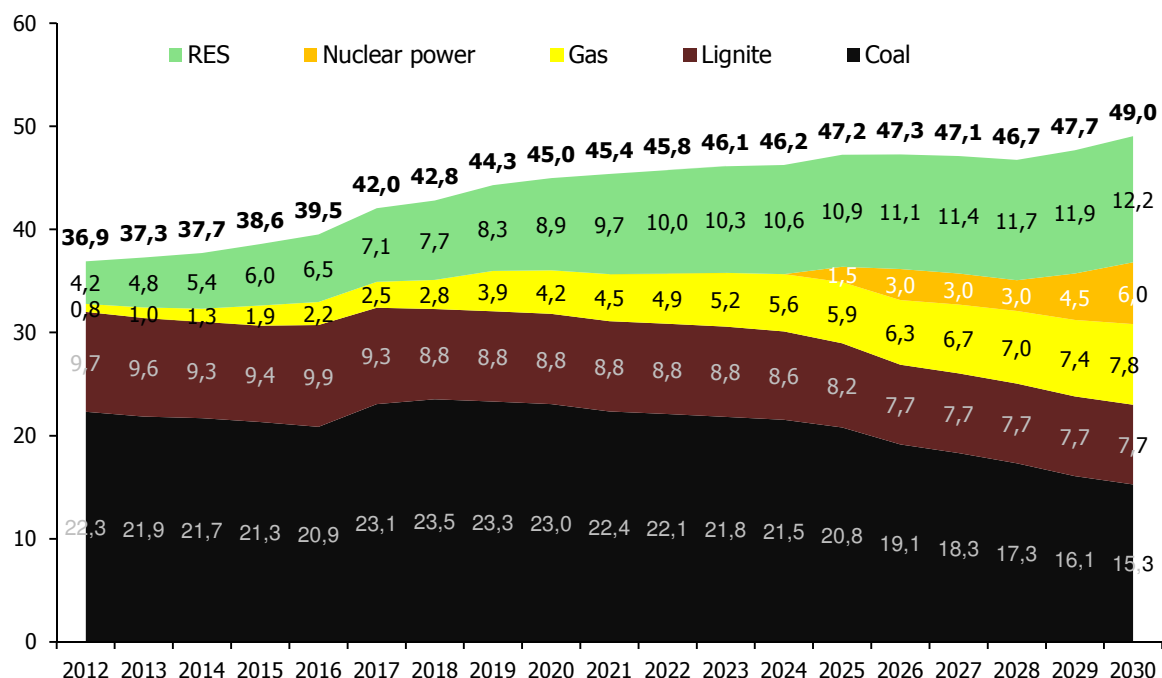
Another key factor, which should determine the shape of the energy sector, is the level of power demand in our country. The crucial demand is the peak demand, therefore in the analyses of the current and future condition of the energy mix in Poland the relation between the consumption of energy in the peak demand and the quantity of the energy in the system should be seriously considered.

Anticipated changes in terms of losses and gains in production capacity in the system

According to the data presented by PSE Operator, the peak demand will grow from 26.6 GW (current value) to 36 GW in 2025 and the compound annual growth rate ("CAGR") in 2011-2025 will reach 2.2%¹⁷. The increase of the peak demand in the Polish power system will be correlated with the rate of economic growth. On the basis of data on the economic growth we can assume that the peak demand will increase in 2011-2030 by ca. 52.5% and in 2030 it will reach 40.5 GW.

On the basis of analyses of the level of generating capacity of utility power plants, heat and power plants, RES (including storage power stations) and nuclear power plants we can state that the level of generating capacity in the NPS will increase from 36.9 GW in 2011 up to 49.0 GW in 2030. The utility power plants will have the largest share in the structure of generating capacity - their share will drop from 68.4% (25.2 GW) in 2011 to 45.0% (22.1 GW) in 2030. The share of heat and power plants will change from 20.4% (7.5 GW) in 2011 to 17.8% (8.7 GW) in 2030 and the share of renewable energy sources and nuclear power plants in 2030 will be 24.9% (12.2 GW) and 12.2% (6.0 GW) respectively.

Diagram 6. Capacity in the system – fuel structure – current assets and certain investment projects



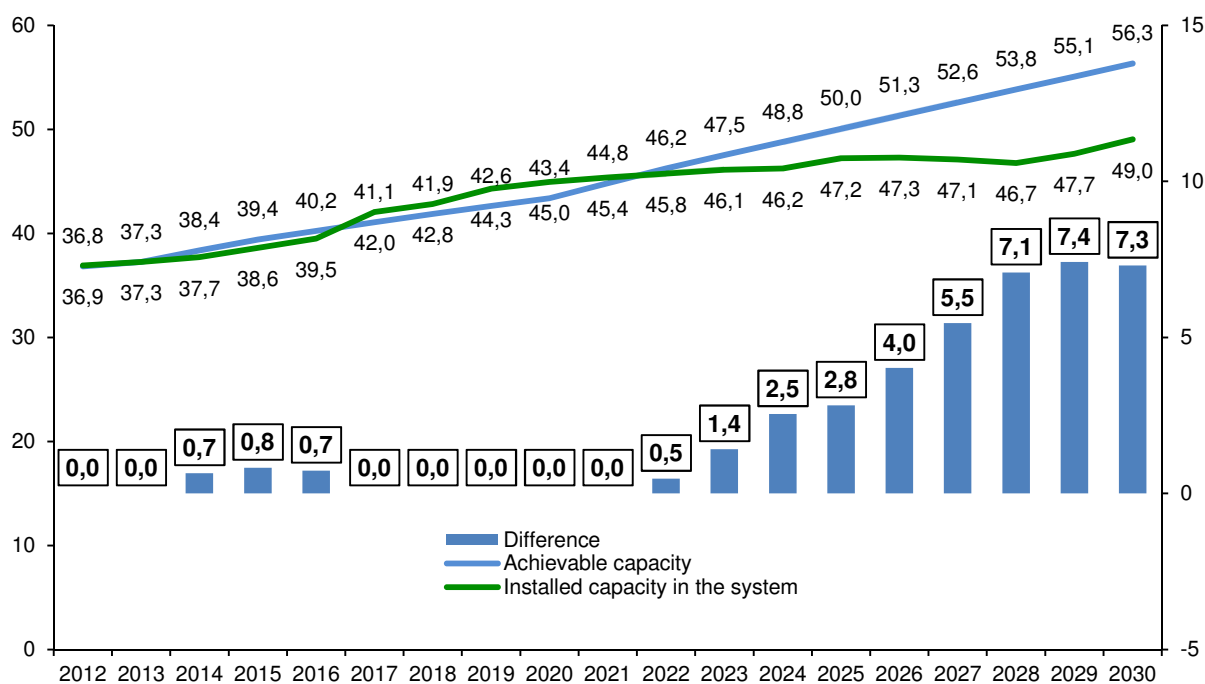
Source: FNEZ, Analiza bilansu energetycznego w Polsce w latach 2012-2030 (*Analysis of the energy balance in Poland in 2012-2030*), Warsaw 2012

¹⁷ PSE Operator. 2010. Plan rozwoju w zakresie zaspokojenia obecnego i przyszłego zapotrzebowania na energię elektryczną na lata 2010-2025. (*Development plan related to the satisfaction of the current and future demand for electric energy in 2010-2025*). Konstancin-Jeziorna.

Difference between the power demand and installed capacity

According to the document prepared by the experts of the Foundation for Sustainable Energy in terms of the peak demand for energy (conditioning the necessary level of generating capacity) and the forecast of available generating capacity in NPS in the 2030 perspective (Diagram 7), **there is a probability that in Poland a shortage of installed capacity of approximately 7.4 GW¹⁸ will occur even if all planned and prepared investments from the previous years will be executed.** What is more, we can assume right now that some of those investments will never be completed or will be commissioned with a considerable delay.

Diagram 7. Difference between the power demand and installed capacity



Source: FNEZ, Analiza bilansu energetycznego w Polsce w latach 2012-2030 (*Polish energy balance in 2012-2030*), Warsaw 2012

Such a serious shortage in available capacity, even with the assumption that all planned investments in conventional power plants will be executed (although we know that some domestic and foreign investors are already withdrawing from certain plans) and with the assumption that the increase of the demand for energy will be less rapid, gives room for new investments in new generating units, such as the offshore wind farms to be constructed and exploited in 2020-2050.

1.2.3. Delivery and logistics facilities

Ambitious plans of the European states assume the development of OWF up to the level of 40 GW by 2020 and up to 150 GW by 2030¹⁹. Most of the projects are planned to be constructed within the North Sea, but there is a considerable number of projects related to the areas of the Baltic Sea. According to EWEA statistics ca. 20% of OWF, which have already obtained their permits, will be located within the Baltic Sea²⁰. What is more, the total capacity of planned OWF to be constructed within the Baltic Sea (projects at different stages, from the conceptual phase up to those which have already obtained their permits) is ca. 19 GW²¹, not including the projects within the Polish maritime areas.

Currently the average turbine capacity is 4 MW, but we anticipate that up to 2015 this value will increase to 4.5 MW due to the introduction of larger turbines. Today the 6 MW wind turbines are already available and the 8 MW

¹⁸ FNEZ. 2012. Analiza bilansu energetycznego w Polsce w latach 2012-2030 (*Polish energy balance in 2012-2030*). Warsaw.

¹⁹ EWEA. 2011. Pure Power Wind energy targets for 2020 and 2030.

²⁰ EWEA. 2012. The European offshore wind industry - key trends and statistics 2012.

²¹ Baltic Offshore Wind Energy Map. Baltic sea Transport, 6/2012, p. 28-29.

turbines are now subject to testing. Hence, the potential demand may be determined at the level of 26,000 wind power plants (generators, rotors, foundations, towers) along with the additional components (seabed cables, land cables, transformer stations) for the European market up to 2030, including 8,000 constructions up to 2020²². It is far more difficult to estimate the demand for the Baltic Sea, however, we can expect that the demand will reach up to 3,500 constructions (not including the projects intended for the Polish maritime areas).

Such ambitious plans will require a special delivery, logistics, operation and maintenance facilities allowing for the production of components and for the installation and provision of operation and maintenance services for the planned OWF. Crucial will be here the plants specialised in offshore industry, including the shipyards producing steel components (foundations, towers, met-masts, casings for transformer stations) and seaports, which support the execution of OWF project at each stage. In practice there are 3 types of ports depending on their role:

- **Production ports** - in which the production plants of large size OWF components are located (*e.g.* foundations, towers, nacelles, rotor blades, etc.) Production plants are usually located in ports due to the sizes of the components and their target installation at sea.
- **Construction ports** - which are the direct logistics base for OWF projects, in which the components are assembled and prepared for installation at sea. Assembled elements are loaded onto installation vessels directly in the construction ports and are transported to the OWF site, where the installation is performed. It is possible to combine the production and the construction ports. The selection of a port function will depend mostly on the location of production ports (in case of a serious distance from the OWF projects, a more economically efficient solution could be to create a construction port near the OWF projects).
- **Operation and maintenance ports** - which support the daily operation and maintenance of the OWF. Usually the ports are characterised by an increased small vessel and helicopter traffic, therefore the distance from the supported OWF is here crucial. Serious failures, however, require other solutions than the standard maintenance or repair services and may be associated with the use of alternative ports equipped with infrastructure able to support large size components.

A substantial factor affecting the development of the operation, maintenance and logistics facilities for Polish OWF is the location of the OWF projects. Thanks to the organisation of the so called "supply chain" based on the domestic production of components of offshore wind farms, such as foundations, towers, turbines and cables, with logistics bases within small distances from the maritime areas where the OWF construction sites will be located, it is possible to significantly reduce the costs of the construction process. The costs of offshore transport and the periods of downtime (standstill) associated with the necessity to take into account weather conditions - are fundamental for the construction process.

Due to the rich history of shipbuilding industry, Poland has a serious potential for offshore engineering based on the large shipyard and port areas fundamental for the national economy, which are located in Gdynia, Gdańsk, Szczecin and Świnoujście. EY estimate that ca. 16% of investments associated with the OWF may be received - directly or indirectly - by ports, shipyards and shipowners, where 1-3% of investment costs may be directed to the ports supporting the construction of an OWF. The development of accompanying infrastructure is closely related to the scale of development of the entire sector - the more OWF projects, the stronger the stimulus for the development of the shipyards and ports in Poland²³.

With an appropriate approach to the extension and modernisation of Polish ports, they can serve both as the production and construction ports supporting OWF projects. In case of the construction ports, if we assume that the capacity of the construction ports reaches 100 turbines/year²⁴, then the large Polish ports could assemble and install in total even up to 400 turbines /year.

At the stage of OWF exploitation, the smaller ports and facilities located in the middle section of the Polish coast will gain significance. In those ports and facilities the operation and maintenance points for OWF can be established, along with the repair and management points. The development of OWE may bring benefits not only to the large ports in Poland, but also to the smaller ones, especially those located near the OWF development

²² On condition that we assume the average capacity of the turbine at the level of 5 MW up to 2020 and 6 MW up to 2030.

²³ EY. 2013. Morska energetyka wiatrowa – analiza korzyści dla polskiej gospodarki oraz uwarunkowań rozwoju. (*Offshore wind energy - analysis of benefits for the Polish economy and development conditions*). PWEA.

²⁴ Department of Energy and Climate Change. 2009. UK Ports for the Offshore Wind Industry: Time to Act. p. 15.

areas, *i.e.* in Darłowo and Ustka. The development of technological facilities and OWF will stimulate the economic growth in the coastal regions.

An important factor providing the construction capacity of the OWF market is the availability of specialist vessels for the transport and construction of offshore wind power plants. Currently there are 35 such vessels on the European market, and up to 2020 another 20 vessels should be build, solely for the purpose of European OWF market demands²⁵. **For the support of the Polish OWF market in 2020-2030 it will be necessary to provide 5 specialist installation vessels²⁶ and 10 supporting vessels.** The final number of ships required for the construction of one offshore wind farm is very hard to estimate. In Europe there were 100 vessels of various types used during the construction phase of an OWF project²⁷. CRIST - a Polish shipyard - has specialised in the construction of such vessels, therefore there is a chance that the Polish market will be supported by Polish vessels.

As stated above, the port facilities associated with the smaller port centres located in the middle section of the Polish coast are very important. Special attention should be paid to the following ports: Kołobrzeg, Ustka, Darłowo, Władysławowo and Hel, which due to their favourable location in relation to the planned OWF sites may play a vital role as the operation and maintenance facilities for OWF projects executed in Polish maritime areas. What is more, if we assume that the necessary investments in the development and modernisation of the port infrastructure are made, then several of the listed ports may also become significant construction ports.

1.2.4. HR resources

In the offshore wind energy sector the demand for highly qualified personnel can be observed in the following areas:

Shipyards - dynamic development of offshore wind energy in the North Sea and in the Baltic Sea caused a huge demand for new, specialist vessels for the transport and installation of offshore wind farms. This requires an increase in the employment in the shipbuilding sector focused mostly on the development of vessels supporting OWF project execution. Moreover, in the shipbuilding industry new employment opportunities will occur in relation to the support of the tower, foundation and other steel structure production lines associated with the construction and maintenance of offshore wind farms.

Ports - for the support of offshore wind farm construction processes it is necessary to prepare appropriate port facilities. The distance from the site camp is also an important issue for the construction phase, as the transport between the site camp and the construction site is usually a cost-driving factor. Therefore, Polish ports - especially in Świnoujście, Szczecin, Gdynia and Gdańsk, may become very significant in terms of the OWF projects planned to the executed in the Baltic Sea. Small ports and shipyards located within a short distance from the planned OWF sites are also crucial for the proper operation, maintenance and management of the offshore wind farms. It will be necessary to train new personnel to support new fields of activities of those ports.

Warehouses - to store the generators, towers and foundations; large storage areas will be necessary, equipped with cranes and infrastructure for a proper communication with the ports and shipyards - those areas will be fundamental for the provision of logistic services for OWF construction and appropriate staff working at those logistics facilities will need to be employed.

Cables - when an offshore wind farm is constructed hundreds of kilometres of seabed cables are required, therefore due to the location conditions (in Polish maritime areas - large distance from shore) the demand for seabed cables will be higher in Poland than in other EU member states. The seabed cables must be produces in places with direct access to the sea as the transport of the seabed cables requires the use of specialist vessels on which the cables are coiled directly from the production line. This gives a chance of developing seabed cable production lines in Polish ports. Specialist personnel will be required to work at such production plants and to meet the new logistics challenges.

Devices and components for offshore wind power plants - sub-assemblies of offshore wind farms and transformer and research stations will be constructed using certain elements, which have to meet the highest

²⁵ Information from Offshorewind.biz <http://www.offshorewind.biz/2013/01/09/need-for-windfarm-construction-vessels-growing-rapidly-uae/>, accessed on [April 15, 2013]

²⁶ If we assume that one ship is able to install 75 foundations and turbines per year.

²⁷ EWEA. 2011. Wind in our sails.

standards of offshore engineering and technologies. Designing and producing the devices and components will require the employment of qualified engineers.

Engineering, construction, logistics, maintenance and consulting services - development of an OWF project is associated with the performance of specialist research of the marine environment, conducting administrative procedures necessary to obtain the permits for the execution of the investment in Poland, designing, assessing the risk, construction complex financial portfolios, insurances, standardisation. The construction and exploitation processes require professional management and operation.

Science - OWF are still based on new technologies, which constantly require improvements and adjustments related to offshore conditions. The science sector has to be strongly involved in the creation of cheaper and efficient offshore technologies. The participation of our own scientists in the pre-execution environmental analyses and post-execution monitoring of the marine environment is essential.

Education - the development of the OWF market will not be possible without highly qualified personnel - engineers, biologists, technical experts, experts in finance, legal advisers. It is vital to initiate training programmes for employees of construction, operation and maintenance companies, as well as service providers. Educational programmes of universities specialised in marine environment and engineering should include courses related to the OWE issues.

Tourism - in Poland the wind power plants may be located within a distance of at least 22 km from the shore, therefore they will not interfere with the coastal landscape. As it was in case of offshore wind farms in the North Sea (*i.a.* Nysted OWF) cruises to the area of operating offshore wind turbines are a tourist attraction, which can be the source of additional income to the owners of cruise ships.

According to analyses the OWF sector may have a significant impact on the employment market in Poland, in particular during the investment phase. Comparative data on the British market show that during the construction of an OWF there are over 17 jobs (equivalents of full-time jobs) per each 1 MW of OWF capacity in the OWE sector and associated sectors. During the operation phase there should be ca. 0.5-1 equivalent of full-time jobs per 1 MW directly in the OWE sector and in associated sectors.

On the basis of results from the analysis carried out by EY²⁸ and our own experts, we estimated that in case of executing projects with the capacity of 6 GW at the investment and operation stages in total in 2012-2030 in the OWE sector there may be ca. 24,800 new jobs created, and in case of 3 GW of installed capacity - ca. 4,100 new jobs.

In order to assess the scale of the impact of OWF on the development of the labour market in Poland it is necessary to take into account also the operation phase of the installation (2040-2045 perspective). On the basis of estimated data the mean annual employment resulting from the development of OWF should reach ca. 5,100 new jobs, with the assumption that the projects of 6 GW capacity will be executed (pursuant to data of 2013).

Among all sectors associated with the development of offshore wind energy, the majority of new employment opportunities will occur in the shipbuilding, electromechanical and offshore construction sectors.

To sum up, if we take into account the possibility of connecting new generating capacities to the system, the structure of the power system, delivery and logistics facilities and the specificity of the personnel required by the OWE sector, the technical potential of OWF development in Poland may reach the level of 7.4 GW up to 2030, limited mostly by the connection capacity of the NPS.

1.3. Market potential

1.3.1. Limitations resulting from the availability of locations

Theoretical and technical potential is still limited by market conditions, which indicate a real potential of the OWE development in Poland. First limitations associated with the location of OWF may be divided into 3 groups of factors, *i.e.*:

²⁸ EY. 2013. Morska energetyka wiatrowa – analiza korzyści dla polskiej gospodarki oraz uwarunkowań rozwoju. (*Offshore wind energy - analysis of benefits for the Polish economy and development conditions*). PWEA.

Social factors (resulting from the methods of using the maritime areas):

- fishing grounds and navigation routes for the fishermen,
- existing maritime navigation routes,
- tourist aspects and landscape aspects,
- military areas,
- areas covered by exploration and exploitation licences (concessions).

Environmental procedures:

- areas under environmental protection,
- wildlife corridors for various animal species,
- habitats and species sensitive to the construction or presence of OWF.

Economic factors:

- depth (high costs of foundations),
- distance from the logistics facilities,
- geology of the seabed (limitations and barriers to the installation of foundations).

These factors are taken into account at various stages of investment development and execution and may be the cause of different restrictions, imposed by maritime administrative or environmental bodies and by the developers/investors. A certain part of the areas will be excluded at the project development phase, during the procedure for obtaining location decisions *i.e.* the permits to erect and exploit artificial islands, installations and equipment in Polish maritime areas ("PSZW") which have to be approved by 6 ministers, taking into account their potential impact on: fisheries, the environment, national heritage, safety of geological research, national defence, safety of navigation and aviation.

As a result of those limitations we can assume that from the 2000 km² of the Polish EEZ theoretically available areas for the offshore wind energy ca. 20% of areas must be excluded, what gives in total 1600 km².

The environmental impact assessment procedures determine the potential impacts of a project on the marine environment and the environmental conditions affecting its execution. It is estimated that due to the environmental restrictions such as geological aspects and the potential impact of the project on the environment - in particular on fish, seabed habitats and birds and the accumulation of those impacts in the areas of intensive development of OWE, another 20% of the maritime areas may be excluded. Therefore, there is ca. 1,280km² of the areas left.

The economic factors are also very significant as these will force the developers to execute most cost-effective projects first, *i.e.* located in shallow waters and near the shore. The other areas will be occupied later, as the technology develops and the installation costs drop. According to analyses:

- 1. optimum areas for OWF (up to 40 km from shore and up to 30 m deep), therefore the best for the first stage of OWE development, these areas make up for ca. 20% of the maritime areas - 260 km²,**
- 2. moderate areas for OWF (up to 50 km from shore and up to 40 m deep), therefore the best for the second stage of OWE development, these areas make up for ca. 50% of the maritime areas - 640 km²,**
- 3. problematic areas for OWF (up to 50 km from shore and up to 30 m deep), therefore the best for the stage when the OWE market is fully developed and more advanced technologies are available, these areas make up for ca. 30% of the maritime areas - 380 km².**

1.3.2. Limitations resulting from the efficiency

Distribution of offshore wind turbines is an important factor affecting the efficiency of a wind farm. On one hand, a dense distribution of turbines gives a higher value of installed capacity per area, but on the other hand an insufficient distance between the turbines disturbs the flow of wind (aerodynamic pressure effect) and reduced the efficiency of particular wind power plants and decreases their service life due to the increase of air mass turbulence. The costs of wind turbine installation are also an important element. Those costs are inversely

proportional to the size of an installed turbine. The larger the capacity of an installed turbine, the lower the cost of installation per 1 MW. However, the increase of the size of turbines is associated with the necessity to set larger distances between the turbines due to the larger sizes of rotors and intensified disturbance of the flow of air masses.

Determination of an optimum turbine distribution density per area requires the consideration of the factors described above. After comparing different options (4, 6 i 8 MW/km²) the optimum seems the **6 MW/km²** option. The 4 MW/km² option shows higher efficiency, but a lower absolute value of the generated energy (amount of MWh per area unit), what due to aerial restrictions of the issued permits does not give an optimum total result for the investor. The 8 MW/km² option was also considered - this alternative is characterised by a slightly (only several percent) lower efficiency, but higher absolute value of generated energy²⁹. Such a solution would be optimal for the investors, but the limitations resulting from the environmental, social and economic restrictions (required high capital) the safest would be to assume the distribution density at the level of **6 MW/km²**. What is more, the final distribution of the wind power plants is also affected by the turbine manufacturers who can state the minimum distance between the turbines due to the necessity to maintain the proper functioning parameters of the turbines.

Taking into account the above given factors, the potential of development of offshore wind farms in Polish maritime areas in terms of the location, spatial and environmental restrictions is ca. 7,680 MW possible to be installed within the area of 1,280 km², where:

- 1. at the first stage of development it will be possible to install 1,560 MW per 260 km²,**
- 2. at the second stage - 3,840 MW per 640 km²,**
- 3. at the third stage - 2,280 MW per 380 km².**

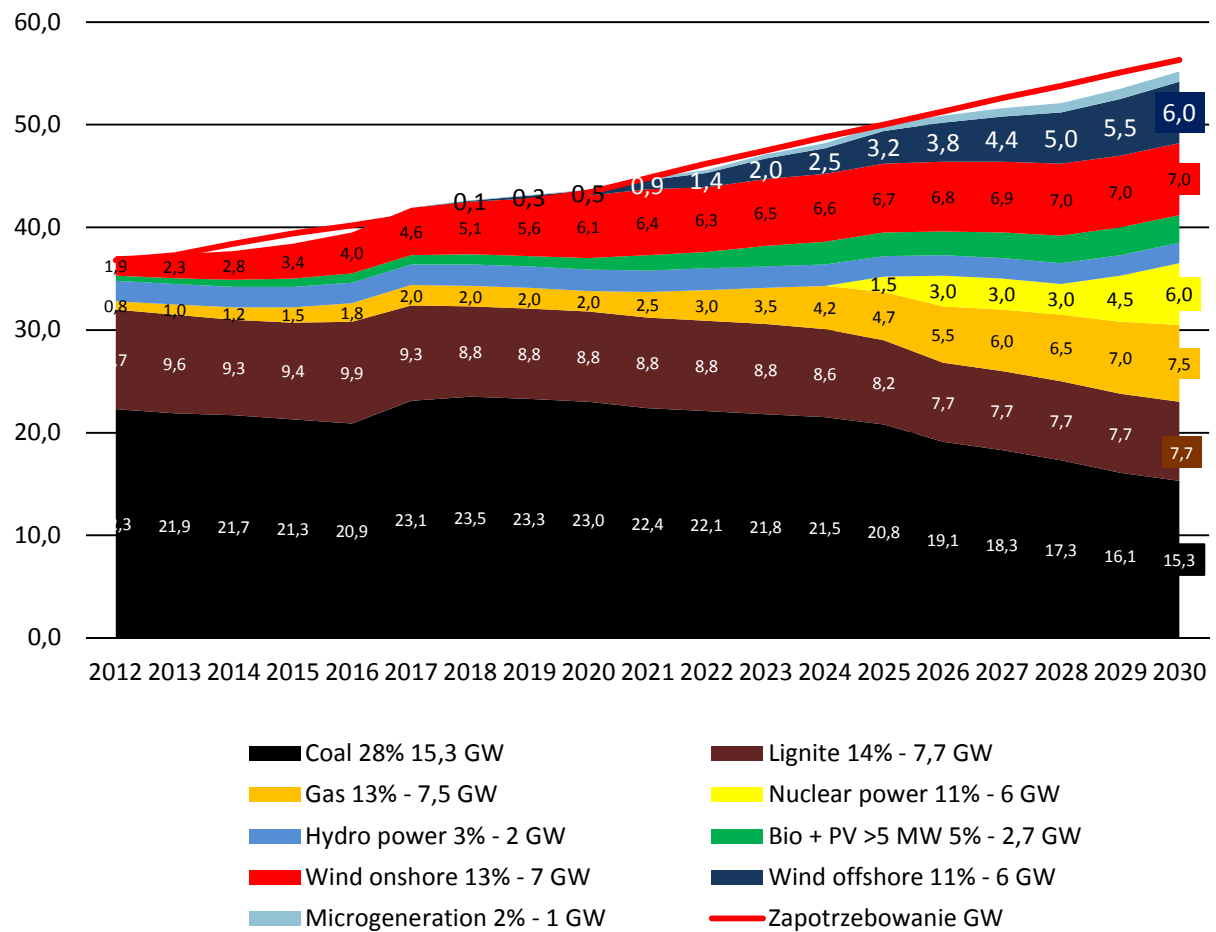
1.3.3. Limitations resulting from system conditions

According to the results of a comparative analysis of the electric energy demand forecast and the possibilities to satisfy the demand using domestic generating sources, there is a high probability that shortage of the installed capacity in the system will occur. The first shortage may occur in the 2020 perspective, but more serious shortages - at the level of a dozen GW of the available capacity - may occur in 2025-2030. This thesis is substantiated by the increasing delays in the execution of investment plans in conventional, nuclear and renewable energy sectors. From the perspective of power demand, it seems that there are no limitations to the development of offshore wind energy in 2020-2030.

On the basis of investment plans and the possibilities of developing offshore technologies in Poland (conditions related to the climate and energy policy of the EU, in particular to the "3x20" package and the specificity of the Polish energy mix in 2013) we can create the energy mix forecast for 2030. The preliminary forecasts of the energy structure in Poland in 2030 assume the maintenance of coal-based energy generation relying on system heat and power plants at the level of 28% of share of bituminous coal (ca. 15.3 GW) and 14% of lignite (7.7 GW). Also a significant growth of the share of gas-based energy generating units up to ca. 13% (7.5 GW), which will rely on the domestic sources of shale gas (with the assumed acceleration of the development of that sector from 2013) and the import of the material. According to the Polish Nuclear Energy Programme, it is planned to develop the nuclear technology at the level of 6 GW, what will result in the share of ca. 11% of nuclear energy in the total energy mix. About 36% of energy should be generated by renewable sources (18.7 GW), where the onshore and offshore wind farms should have the largest share (7 and 6 GW, respectively). Moreover, the full potential of our domestic resources of biomass and biogas will be used and the micro-installations should also develop. The suggested development of energy structure in Poland in 2020-2030 is presented in the Diagram 8 below.

²⁹ Windhunter-prognoza sp. z o. o. and WIND-consult Ingenieurgesellschaft für umweltschonende Energiewandlung mbH. 2012. Study of the wind potential and the productivity of selected offshore wind farms in Polish maritime areas. FNEZ – unpublished data.

Diagram 8. Suggested energy mix for 2020-2030



Source: FNEZ, Analiza bilansu energetycznego w Polsce w latach 2012-2030 (*Analysis of the energy balance in Poland in 2012-2030*), Warsaw 2012

On the basis of results of analyses presented in the diagram we can conclude that if we take into account the inevitable shortages in available capacity and planned investments in new capacities from various sources, the generation of energy in OWF at the level of 6 GW is still within the limits of the power demand of the system in the 2020-2030 perspective. Those 6 GW of capacity should not have any negative impacts on the stability of the system, especially in the context of the planned significant growth of the gas-based generation, which will allow for a better balancing of the less stable renewable sources.

1.3.4. Limitations resulting from the grid connection possibilities

Up till now the transmission system operator has issued the connection conditions for two OWF projects with the total capacity of 2.2 GW, out of which 900 MW to be available by 2020 and 1.3 GW by 2025. According to the operator, the condition of the National Power System today and the planned investments in the coming years cannot give sufficient grounds to issue any other connection conditions for the remaining OWF projects.

When estimating the current connection potential of OWF the operator was relying on the analogy to the German system, where per 170 GW of installed capacity only 30 GW of wind energy are functioning in the system. In the Polish system there are 37 GW of installed capacity. Taking into account the capacity of wind farms in relation to the installed capacity in the entire German system, the ratio is 17%. If in 2020 we can reach 44 GW capacity in the Polish system, out of which 7 GW will be generated by OWF, then the ratio will be near 16%. Therefore, the mentioned 7 GW should be the maximum capacity for the NPS. It should be remembered, though, that in accordance with the German energy policy, by 2020 4 GW of nuclear power should be shut down and the following 12 GW in the next 2 years and ca. 10 GW should be received from the installed offshore wind farms. Taking into account the fact that the withdrawn nuclear capacity in the German system will be substituted not

only with OWE, but with other gaseous and renewable energy sources as well, and by applying comparative analogy - the Polish energy system should be able to take even 10 GW from wind farms (onshore and offshore) by 2020, and at least 13 GW by 2030. The case of the size of the share of offshore and onshore wind energy is still an open question, but it seems that a proportionate share of both technologies in the energy system in 2030 is possible and desirable.

The connection potential of OWF will result from the actual power demand in 2020-2030 and the adopted policy of satisfying the demand using various energy sources. The increase of the share of flexible energy sources, especially gaseous, a reasonable division of the share of onshore and offshore wind energy in the system, in combination with the development and extension of the north-south transmission grid and the storage and pumped-storage systems may considerably improve the OWF connection potential.

1.3.5. Limitations resulting from the supply chain and available port facilities

At the current stage of project development in Poland the market demand is related mostly to the consulting and advisory companies, which have the experience in carrying out administrative procedures and in project management, and the environmental research contractors. If the research is to be conducted simultaneously on a larger area, there is a risk that the research companies will not be able to perform all orders due to an insufficient number of specialist research vessels.

It will also be necessary to create a favourable environment for the establishment of a full supply and service chain at further stages of project execution, *i.e.* during construction and exploitation phases. It will be necessary to coordinate those works with the education and training actions.

There are several manufacturers on the Polish market involved in the production of components for OWF for export. Those are mostly steel structures of low technical requirements - such as the foundations or wind turbine towers. In case of a dynamic growth of OWE in Poland it will be necessary to establish new production plants capable of satisfying the Polish and foreign demands. It would be reasonable to use the Polish shipbuilding industry, which is quite well developed for this purpose.

Production capacities of the plants are different. Below we present some examples:

- monopile foundation manufacturing plant in Rostock - 120 constructions per year,
- planned jacket foundation manufacturing plant in Szczecin - ca. 80 constructions per year,
- wind turbine tower manufacturing plant in Gdańsk - ca. 300 constructions per year.

Moreover, according to the data prepared by EWEA, a single plant where the wind turbines are assembled along with the auxiliary plants can produce wind turbines of the capacity of 500-1000 MW per year, depending on the shift system³⁰.

It will also be necessary to create a favourable economic environment for the manufacturers of turbines and cables, who could locate their new production plants in Polish ports. It is estimated that the HV cables may become a bottleneck items on the OWF market.

Port facilities in Poland should not hinder the development of OWE in Poland on condition that the investments in the modernisation and extension of ports allowing for the location of new production plants and the assembly of large size components are implemented. Theoretically, Polish ports could provide the support and service for ca. 400 wind power plants per year, therefore in 2020-2030 for ca. 4,000 turbines with the total capacity of 24 GW. **However, if we take into account the other functions of the Polish ports and the limitations related to the necessity of introducing serious modernisation in order to provide the support for OWF (especially in terms of the storage areas and transport capacity), we can assume that 4 of the major Polish ports will be loaded at the level of 25%. Hence, in 2020-2030 those ports would be able to provide ca. 1,000 wind turbines with the total capacity of 6 GW. Other investments may be supported by foreign ports - in Rostock or Sassnitz.**

³⁰ EWEA. 2011. Wind in our sails.

1.3.6. Limitations resulting from the HR potential

The development of offshore wind energy is associated with the growth of demand for qualified engineers, technicians and project managers. Therefore, one essential question must be answered - are Polish education and training facilities and centres able to satisfy the demand for such a specialised personnel, if the quantitative objectives specified in the Programme are met?

Polish scientific centres in Pomerania have already noticed the potential of offshore wind energy and have started to adjust their educational offer to the needs of the new developing sector. Higher education facilities in Pomerania and centres oriented at marine and maritime science (Maritime Universities in Gdynia and Szczecin, etc.) and quite properly developed offshore industry (in comparison to other branches of the OWE sector) in Poland allow for the provision of required knowledge and experience - *i.e.* the key elements in the process of educating and training the best and highly specialised staff in the offshore wind energy. The possibilities of educating and training the personnel (described in detail in sec. 3.2.7 and 3.2.8 herein) should not be the source of any obstacles on the Polish way to the development of offshore wind energy.

However, in Poland the negative "brain drain" effect may occur due to the demand of the highly specialised and developed foreign markets (in the UK, Germany). In order to eliminate the said effect and to prevent the outflow of educated and qualified employees of the offshore wind energy sector, we should strive to create optimum working and professional development conditions for the Polish staff. Preventing the "brain drain" phenomenon should be based on the creation of a developed sector of offshore wind energy in Poland, so that it could meet the requirements of potential employees. Providing the competitiveness and stable investment conditions on the Polish market and the development of the sector at an optimum level should guarantee the achievement of objectives stated in the Programme.

Potential benefits from creating new jobs in the offshore wind energy sector and offshore industry are huge - EWEA estimates that in Europe there will be ca. 30,000 direct and indirect new jobs created by 2030.

There is a common conviction in the European offshore wind energy sector that it is about to face the probable shortage of qualified employees, in particular of engineers and technicians to support the operation and maintenance branch of the sector, followed by project managers.

In those EU member states which decided to develop offshore wind energy serious actions were taken in order to prevent the mentioned shortage by initiating special training programmes. The German Training Centre for Renewable Energy (Bildungszentrum für Erneuerbare Energie - BZEE) offers a wide range of specialist trainings, including a programme for the improvement of qualifications in terms of the operation and maintenance of OWF. The National Renewable Energy Centre provides academic and technical training for the offshore sector.

What is more, it may be possible to transfer staff from the offshore oil & gas sector. This refers in particular to the field of Health, Safety and Environment (HSE) due to the similar specificity of both offshore sectors.

In relation to the fact that the education process, along with the adjustment of training and education programmes, is relatively long and takes at least 5-6 years (bachelor's and master's degrees, additional specialist trainings and courses associated with the market demand) in order to prevent the shortages which may seriously and negatively affect the development of the offshore wind energy sector, further actions aimed at the provision of trainings and education for engineers and technicians should be taken. Those actions should involve the industry, higher education facilities and politicians in Europe.

1.3.7. Limitations resulting from the financial potential

A significant factor limiting the market potential of OWF is the availability of the capital. In order for an OWF project to be profitable for the investor, it should cover the target capacity of at least 300 MW. Taking into account the present costs at the level of ca. 3.5 million EUR/MW, the total cost of constructing a medium size offshore wind farm exceeds EUR 1 billion.

In case of investment projects in Poland, which are different from the projects executed in other EU states due to the differences in location conditions, the investment costs may be relatively higher. It is estimated that CAPEX for the projects located in Polish maritime areas will be between 3.32 million EUR/MW - 4 million EUR/MW.

It is also important to note the strong relation between the capital costs and the future offshore wind farm energy production costs, which will affect the profitability of the investment. In accordance with the latest analyses, the decrease of the average weighted capital cost by 1% causes the drop of costs of energy production by 6 percentage points. This relation leads to a conclusion that the appropriate financial guarantees and investment risk limitation will lead to a significant decrease of costs.

During the last decade, the rating of 11 largest energy companies in Europe engaged in the OWF projects was decreased from the average A+ to A-/BBB+. Although it is still a sufficient level to implement investment projects, the creditworthiness of the sector dropped, what was caused mostly by the financial crisis of the EU-27.

In practice, this means that the capital required for the execution the an OWF investment increases, reflecting the growth of risk for the capital providers. Therefore, a tendency was observed on the European OWF market to actively search for the possibilities of cooperation with other energy companies or commercial or financial institutions, which may provide financial liquidity, the access to know-how or limitations to long-term operating risk.

It is estimated that in Europe there are currently 15-20 banks, which are ready to grant credits to the offshore wind energy sector. This results from the general reluctance of the credit providers to be exposed to any risk associated with the complicated and time-consuming process of investment implementation. Due to the increasing capital costs project developers more often choose to finance the investment by including it in own balances, instead of relying on commercial external financing (because the increase of risk generated an increase of the costs of financing in average by 2.5 - 3 percentage points)³¹.

Acquisition of funds for a project is becoming more and more challenging. It should be assumed that the cost of an average investment project in the OWE sector will be around EUR 1 billion. Therefore, for the financing of a typical project with the capacity of 300 MW the engagement of even up to ten banks might be necessary. What is more, the approval of common financial framework and the conclusion of a contract between such a number of entities will probably become a very long process (between 12-18 months), what may have an adverse impact on the investment process and increase the costs associated with higher risk.

Assuming that each of the 15-20 commercial banks in Europe may participate in the mentioned 1-2 transactions per year, then the available financing for the OWF sector will reach the level of ca. EUR 1.5 billion. Such a calculation allows for the financing of only several investment projects per year due to still high investment costs and an increasing scale of the planned projects. Therefore, a justified doubt occurs regarding the investment liquidity and stability of execution of certain projects in OWF sector.

Important, however, is also the possibility of engaging international financial institutions and export credit agencies, what can increase the chance of guaranteeing commercial credits for investment projects by improving the creditworthiness, reliability and providing financial liquidity.

Previously, the European Investment Bank (EIB) was the largest active institution which could allocate EUR 2 billion for the financing of projects in the OWE sector. It is estimated that in the coming years it will be necessary to engage also the KfW³² in Germany and the British Green Investment Bank, which should assign EUR 5 billion and EUR 3 billion respectively for the implementation of offshore wind farm projects.

Even with the engagement of financial institutions the financial resources required for the execution of projects of 1-1.5 GW capacity will require the provision of financing at the level of EUR 4-5 billion per year. If we look at the ambitious investment plans of the United Kingdom and Germany in this sector, we can expect to see that actions will be taken to provide the best possible competitive conditions for the development of the sector in Poland even in 2013. Only stable and efficient system conditions will allow for the provision of external financing necessary for the execution of the projects. In case of further delays in works on the legal and economic environment in Poland, it is highly probable that a gap will occur in terms of financial resources.

Despite the fact that the new financial instruments are currently being developed (*i.a.* targeted instruments such as "Connecting Europe Facility") and the EU-27 budget in the 2014-2020 perspective should be focused on the execution of infrastructure projects in energy sector and should finance the innovative and low-emission

³¹ Ibid.

³² Kreditanstalt für Wiederaufbau.

technologies (including the OWE sector), for the financing of projects fundamental will still be the decisions made at the local, domestic level. In 2007-2013 for the implementation of investments in the offshore wind energy sector there were over EUR 0.5 billion allocated from the EU budget. The European Energy Programme for Recovery guaranteed the financing of 9 OWF projects at the level of EUR 565 million: for the execution of the offshore grid EUR 311 million were allocated and for the financing of research and development programmes - EUR 254 million.

Due to high level of innovation, offshore wind farm projects are high-risk investments. Offshore wind energy in Poland requires the financial support of the government. Apart from the currently valid support mechanism, it would be recommended to use the experience of other countries and make an attempt to use the EU resources for the implementation of investments in this sector. An example of an efficient activity in the said matter is the use of financial resources in the amount of EUR 535 million for the financing of 9 offshore wind farm projects and the offshore grid project executed within the areas of the UK, Germany and Denmark (support for the following OWF projects: Thornton Bank, Borkum West II, Bard I, Nordsee Ost, Baltic Kriegers Flak, Aberdeen and offshore grids: Global Tech I, Cobra Cable, HVDC Hub).

If Poland will not be able to be competitive on the international OWF market and will not eliminate the legal restrictions (including those associated with the connection infrastructure, which is one of the key cost-generating parameters for the sector), then the market potential of the technology in Poland will not be used.

For the financing of OWF investment at a feasible scale in Poland it will be necessary to reduce the unit costs of investments, what is possible due to the anticipated development of the technology in the next 10 years and the use of our domestic delivery and logistics facilities. Detailed forecasts in terms of the way to reduce the costs in the OWE sector in Poland were presented in sec. 2.3. of the Programme.

1.4. Summary

The **theoretical potential** resulting from the availability of locations for OWF projects, wind conditions and the maximum possible productivity of OWF was estimated at the level of **12 GW of installed capacity and 48-56 TWh of energy per annum.**

The analysis of the **technical potential** included also the following conditions: chances for the connection to the grid, national power system conditions, possibilities associated with the delivery and logistics facilities and available staff. As a result, the technical potential was estimated at the level of **7.4 GW by 2030**, while the major limitations were identified as resulting from the specificity of the energy mix in Poland and the connection capacity of the National Power System.

The above presented estimates were further verified in terms of the limitations associated with the functioning of the free market economy and the competition rules, including the restrictions resulting from the optimisation of costs and organisational matters, from the perspective of investors and the state. Environmental conditions and the availability of locations resulting from the other methods of using the maritime areas were also taken into account. The analyses led to the conclusion that the **market potential can be estimated at the level of 6 GW by 2030**, where the implementation of such a potential will have to be carried out gradually due to: diverse location conditions in Polish maritime areas (depth and distance from shore), limited connection possibilities, the necessity to establish a domestic supply chain, the modernisation of ports and a limited pool of available financial resources.

2. Programme objectives

Proper planning of the development of the offshore wind energy sector and offshore industry, which constitutes production and logistics facility resources for the sector, requires the determination of quantitative objectives that will specify the scale and conditions for the implementation of potential investments.

Objectives described in this section show both the possible scale of investment in the offshore wind farms, as well as the scope of investment in production facilities and the development of human resources - necessary to achieve the assumed objectives.

2.1. Quantitative objectives for OWF

When setting the quantitative objectives for offshore wind energy in Poland - we took into account the theoretical potential of Polish maritime areas concerning the generation of energy by wind power plants, as well as the economic, system, environmental, economic and organizational factors which limit this potential. On the other hand, we assumed that the quantitative objectives of the OWF development must take into account the economy of scale that will allow for the optimization of costs of market development. The main factor enabling the reduction of the unit cost of investment is the creation of a domestic goods and services supply market, as well as the logistics, service and operation resources in short distances from the implemented projects. This approach ensures the creation of an impulse for the development of maritime regions, based on the modernization and development of offshore industry, employment generation, new skilled personnel education. However, to make the development of the domestic offshore industry around offshore energy possible, quantitative objectives of the industry must exceed the threshold of profitability of the investment in new manufacturing facilities, including highly specialized facilities, such as a wind turbine manufacturing plants, as well as the expansion of existing plants and the modernization and expansion of port facilities. As a result of the analyses of the above mentioned conditions, the following scenario for offshore wind energy development in Polish maritime areas was deemed optimum for Poland:

- I phase of development up to 2020 - up to 1 GW of installed capacity,
- II phase of development 2020-2025 - up to 3 GW of installed capacity in total,
- III phase of development 2025-2030 - up to 6 GW of installed capacity in total.

2.2. Quantitative objectives for OWF

To make the implementation of quantitative objectives for offshore wind energy possible, subject to the investment cost optimization, it is necessary to launch the domestic production and supply facilities that will ensure the construction of major parts of the supply chain for OWF in Polish maritime areas, based on domestic supplies of such components as towers or foundations for the power plants, that have already been produced in Poland. In case of adoption of quantitative objectives ensuring the adequate economy of scale, marine cables and generators plants may also be developed in Poland. Given the above, the following quantitative objectives for the domestic maritime industry were specified:

I phase - up to 2020 (up to 1 GW of installed capacity):

- provision of deliveries of supporting structures for the European market: 500-600 items and for the domestic market: 150-200 items,
- provision of a fixed area of ca. 30 ha for storage and assembly in seaports for the support of OWF construction phase.

The first phase involves the development of the existing domestic potential for the production of low-technological steel constructions, such as foundations or wind turbine towers. Polish industry will cover the total demand for the domestic market (1 GW of total installed capacity), the remaining part of the production will be exported to foreign markets. At this stage, the remaining elements of OWF (turbines, blades, nacelles, seabed cables) will be imported from neighbouring countries such as Germany, Denmark and Sweden.

It is assumed that the construction of all OWF within Polish maritime areas will be supported by Polish construction ports - however, that will require the modernization and expansion of ports and the provision of proper assembly and warehouse space.

II phase - 2020-2025 (up to 3 GW of installed capacity in total):

- provision of deliveries of supporting structures for the European market: 1000 items and for the domestic market: 300-400 items,
- provision of seabed cable deliveries: 200 km,
- provision of a fixed area of ca. 50 ha for storage and assembly in seaports for the support of OWF construction phase.

The second phase involves further development of production of low-technological constructions ensuring the coverage of 100% of domestic demand and the increase of export to foreign markets. New production plants of seabed cables will be created, providing the partial coverage of the projected demand of the domestic market. Other remaining elements will continue to be imported, however at this stage, we forecast the creation of new wind turbines and nacelles plants, as well as new assembly rooms.

It is assumed also for this phase that the construction of all OWF within Polish maritime areas will be supported by Polish construction ports. This will require further investment in ports and larger assembly and warehouse space. Due to the fact that the new production facilities will be located in the coastal regions, most likely in ports, it will be necessary to adjust the offer of Polish marine ports in terms of space and port infrastructure. However, such a range is an individual matter, and hence - hard to predict.

III phase - 2025-2030 (up to 6 GW of installed capacity in total):

- provision of deliveries of supporting structures for the European market: 1500 items and for the domestic market: 500-600 items,
- provision of deliveries of wind turbines for the domestic market: 500 items and for the European market: 500 items,
- provision of seabed cable deliveries: 400 km,
- provision of a fixed area of ca. 80 ha for storage and assembly in seaports for the support of OWF construction phase.

The last phase involves the creation of a full supply chain, including in particular the development of steel constructions production potential, the development of seabed cables production and the launch of new production plants for wind turbine components and new assembly rooms. This phase assumes the complete coverage of the domestic demand for steel constructions and turbines by Polish industry and the partial coverage of the demand for seabed cables. The increase in the export business of Polish manufacturers is also assumed.

What is more, phase III should also trigger the increase in demand for usable areas in Polish ports due to the growing number of OWF projects and OWF dedicated manufacturing plants.

2.3. Economic objectives for OWF

High investment costs of offshore wind farms are the primary factor limiting the attractiveness of the investment, thereby affecting the chances of achieving the assumed objectives. Due to the necessity of the optimization of the power system costs, in order to minimize end-user energy prices, it is necessary to specify the ways to reduce the costs of OWF investment in Poland. It is important to note that the OWF construction is scheduled for 2018-2030, so a time when wind energy technologies in marine areas will be more developed and popular, and thus cheaper than now.

When analysing the forecasts of the change of costs in the OWF sector in Poland, one should refer to the UK - the example of the best emerging offshore wind energy market³³. British sector of OWE has foreseen accurate OWF cost reduction scenarios, which implementation should lead to the reduction of costs of energy generation in offshore wind farms from ca. 140 GBP/MWh in 2011 to about 90 GBP/MWh in 2020 (the most optimistic scenario).

The primary objective of the British OWF sector is to reduce the costs of energy generation to 100 GBP/MWh in 2020, what will optimize the operation of technology in the UK. They have prepared 4 scenarios, which would enable the reduction of OWF energy generation costs:

- slow growth scenario - cost in 2020 - 115 GBP/MWh,
- accelerated technological development scenario - cost in 2020 - 100 GBP/MWh,
- effective supply chain scenario - cost in 2020 - 96 GBP/MWh,

³³ On the basis of: Crown Estate. 2012. Offshore Wind Cost Reduction Pathways Study.

- fast growth scenario - cost in 2020 - 89 GBP/MWh.

After 2020, one presumes further decrease of costs due to the increased use of technological innovations (now estimated use of the potential of the most important technological innovations equals only 50%).

Authors of the UK analyses predicting the decrease of costs underline that the key conditions for the reduction of costs within the sector are:

- the maximization of the domestic supply market,
- the investment in the optimization of available technology and innovation,
- efficient and stable investment conditions guaranteed by government policies, including quantitative objectives and a schedule for the achievement of objectives.

The policy adopted by the UK government - the absolute leader in the global offshore market - is correct: the goal of the support system of new energy technologies, including offshore wind farms, must be their marketization by reducing the cost of energy generation due to the popularization of technology. To make this process possible, it is necessary to adopt specific objectives of costs reduction and to create conditions for such development of the industry, in which the scale of development will allow for the achievement of cost objectives.

This Programme recognized that the British guidelines for the reduction of costs of OWF energy generation by 25% - 35% in relation to today expenditures are possible to achieve and that they ensure proper optimization of costs of industry development. Analyses of the Polish market development prospects confirm that such expenditures reduction will be possible also on the Polish market, what should set out costs objectives for the Programme. To achieve these objectives - the Programme includes and describes all key elements ensuring OWF sector expenditures reduction adopted in UK strategies.

Schedule for the offshore wind energy development in Poland

To determine the shape of the learning curve³⁴, which will be the key factor reducing the investment costs, one should refer to the established schedule for the development of offshore wind energy in Poland. Current data on the possibility of connecting offshore wind farms to the National Power System and adopted simple objectives for OWF (500 MW by year 2020)³⁵ cause the expected decrease in investment costs, due to market saturation with technologies, services and so-called learning factor, to occur on the Polish market too late, and the "learning curve" will not be sharp enough to bring a substantial reduction of investment costs. This would cause OWF energy generation to rely on the support for a longer time.

However, if we accept the market development scenario established in the Programme, one should expect a significant decrease in the unit cost of OWF energy generation (due to the increase in production efficiency and the impact of the learning curve - described further in the Programme), which at the same time, with the likely increase of electricity prices, will decrease significantly the necessary level of support (i.e. the revenue gap).

2.3.1. Reduction of capital expenditures

At present³⁶, capital investment in OWF sector in Poland, estimated on the basis of the data from the British market, appears to be at the average level of 14.7 million PLN/MW.

Based on the carried out analyses, it can be concluded that due to the impact of the learning curve, while maintaining the dynamic development of the industry from 1 GW in 2020 to 6 GW in 2030 and the parallel dynamic development of the domestic supply-and-service resources, one should expect a systematic decrease in the average capital expenditures from ca 14.7 million PLN/MW in 2012 to about 11 million PLN in 2021. After 2021 average investment expenditures may stabilize around 10-10.9 million PLN/MW. Stabilisation of CAPEX is a result of balancing the impact of cost factors and the learning curve after 2022, as well as EUR/PLN rate.

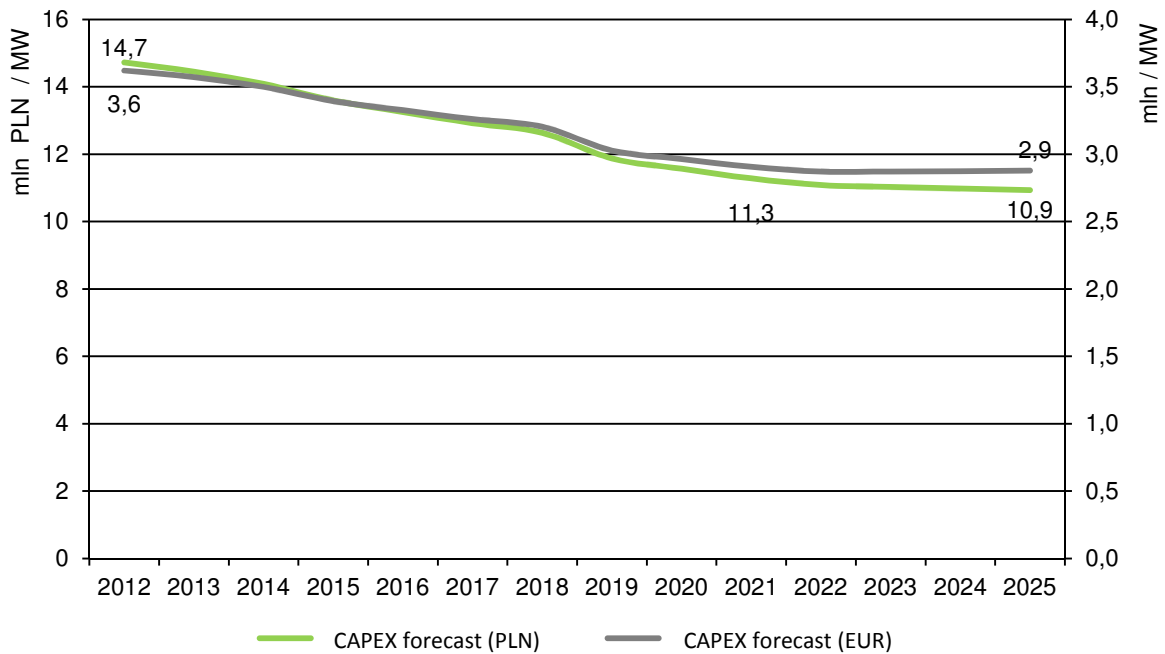
³⁴ The ratio reflecting the increase of cost-efficiency of OWF construction/operation due to technological advances and/or economy of scale associated with the increase of the number of installed MW in offshore wind energy sources.

³⁵ Ministry of the Economy. 2010. National Renewable Energy Action Plan.

³⁶ *i.e.* according to the price terms of 2012.

Detailed information on the anticipated cost of the generation of 1 MW of energy in offshore wind farms in Poland in 2012-2025 is presented in the following diagram.

Diagram 9. The forecast of capital expenditures (CAPEX) taking into account the impact of cost factors and the learning curve up to 2025



Source: own work

As an objective in terms of the reduction of investment costs ("CAPEX") in up to 2025 perspective - the reduction by ca. 25% must be adapted in relation to CAPEX unit costs with respect to the estimated costs for 2012.

2.3.2. Reduction of operating expenditures

The approach to estimate the operating expenditures associated with the operation of OWF assumes the division of operating expenditures into the expenditures of a fixed nature (independent of the volume of production) and expenditures of a variable nature, which is highly correlated with power generation.

Based on the data source projected for 2013 - the fixed part of operating expenditures (OPEX_f) has been estimated to 250 000 PLN/MW. A key component (ca 45% i.e. 115,000 PLN/MW) is the cost associated with the maintenance and repairs of OWF. The issue was described in detail in chapter 3.2.2.

The forecast of operating expenditures associated with the exploitation of offshore wind farms in Poland was performed using baseline OPEX expenditures estimated for 2011 and indexed with reference to the influence of the learning curve, assuming that operating expenses will be subject to the influence of the learning curve for most of fixed expenditures. This is mainly due to the projected increase in the size of individual turbines and the development of technology and the market. In particular, it is assumed that the learning curve includes the following expenditures:

- fixed service charges,
- maintenance and repairs,
- management and other fixed charges,
- insurance.

Based on carried out analyses³⁷ we concluded that the decrease in average OPEX_s is possible, according to the impact of the learning curve, from around 250,000 PLN/MW in 2013 to ca. 190,000 PLN/MW in 2025.

Variable operating expenses of offshore wind farms' operation in the Polish maritime areas were estimated to 30 PLN/MWh in 2013 (including balancing costs).

OPEX_z (variable part of operating expenses) can up to 2025 remain at a similar level, mainly due to the increase in the rate of use of 1 MW of installed capacity, and thus most of the variable service charges constituting the surplus over the fixed service charges. According to forecasts, the variable operating expenses ("OPEX_z") may amount to 29 PLN/MWh in 2025.

The reduction objective, as for the operating expenses ("OPEX"), should be to reach the reduction of fixed operating expenditures by ca. 24% in comparison to estimates for 2013, in up to 2025 perspective.

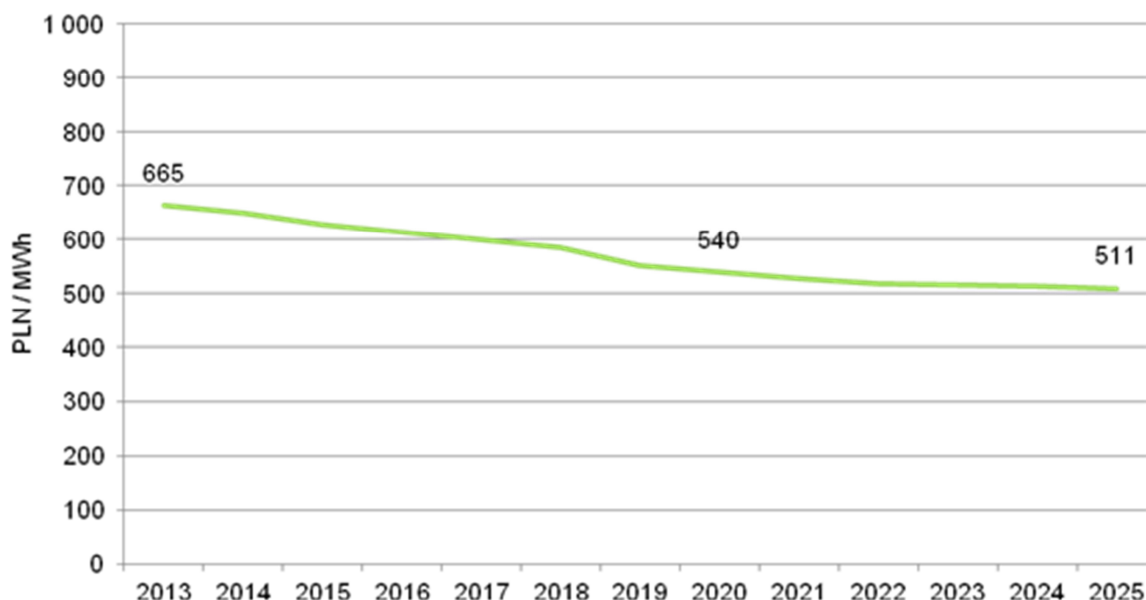
2.3.3. Reduction of energy generation unit cost

Based on forecasts of unit investment costs, operating expenses and assumptions concerning the required rate of return by investors constructing offshore wind farms, it is possible to estimate the unit cost of energy generation ("EGUC") in offshore wind farms in Poland up to 2025.

It should be noted that EGUC corresponds to the limit revenue from the energy sale and property rights from the sale of certificates of origin, which the investor should obtain as to secure the profitability of the execution of OWF projects in Poland.

According to forecasts up to 2025 the decrease of EGUC is possible, from the estimated as for today 665 PLN/MWh to about 511 PLN/MWh for the scenario in which the productivity of OWF will amount to 45%, and from 809 PLN/MWh to 534 PLN/MWh for the pessimistic and unlikely scenario, where the average productivity will amount to 38% in 2013-2020. In the best-case scenario (the base scenario), one expects the decrease of energy generation costs by ca. 23% compared to 2013. Detailed data of projected unit cost of energy generation in OWF in Poland are presented in Diagram 10.

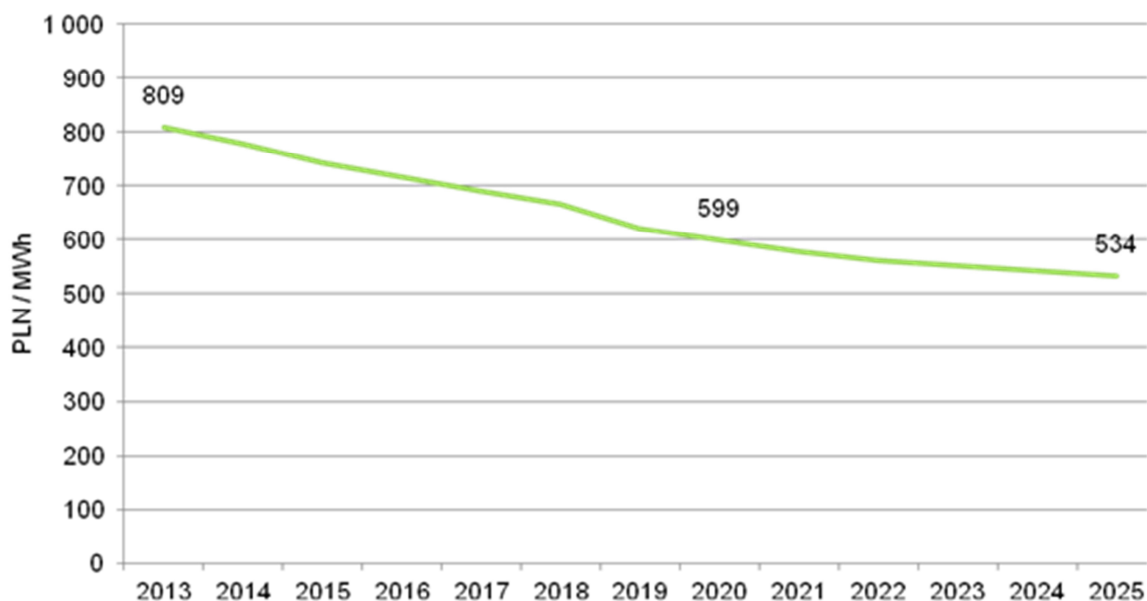
Diagram 10. The projected unit cost of 1 MWh of energy generation in OWF in Poland in 2013-2025, assuming a capacity utilization rate of 45% - optimistic scenario



Source: own work

³⁷ FNEZ. 2012. Analysis of the required level of support for offshore wind farms in Poland up to year 2025. (*Analysis of the required level of support for offshore wind farms in Poland up to year 2025*). Annex to the report of January 16, 2012, including the provisions of the draft of the Act on Renewable Sources of Energy of October 4, 2012.

Diagram 11. The projected unit cost of 1 MWh of energy generation in OWF in Poland in 2013-2025, assuming a capacity utilization rate of 35-40% - pessimistic scenario



Source: own work

The objective concerning the reduction of the unit cost of energy generation by OWF in 2025, in relation to the estimates for 2013, should be the reduction of costs by ca. 23%.

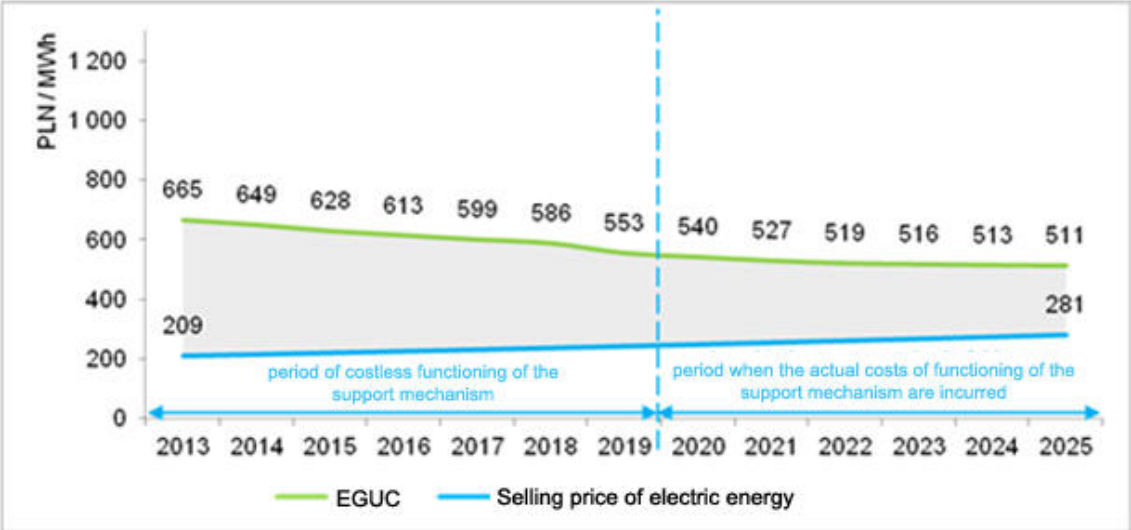
2.3.4. Reduction of the amount of support

Offshore wind farms, as any other new energy generation technology, require support at the development stage. This support will allow for their marketization in relation to other sources, which have also been supported at the marketization stage. One should note that the Polish energy market is dominated by old conventional energy sources, which maintain relatively low energy generation prices due to the depreciation. All new renewable energy technologies, including co-combustion, were in the early years of development supported by the existing support system. Currently, the revision of the support system is being prepared in order to minimize the cost of achieving the objectives regarding renewable energy development set in the European Union climate and energy package. The development of offshore wind energy will also require the support of this technology. However, it should be noted that planning of the support system for offshore wind energy, as well as the evaluation of the cost of this support, should not take place during the discussions on the amount of the correction factors for particular renewable energy technologies and the costs of obligations under the Directive 2009/28/EC. The reason is that the first wind farms can be built in Poland in 2020 and only then the first certificates of origin for OWF will be issued to be settled in 2021. Thus, by 2020 renewable energy support system will not generate costs on account of OWF support, because the system costs, affecting the price of energy for end-users, will come from the purchase of certificates of origin by the entities (energy suppliers). However, this does not mean that in 2014-2020 the value of the correction ratios for OWF certificates of origin should not be determined. To enable investors to prepare projects and obtain funding, it is necessary to determine the financial terms of the implementation and operation of wind farms at the time of putting them into service (commissioning date). To make this possible, the support for OWF for a longer period than for other renewable energy technologies should be specified - from date of when the Act comes into force, up to the period when 3 first OWF are put into service - or for the same period as other RES (3 or 5 years) - but not from the date when the Act enters into force, but for the period in which first OWF projects are being contracted, built and put into service - 2019-2021. The determination of the amount of support in the new legal system governing renewable energy industry in a long term should also constitute a tool indicating the expected path of the reduction of investment costs, being the basis for planning the strategy of market development for OWF and national development of delivery and logistics facilities as well.

On the basis of investment and operating costs estimations for OWF constructed and exploited on foreign markets, in comparison to the Polish location and wind conditions and taking into account the reduction of CAPEX and OPEX assumed in the Programme and resulting from the accepted forecast of the development of OWF market and from the "learning curve", it can be estimated that in order to provide the profitability of OWF in Polish maritime areas the level of support for this technology should be determined at the following levels in the new mechanism:

1. from 456 PLN/MWh (with the productivity of 45%³⁸) up to 600 PLN/MWh (with the productivity of 35%) in 2013,
2. from 292 PLN/MWh (with the productivity of 45%) up to 351 PLN/MWh (with the productivity of 35%) in 2020,
3. from 230 PLN/MWh (with the productivity of 45%) up to 253 PLN/MWh (with the productivity of 35%) in 2025.

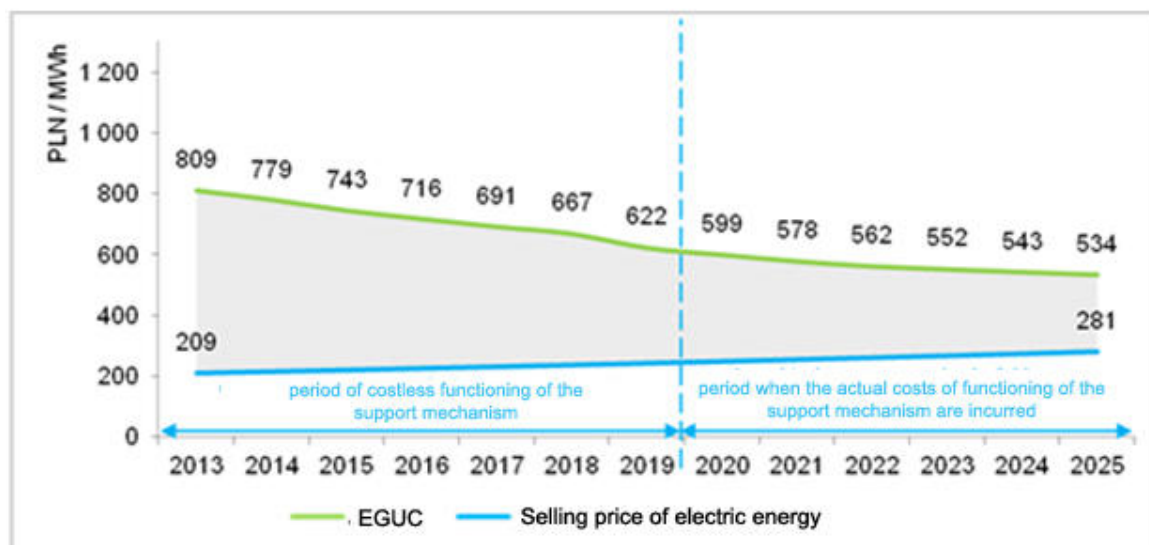
Diagram 12. Assumed gap in the revenues between the energy generation unit cost (EGUC) in OWF and a forecast electric energy price in Poland in 2013-2025 - an optimistic scenario.



Source: own work

³⁸ Productivity - the value determined as the relation between the number of working hours and the number of hours in a year in total (this indicator is expressed as percentage value).

Diagram 13. Assumed gap in the revenues between the energy generation unit cost (EGUC) in OWF and a forecast electric energy price in Poland in 2013-2025 - a pessimistic scenario.



Source: own work

The costs of the support mechanism due to the additional payments to the sold energy, with an assumption that the parameters given in the previous draft Act on Renewable Energy Sources of October 2012 (specified guaranteed price of energy indexed by the inflation value, certificate of origin with the coefficient guaranteeing the coverage of the gap in revenues so that the project can reach IRR=12%) in a mean annual perspective should not exceed PLN 1.1 billion for wind farms commissioned up to 2020 (1 GW) an additionally PLN 1.8 billion for wind farms commissioned up to 2025 (2 GW). **Up to 2020 the support mechanism for OWF will not involve any costs.**

2.3.5. Increase of revenues and economic benefits

Construction of 6 GW by 2030 will have a strong impact on economic growth in Poland. On the basis of the report "Morska energetyka wiatrowa – analiza korzyści dla polskiej gospodarki oraz uwarunkowań rozwoju" (*Offshore wind energy - analysis of benefits for the Polish economy and development conditions*) prepared by EY in cooperation with the Polish Wind Energy Association (PWEA), the estimates of economic benefits that may be achieved in year 2030 were prepared.

The development of OWE in Poland is associated with very big capital expenditures, highly dependent on the installed capacity in OWF completed and put into service in 2030. The aim of the Programme is to organize the development of the industry - so the total expenditures for 2030 would amount to PLN 92 billion, of which ca. PLN 60 billion (approx. 65% with the volume objective of 6 GW by 2030) would apply to the purchase of equipment and services from companies located in Poland, and the first capital expenditures would be incurred in 2012-2015 (location fee and first OWF project development costs, such as costs related to environmental analyses).

Offshore wind energy development in Poland will bring 3 types of effects:

- direct effects connected with the change of selected measures of economic activity resulting from the change of the value added for the wind energy sector (e.g. direct employment changes),
- indirect effects determining the impact of OWE investments on related companies, which operate within other sectors of economy,
- induced effects related to consumption expenditures of employees directly involved in the investment process, as well as of related companies (associated businesses).

Based on performed analyses - 4 groups of economic benefits were identified: economic growth (economic added value), employment growth, tax revenues and avoidance of CO₂ emission expenses. Individual benefits are described in sections below:

1. The added value for Polish economy up to 2030 should reach the amount of PLN 81.8 billion (aggregated value for the investment and operation phase). After 2030 we should expect from PLN 13 to 14 billion of added value in economy generated during the operational phase of 6 GW OWF.

The biggest added value will be produced - outside OWF sector - by the construction industry, engineering industry, services and maritime transport, including shipbuilding industry and ports. Thus, these sectors will be the biggest beneficiaries of the development of OWF in Poland.

2. As a result of the development of the OWF sector and the related sectors, there will be an increase in employment of 24,800 permanent jobs by 2030. The majority of new employment opportunities (ca. 85%) will be related directly or indirectly (through the execution of purchase orders) with OWF sector. The remaining 15% of the posts (less than 4000) is the result of an increase in consumption expenditures of employees from OWF industry and of related companies.

After 2030 the working 6 GW OWF will maintain the average employment at the level of ca. 5,100 permanent jobs.

3. Tax revenues from business entities by 2030 will amount to approximately PLN 16.4 billion. The majority of this amount (80%) will come from value-added tax (VAT), excise and corporate income tax (CIT). Slightly more than 80% of the income (i.e. PLN 13.5 billion) will go to the central budget (State Treasury). The rest of the tax revenues will constitute voivodeships, communes and counties revenue budgets.

After 2030 the annual tax revenues to the budgets of local governments and the central government will amount to PLN 3.1 billion.

4. The production of energy in OWF will enable the avoidance of the cost of purchasing CO₂ emission licences. When estimating the average price of CO₂ emission licence around 10 EUR/tCO₂ - the overall benefit resulting from this avoidance will amount to approximately PLN 5.5 billion up to 2030. After 2030 the benefits resulting from the avoidance of emissions should amount to PLN 1 billion per year.

2.3.6. Summary of benefits and costs associated with the development of OWF

Total benefits by 2030 may reach PLN 98 billion (added value in the economy and budgetary revenues), including benefits connected with the avoidance of CO₂ emissions - PLN 104 billion. It should be noted that since 2030, operating OWF will have a positive impact on the economy for about 20-25 years of their operation.

The achievement of the benefits will require certain costs, related to the revenue gap, to be incurred. However, it seems probable that in spite of decreasing unit costs of energy generation in offshore wind farms, the revenue gap will remain at the level of 140-187 PLN/MWh until 2030.

We estimate that the cost of operation of offshore wind energy covering the revenue gap and taking into account the cost of energy system balancing (in the amount of 10 PLN/MWh) may amount in 2020-2030 to PLN 22-31 billion. Average OWF support costs will therefore amount to PLN 2-2.8 billion per year, starting from 2020.

Differentiation of OWF development costs results from various assumptions on electricity price, at which the owner of OWF will be able to sell the generated energy. The lower the selling price at the wholesale market, the greater the role of the support system, and as a result higher costs of the system supporting this technology.

It should be noted that up to 2020 the support mechanism for OWF will not generate any costs. However, at that time, the state budget will record first receipts from location charges. Estimated value of location charges that will be received up the moment of production commencement from first OWF installations amounts to ca. PLN 0.3 billion. In the period up to 2030 it will give the revenue of in total ca. PLN 0.9 billion (this amount was taken into account in the budgetary revenues described in the section on benefits from OWF operation).

To sum up, we can state that the benefits associated with the development of offshore wind farms in Poland will several times exceed the costs related to the creation of appropriate conditions for their development. The scale of benefits (and the surplus over the costs) directly depends on the scale of

development of the OWF sector in Poland. This results, in particular, from the fact that in case of the development of the sector up to the level of ca. 6 GW of installed capacity, the proportion of capital expenditures associated with the construction of OWF, which will be the revenue of Polish companies and it will contribute to the economic development of Poland, will be considerably larger. Therefore, from an economic point of view, it should be acknowledged that the support mechanism for offshore wind farms is an investment, which in the 2030 perspective will bring benefits to the Polish economy and may even contribute to the creation of a new economic sector in Poland, which will provide the increase of GDP and general employment, especially in the coastal regions.

3. Analysis of the current situation

3.1. Legal conditions

Development and execution of an OWF project is a long-term process, which depends on certain legal acts. Below we present a short information on subsequent stages of the process and a description of the most important legal conditions determining the course of the said process.

Table 2. Planned offshore wind farm execution schedule

| Development stage | Time [Q ³⁹] | I year | II year | III year | IV year | V year | VI year | VII year |
|---|-------------------------|--------|---------|----------|---------|--------|---------|----------|
| Procedure for obtaining the permit to erect and exploit artificial islands, installations and equipment in maritime areas for an offshore wind farm and the research and measurement station (PSZW) | 3 | █ | █ | | | | | |
| Procedure for obtaining the connection conditions and the connection agreement | 5 | | █ | █ | █ | | | |
| Environmental impact assessment procedure and the procedure for obtaining the decision on environmental conditions (including environmental research) | 12 | | █ | █ | █ | █ | █ | |
| Obtaining the permit to construct the research and measurement station and to carry out wind measurements | 10 | | | █ | █ | █ | █ | |
| Procedure for obtaining the permit to lay and maintain the seabed cables and pipelines in internal waters and territorial sea (including the agreements on the seabed cables and pipelines routes) | 4 | | █ | █ | █ | | | |
| Procedure for obtaining the permit to lay and maintain the seabed cables and pipelines within the Polish EEZ (including the agreements on the seabed cables and pipelines routes) | 4 | | █ | █ | █ | | | |
| The procedure for obtaining the decision on environmental conditions for | 8 | | | █ | █ | █ | █ | |

³⁹ Q - quarter

Fees for the issuance of the permits

For the issuance of PSZW the authorities charge the amount equal to 300 calculation units specified in Art. 55 of UOM. Moreover, in case of offshore wind farms located only within the exclusive economic zone the authority charges an additional amount of 1% of the value of the planned project, whereas this cost is distributed in time for the subsequent stages of the investment.

Deadline for the issuance of the permit

The Minister in charge of maritime economy, after publishing an announcement, submits the application to other ministers who should express their opinions within 90 days from the moment of receiving the application. After obtaining all opinions the minister in charge of maritime economy issues or refuses to issue the permit. PSZW should be issued in accordance with Art. 35 KPA, *i.e.* within 30 days, unless the case is officially deemed as complicated. The decision must be issued within 60 days.

Permit validity period

PSZW is issued for the period necessary for the erection and exploitation of artificial islands, constructions and devices, however, the period cannot exceed 30 years (Art. 23 sec. 6 of UOM) and can be extended by another 20 years (Art. 23 par. 6g of UOM). There are circumstances, which give the minister in charge of maritime economy the reasons to cancel the permit, if:

- within 6 years from the issuance of the permit the entity, which received the permit, fails to obtain the construction permit (there is a possibility to extend this period by 2 years),
- within 3 years from the day on which the decision regarding the construction permit becomes final, the erection of the OWF will not commence or within 5 years from the day on which the erection commenced, the exploitation of the OWF will not commence,
- execution of the investment is not compliant with the conditions specified in the permit.

Determination procedure

The determination procedure is carried out by the minister in charge of maritime economy, if more than one complete submitted application is lodged within 60 days from the date of the announcement about the first application being submitted. Other applications must refer to the same location indicated first in the announcement. If within the specified deadline another application is lodged, which refers only to a part of the area indicated in the first application, then it must remain unconsidered until the decision on the first application is issued.

After submitting another application for the issuance of PSZW in relation to the application indicated in the announcement, the minister in charge of maritime economy verifies the completeness of the application in terms of formal matters. When the minister states that the application contains all necessary elements and attachments listed in Art. 27a sec. 1 and 2 of UOM), the application is submitted to other ministers in order to obtain their opinions.

It is unclear, however, whether in case of receiving opinions from the other ministers in the determination procedures, those ministers can request the applicant to supplement the application. Art. 27d of UOM states that the determination procedure is initiated only if another complete application is submitted, then a decision of any of the ministers about the incompleteness of the second application should result in the conclusion of the determination procedure and a refusal to consider the second, incomplete application.

In case, where the submitted applications, which relate to the same body of water, will be deemed complete, the minister in charge of maritime economy informs the applicants about the initiation of the determination procedure. The minister request the applicants to submit, within 21 days, the information and documents enabling the determination whether the applicants have satisfied the criteria according to which the applications will be assessed. Those criteria were listed in Art. 27g and are as follows:

- the compliance of the planned projects with the provisions of the maritime areas spatial development plan mentioned in Art. 37a of UOM or, in case of lack of such plan, the possibility to use the body of water for the purposes stated in the application, including the opinions mentioned in Art. 23 sec. 2 of UOM (opinions of the ministries),

- permit validity periods, proposed by the applicants, including the date of commencement and completion of the construction and exploitation of the planned projects,
- the method for securing financial means for the payment mentioned in Art. 27b sec. 1 item 1 of UOM,
- methods of financing the planned projects, taking into account own financial means, credits, loans and proposed additional financing of the investment from public means,
- possibilities to establish a team of skilled workers, create an organizational and logistics potential, which will allow for the execution of the planned projects, contribution of the planned projects to the European and national sector policies.

The minister in charge of maritime economy will also be obliged to determine:

- the major application assessment criteria for the determination procedure, from among the set of criteria mentioned in Art. 27g,
- number of points for each criterion mentioned in Art. 27g,
- minimum level for qualification.

On the basis of documents submitted by the applicant the minister in charge of maritime economy performs the assessment of applications.

Seabed cable location permit

Seabed cables included in the external connection infrastructure of an OWF (located within the area of the exclusive economic zone and the territorial sea) require the issuance of separate permits to lay and maintain seabed cables and pipelines. The legal basis for the issuance of those permits is given in Art. 26 and Art. 27 of UOM - separate regulations for the territorial sea and for the EEZ.

Jurisdiction of administrative authorities

The permit to lay and maintain the seabed cables and pipelines in **internal waters and territorial sea** is issued by the director of the appropriate maritime office (Art. 26 of UOM).

The decision containing the permit to lay and maintain seabed cables and pipelines in **Polish exclusive economic zone** is issued by the minister in charge of maritime economy, after receiving the opinion of the minister in charge of the environmental issues (i.e. 1 of UOM).

Fees for the permits

For the issuing the permit to lay and maintain seabed cables and pipelines within the territorial sea the authority issuing the permit shall charge the entity requesting for the permit with the amount equal to 300 calculation units specified in Art. 55 of the said Act.

This fee does not refer to the permit to lay and maintain seabed cables and pipelines within the Polish EEZ.

Permit validity period

The Act does not provide the period, for which the permits to lay and maintain the seabed cables and pipelines are issued. This means that these permits are issued for an indefinite period.

Location permit for the onshore connection infrastructure

In case of the onshore elements of the Act on spatial planning and development applies (Dz.U. [Journal of Laws] of 2012, item 647, consolidated text) ("UPZIP"). Pursuant to Art. 4 of UPZIP the determination of the intended use of an area, the distribution of a public purpose investment and the specification of development methods and conditions are regulated in a local spatial development plan. If such a plan has not been adopted, it is necessary to prepare or obtain a decision on establishing the location of a public purpose investment ("ULCIP decision") or a decision on land development conditions (planning/zoning permission).

Additionally, it is necessary to obtain:

- the permit to use the service strip for purposes other than the maintenance of the coast in a condition compliant with the safety and environmental protection regulations,

- exemption from the prohibition to perform works and other activities hindering the protection against floods or increasing flood risk within the service strip.

Jurisdiction of administrative authorities

ULCIP decision is issued by commune authorities or a mayor in consultation with a voivodeship marshal in case of public purpose investments of national or regional significance. In case of a public purpose investment of local significance (poviat or commune) the decision are issued by the same authorities, without the necessity to consult with the voivodeship marshal. For enclosed areas the ULCIP decision is issued by the voivodeship governor.

The decision on land development conditions is issued by commune authorities or a mayor in consultation with appropriate bodies mentioned in Art. 53 sec. 4 of UPZIP and after obtaining approvals or decisions required by separate provisions. For enclosed areas the decision on land development conditions is issued by the voivodeship governor.

The permit to use the service strip and the exemption from the prohibition to perform works and other activities hindering the protection against floods or increasing flood risk within the service strip are issued by a competent maritime office.

Planned Act on transmission corridors

The act on transmission corridors aims at introducing new system solutions for infrastructure line investments, which will improve and accelerate the process of obtaining permits by investors allowing for the construction of technical infrastructure, its extension and modernisation and will create favourable conditions for the development and execution of future investments.

According to the assumptions of the latest version of the draft act of December 3, 2012⁴⁰, the act will simplify the procedures to obtain the decision on establishing transmission corridors. Draft act includes also the following proposals: combining all procedures in one administration centre, possibility to obtain the construction permit and the approval for the construction design in the decision on establishing the transmission corridors, introduction of new deadlines for the issuance of permits and penalties for failures to observe those deadlines, introduction of algorithms to calculate compensation for the utility easement, introduction of the possibility to correlate the option to file a claim to the administrative court with the payment of a deposit by the claimant.

Investments in terms of transmission corridors were presented in the act as priority investments. On the other hand, the act focuses mostly on solving problems with the construction of onshore transmission grids. There are hardly any provisions which directly regulate the offshore issues, as in Art. 3 which stipulates that the act does not infringe any provisions of the Act of March 21, 1991 on the maritime areas of the Republic of Poland and maritime administration.

The draft act is currently being consulted by the Standing Committee by the Council of Ministers. Unfortunately, it is still not confirmed when the draft act will be submitted to the Polish Sejm.

3.1.2. Environmental procedures

The Environmental impact assessment ("EIA") issues for projects based on the construction of offshore wind farms are regulated by the provisions of the following acts:

- the act of October 3, 2008 on publishing information about the environment and its conservation, public participation in the environmental protection and environmental impact assessment (Dz. U. [Journal of Laws] No 199, item 1227, with further amendments) ("EIA Act"),
- the Regulation of the Council of Ministers of November 9, 2010, on projects which may significantly affect the environment (Dz. U. [Journal of Laws] No. 2013, item 1397) ("The EIA Regulation"),
- Directive of the European Parliament and of the Council 2011/92/EU of December 13, 2011 on the assessment of the impact of certain public and private projects on the environment ("EIA Directive").

⁴⁰ <http://legislacja.rcl.gov.pl/lista/2/projekt/23511/katalog/23540>, accessed on [April 15, 2013].

An offshore wind farm consists of the following elements:

1. wind power plants,
2. offshore substation (transformer station, external GPZ) or several such stations,
3. medium voltage ("MV") seabed cables, connecting the wind power plants with the offshore substation (the internal connection infrastructure - "IPW"),
4. telecommunication lines (fibre optic lines) connecting the wind power plants with the management centre,
5. offshore research and measurement platform (optional),
6. optional are also elements of the accompanying infrastructure, *e.g.* accommodation and service station, helipad, etc.

The external connection infrastructure („IPZ”) for the transmission of energy produced by the wind power plants to the National Power System is composed of:

1. high voltage ("HV") seabed cables evacuating energy from the offshore wind farm and transmitting it to mainland, cables running from the internal wind farm GPZ,
2. onshore connection - high voltage seabed cables and overhead power lines leading to the indicated NPS connection point (the external GPZ),
3. onshore substation raising and reducing voltage to the values required by NPS and adjusting parameters of the transmitted current (DC/AC),
4. seabed (in the offshore part of the IPZ) /underground or overhead (in the onshore part of IPZ) fiber optic lines for the transmission of data from the OWF.

The OWF external connection infrastructure may be indicated as an element of a project based on the construction of an offshore wind farm or as a separate project subject to separate environmental procedures.

EIA procedure for OWF

Pursuant to § 2 par. 1 sec. 5 of the EIA Regulation, the OWF are among the projects that may always have a significant impact on the environment, for which the EIA procedure is obligatory. The EIA procedure is conducted as a part of the proceedings on the issuance of the decision on environmental conditions ("DSU").

Jurisdiction of administrative authorities

According to the EIA Act the body responsible for the issuance of DSU for projects executed in the maritime areas (in part or as a whole) is the Regional Director for Environmental Protection ("RDOŚ"), whose local competence is determined by reference to the maritime area along the coast, within the area of a given voivodeship.

Administrative procedure

Investors planning to construct an OWF can follow one of two ways to obtain DSU:

1. by applying for the issuance of DSU along with the report on the assessment of the impact of the project on the environment ("the EIA report"),
2. by applying for the issuance of DSU and for the determination of the scope of the EIA report, attaching the project information sheet ("KIP") (this way is obligatory if the applicant suspects that the project may be the source of the transboundary impact).

Due to the fact that at the stage of filing the application for the issuance of DSU the investor has insufficient data to exclude the transboundary impact, it is recommended to always file the application for the determination of the scope of the EIA report in case of OWF, pursuant to the description above. Such a procedure is advantageous also for other reasons - it allows the investor to obtain information on the scope of the EIA report required by the administrative body, *i.e.* on the scope of environmental research for the project. This procedure was selected by the investors who were recently filing their applications for DSU for the OWF planned to be constructed within the Polish maritime areas.

The administrative body in charge of the procedure is obliged to issue the decision on the scope of the EIA report within 30 days from the moment of initiating the procedure (Art. 70 par. 4 of the EIA Act), obtaining previously the opinion of a competent body of the Chief Sanitary Inspectorate and the director of a competent maritime office. Pursuant to Art. 68 of the EIA Act, when the scope of the EIA report is determined, the body takes into account the current knowledge and status of research and the available technical possibilities and data availability. The body issues also a decision on the suspension of the DSU procedure until the submission of the report by the applicant (Art. 68 par. 4 of the EIA Act).

After obtaining the decision on the scope of the EIA procedure the investor may initiate the necessary environmental research. The research period will depend on the scope of the required research specified by RDOŚ, but also on the meteorological conditions and the availability of specialist research equipment. Research must be carried out at least in a 1-year cycle. Taking into account the variability of weather conditions and the limited availability of specialist research equipment, the research planned for a 1-year cycle may take longer, even up to 2 years.

After carrying out all the necessary research the EIA report may be prepared. The scope of the EIA report must be compliant with the provisions of Art. 66 of the EIA Act or with the provisions of the above mentioned decision directly specifying the scope. According to Polish law, the element assessed in the EIA report for projects which may (always or potentially) significantly affect the environment is the impact on the Natura 2000 areas (Art. 66 of the EIA Act).

The EIA report is submitted to the body in charge of the procedure. RDOŚ analyses the document and is obliged to consult with a director of an appropriate maritime office and a competent body of the Chief Sanitary Inspectorate regarding the project execution conditions. Additionally, according to Art. 79 par. 1 of the EIA Act, RDOŚ is also obliged to provide the possibility for the society to participate in the procedure, *i.e.* to carry out social consultations during which the society can inspect the documentation of the project and submit remarks and requests related to the project, within 21 days.

After the above described actions the body in charge of the procedure may issue the decision on environmental conditions, in which, pursuant to z art. 82 of the EIA Act, the following elements are specified:

- type of project and place of execution of this project,
- terms of use of area at the stage of construction and exploitation or maintenance of the project, with a particular emphasis on the necessity to protect precious natural values, natural resources and historic sites, and to reduce nuisance to neighbouring areas,
- requirements regarding the environmental protection necessary to be included in the documentation for the issuance of the construction permit,
- requirements on countering the effects of industrial accidents, for projects treated as plants posing threats of serious failures within the meaning of the Act of April 27, 2001 - Environmental Protection Law,
- Requirements on reducing the transboundary environmental impact with respect to the projects for which the transboundary environmental impact proceedings were carried out.

If from the conducted environmental impact assessment a necessity results to:

- carry out environmental compensation - then the authority states in the decision that such a compensation must be carried out,
- prevent, limit and monitor the environmental impact of the project - then the authority imposes the obligation to perform such actions.

In the case referred to in Art. 135 par. 1 of the Act of April 27, 2001 Environmental Protection Law, the authority states the necessity to establish the area of restricted use.

The authority in the environmental decision presents also the position statement on the necessity to carry out another EIA procedure (described further in this document).

The authority may impose an obligation in the environmental decision on the applicant to present the post-execution analysis, determining the scope and deadline for the submission of such an analysis.

The issuance of DSU cannot occur before the conclusion of the transboundary proceedings.

EIA procedure for IPZ

The law in Poland does not prohibit separate environmental procedures for OWF and IPZ. Such an approach is recommended in particular in the two following cases:

- the OWF investor, when submitting the application for DSU, does not have the grid connection conditions - so the investor is not able to determine the exact parameters of the seabed cable and its course along the seabed, the point where the cable reaches the coast and the location of the onshore infrastructure, then the investor will also not be able to carry out a proper environmental impact assessment for the IPZ,
- IPZ will be a part of a completely different project, involving the construction of an international marine electricity infrastructure, aiming at the integration of electricity systems of the EU countries or the infrastructure for the reception and transmission of electricity generated by offshore wind farms located in the Polish maritime areas.

Neither Polish provisions, nor the provisions of the EIA Directive specify the seabed cables as elements which may significantly affect the environment. Other elements of the external connection, though, such as overhead power lines or substations, may be subject to EIA.

According to the EIA Regulation, the elements which are subject to obligatory EIA are specified in § 2 par. 1 sec. 6 the EIA Regulation and these elements include the substations or the overhead power lines with the rated voltage not less than 220 kV, with the length not less than 15 km (this is the I group of projects, similar to the OWF). In such a case, the course of the procedure will be the same as in case of an OWF (described above), *i.e.* appropriate for the majority of projects related to the connection of an OWF due to the HV substations included in such a project.

The elements indicated in § 3 par. 1 sec. 13 of the EIA Regulation, *i.e.* substations or overhead power lines with the rated voltage of at least 110 kV, not mentioned in § 2 par. 1 sec. 6 therein, are subject to optional assessment (about which the administrative body in charge of the screening procedure decides - Art. 63-64 of EIA Act). In such a case the procedure related to the issuance of DSU will have a slightly different course than the one described above.

It will depend on the level of voltage of the energy evacuated from the offshore wind farm.

Jurisdiction of administrative authorities

The administrative authorities should carry out a common procedure related to DSU for all elements included in the external OWF connection (seabed cables, overhead power lines and substations). In other case there will be no legal basis to initiate the DSU procedure for the seabed cable. The EIA report prepared for the external connection must contain the analysis of the accumulated impact of the connection and the OWF.

Due to the fact that IPZ is a project partly located within the maritime areas, the authority competent to issue DSU is RDOŚ.

Administrative procedure

DSU procedure for projects which may potentially significantly affect the environment were described in Art. 59-120 of the EIA Act. In case of procedures referring to projects which may potentially significantly affect the environment, to the application for the issuance of DSU instead of the EIA report the Project Information Sheet (KIP) is attached.

The body in charge of the procedure, on the basis of data about the project specified in KIP and after consulting with the director of an appropriate maritime office and the competent body of the Chief Sanitary Inspectorate, issues the decision on the necessity (or lack of such a necessity) to carry out the EIA procedure. In the decision on the necessity to carry out the EIA also the scope of the report is indicated, along with the scope of required environmental research.

The body is also obliged to issue the decision on the necessity to carry out the EIA procedure and on the scope of the report within 30 days from the moment of initiating the procedure.

If the decision was issued that there is no need to carry out the EIA, then the next step is the issuance of DSU. If the decision is made that the EIA procedure is necessary, then the body issues also a decision on the suspension of the DSU procedure until the submission of the EIA report by the applicant.

Prepared EIA report is submitted to the body in charge of the procedure. The body analyses the document and is obliged to consult with a director of an appropriate maritime office and a competent body of the Chief Sanitary Inspectorate regarding the project execution conditions. Additionally, according to Art. 79 par. 1 of the EIA Act, RDOŚ is also obliged to provide the possibility for the society to participate in the procedure, i.e. to carry out social consultations during which the society can inspect the documentation of the project and submit remarks and requests related to the project, within 21 days.

After the above described actions the body in charge of the procedure may issue the decision on environmental conditions.

The issuance of DSU should occur before the conclusion of the transboundary proceedings.

Transboundary procedure

An additional procedure associated with the procedure for the issuance of DSU is the transboundary environmental impact assessment procedure (transboundary procedure). It is regulated by Art. 104-120 of the EIA Act. This procedure will apply to a majority of OWF projects, especially those located near the offshore exclusive economic zones of other countries (where the transboundary acoustic, visual or other impact may occur).

Administrative procedure

Pursuant to Art. 108 of the EIA Act, if there is a possibility that the transboundary environmental impact will occur due to the execution of the planned project, then the body in charge of the procedure:

- issues a decision on the necessity to carry out the transboundary environmental impact assessment procedure, in which the scope of documentation required for the procedure is determined along with the obligation to prepare the documentation by the applicant in the language of the state on which the project may have an impact (the decision is issued within 14 days from the moment of receiving the application for the issuance of the environmental decision),
- immediately informs the General Director for Environmental Protection ("GDOŚ") about the possibility of a transboundary environmental impact of the planned project and submits the project information sheet to GDOŚ,
- submits to GDOŚ the documentation related to the project (to an extent specified in the Act).

Then, pursuant to Art. 109 of the EIA Act, GDOŚ notifies the state on which territory the project may have an impact (*i.e.* the affected state), informing about the decision which might be issued for the considered project, and about the body competent to issue the said decision, and attaches KIP. In such a notification GDOŚ suggest a deadline for the reply to the question whether the affected state is interested in participating in the transboundary procedure.

If the affected state informs GDOŚ that they are interested in participating in the procedure, then GDOŚ:

- in consultation with the administrative body in charge of the EIA procedure determines the stages of the procedure with the affected state, taking into account the provision of the possibility for the affected state's competent authorities and the society to participate in the procedure,
- submits documentation specified in the act to the affected state (including the EIA report).

According to Art. 110 of the EIA Act the body responsible for the issuance of DSU carries out - through GDOŚ - the consultations with the affected state. The consultations are related to the measures eliminating and mitigating the transboundary environmental impact. The consultation procedure may also be fully taken over by GDOŚ.

The affected state may submit their remarks and requests during the entire period of the DSU procedure.

According to Art. 111 of the EIA Act:

- remarks and requests related to KIP, submitted by the affected state, are considered after the issuance of the decisions mentioned in Art. 63 par. 1 of the EIA Act (*i.e.* the decision about the necessity to carry out the EIA procedure and the scope of the EIA report - for projects which may potentially significantly affect the environment) and Art. 69 par. 3 of the EIA Act (*i.e.* the decision about the]scope of the EIA report - for projects which may always significantly affect the environment),
- remarks and requests submitted by the affected state, including the results of the consultations mentioned in Art. 110 of the EIA Act, are considered and taken into account during the issuance of DSU.

The issuance of DSU should occur before the conclusion of the transboundary proceedings.

Another EIA procedure

Another EIA procedure is regulated by Art. 88-95 of the EIA Act.

Another EIA procedure for OWF or IPZ may be carried out:

- upon the request of an entity planning to execute the project, submitted to an appropriate authority competent to issue the construction permit,
- if the authority competent to issue the construction permit states that in the application for the issuance of DSU certain changes related to the requirements specified in DSU were made,
- if the procedure is required by DSU on the basis of Art. 82 par. 1 sec. 4 of the EIA Act.

Another EIA procedure may be carried out only within the procedures aiming at the issuance of the decisions mentioned in Art. 72 par. 1 sec. 1, 10, 14 and 18 of the EIA Act, which include *i.a.* the construction permit required for the offshore wind farm.

Another EIA procedure will be carried out if certain changes are introduced to the OWF or IPZ construction design in comparison to the requirements stated in DSU.

The decision on another EIA procedure for OWF or IPZ is made by RDOŚ in consultation with the body issuing the construction permit. The EIA report is prepared, social consultations are carried out and the result of the procedure is the issuance of the decision on the approval of the project execution conditions by RDOŚ.

3.1.3. Construction permit

Wind power plants and elements of the technical infrastructure of the farm and the power connection are **structures**. Pursuant to the definition given in Art. 3 sec. 3) of the Act of July 7, 1994 on the Construction Law (consolidated text: Dz. U. [Journal of Laws] of 2010, No. 243, item 1623, as amended) ("CL"), whenever a structure is mentioned - it should be understood as any construction object which is not a building or a small architectural object, such as roads, culverts, technical networks, detached aerial masts, detached industrial installations or technical devices, utility infrastructure and structural parts of technical devices (*i.a.* wind power plants).

Offshore wind farm along with its connection is **a construction object**. According to the definition presented in Art. 3 sec. 1)b) of CL, whenever the act mentions a construction objects - it should be understood as **a structure which is a complete technical-utility structure along with installations and equipment**. On the other hand, pursuant to the definition of Art. 3 sec. 3a) whenever the act mentions a line object - it should be understood as a construction object, which characteristic parameter is the length, in particular [...] **power lines and overhead lines, cables above-ground lines and lines placed directly in the ground**.

According to Art. 28 par. 1 of the Construction Law, construction works can be initiated only on the basis of a **final decision on the issuance of the construction permit**, subject to Art. 29-31.

In Art. 29 of CL also the objects, for which the construction permit is not required, were mentioned. **There are no wind power plants, nor the elements of the accompanying infrastructure, what means that the construction of such items and elements requires a construction permit.**

Jurisdiction of administrative authorities

Pursuant to Art. 82 par. 2 of the Construction Law, the first instance administrative body involved in the architectural and construction matters, subject to par. 3 and 4, is the staroste.

However, the voivodeship governor is a higher level administrative authority involved in the architectural and construction matters in comparison to the staroste and the first instance body *i.a.* in relation to the matters of construction objects and works located within the service strip, ports and harbours, internal waters, territorial sea and the exclusive economic zone, and within other areas intended for the maintenance of traffic and marine shipping (Art. 82 par. 3 sec. 1) of the Construction Law). **This means that the authority in charge of the procedure related to the issuance of the permit to construct an offshore wind farm and the accompanying infrastructure at sea is the voivodeship governor and the permit to construct the onshore infrastructure will be issued by the staroste.**

Administrative procedure

Constriction permit is an administrative decision allowing for the initiation and continuation of works or for the performance of construction works other than building a construction object (Art. 2 sec. 12 of the CL).

Pursuant to Art. 33 par. 1 of the CL the construction permit refers to the **entire construction project**. In case of a construction project related to more than 1 object, the construction permit may refer to the selected objects or groups of objects, which may function independently in accordance with their intended use, upon the request of the investor.

An offshore wind farm along with the power connection may be regarded as a complete construction project (because the wind power plants without the cables or the cables without the power plants cannot function independently in accordance with their intended use). Due to the fact that the administration bodies responsible for issuing the construction permits (also for onshore wind farms) interpret this ambiguous provision differently, it seems necessary to request for a proper legal interpretation from the body, which will be in charge of the procedure.

Pursuant to Art. 32 par. 1 of the CL, the construction permit may be issued after:

- conducting the environmental impact assessment procedure or the assessment of the project impact on the Natura 2000 areas (if required),
- obtaining the permits, approvals or opinions of other bodies, required by separate provisions, by the investor (the Act does not specify which bodies, as it depends on the type of project, *e.g.* if a registered historical monument is found within the area of the investment, it will be necessary to obtain a special permit of the voivodeship conservator of monuments).

Deadline for the issuance of the permit

Pursuant to Art. 35 par. 6 of the CL, the body has 65 days for the issuance of the construction permit, but the deadline does not refer to projects subject to the environmental impact assessment procedure or the assessment of the project impact on Natura 2000 areas (as in case of OWF projects). Pursuant to Art. 35 KPA, to those projects the general provisions regulating the deadlines for the consideration of such matters shall apply.

Therefore, the body should issue the construction permit immediately, but not later than within one month, and in case of particularly complicated matters - not later than within two months from the moment of initiating the procedure.

Permit validity period

Pursuant to Art. 37 par. 1 of the CL, the **construction permit expires if the construction failed to commence before the expiry of 3 years from the day on which the decision regarding the construction permit became final** or the construction was stopped for a period exceeding 3 years. The decision becomes final when it cannot be appealed against in the course of the administrative procedure (*i.e.* when the deadline for the lodging an appeal expired).

3.1.4. Support mechanism

Assessment of the current support mechanism

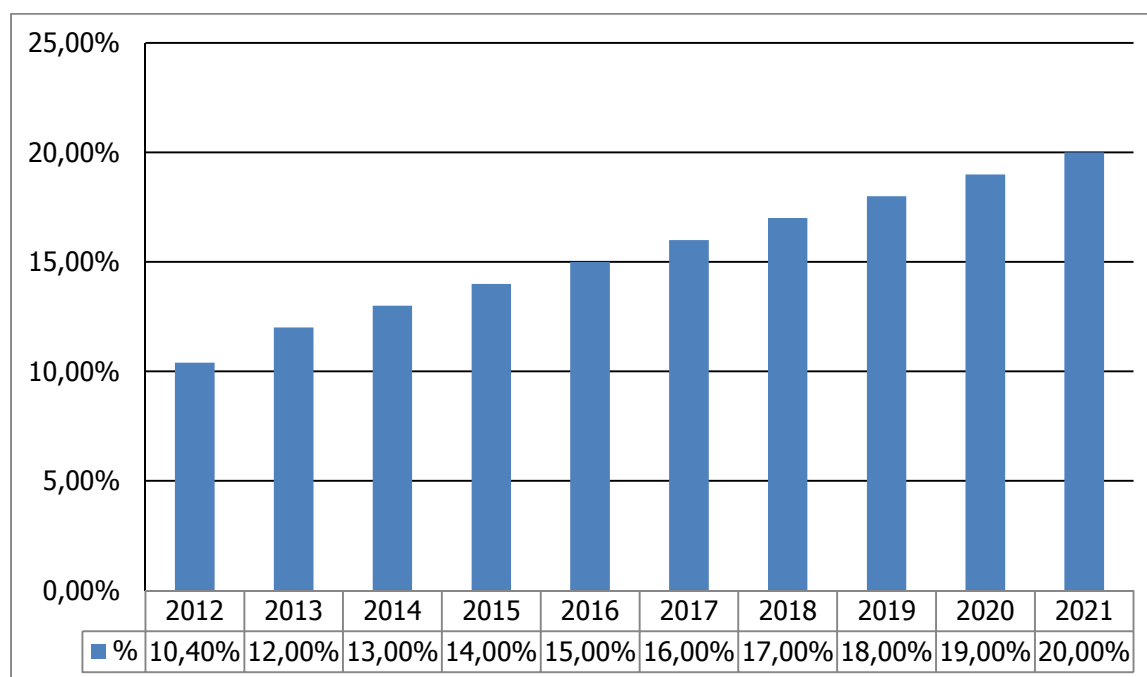
The system of green certificates in Poland is based on the mechanism of renewable portfolio standard, which places an obligation on particular entity to provide or purchase a specified fraction of electricity from renewable energy source covered by the support.

The Polish support mechanism for the production of energy from renewable sources is functioning in the current form since October 1, 2005 and is regulated by the Energy Law. It is based on the obligation of energy companies involved in the energy production or trade and in the sales of energy to the consumers to obtain and submit certificates of origin (referring to the energy produced from renewable sources) to the President of the Energy Regulatory Office ("URE") for cancellation or to pay a substitution fee.

Certificates of origin are used for the determination of the amount of produced energy (quota system). The regulatory authority determines the quantitative objective for the production of energy from renewable sources and its price is specified as a result of market mechanisms. Green certificates are the proof that the energy was generated by a particular renewable sources. These certificates are marketable and are may be traded on a separate market.

Pursuant to the Ordinance of the Minister of the Economy of October 18, 2012⁴¹ the required quantitative share of energy resulting from the certificates of origin or the paid substitution fee in relation to the total annual sales of electric energy by a particular company to the consumers in 2012-2021 should take values presented in the Diagram 14 below.

Diagram 14. Quantitative share of electric energy produced from renewable sources resulting from the certificates of origin or the paid substitution fee.



Source: Ministry of the Economy, "Ordinance of the Minister of the Economy of October 18, 2012 on the detailed scope of obligations in respect to obtaining certificates of origin and submitting them for cancellation, payment of the substitution fee, purchase of electricity and heat from renewable energy sources, as well as on the obligation to confirm the data on the amount of electricity produced from a renewable energy source".

⁴¹ Ministry of the Economy, "Ordinance of the Minister of the Economy of October 18, 2012 on the detailed scope of obligations in respect to obtaining certificates of origin and submitting them for cancellation, payment of the substitution fee, purchase of electricity and heat from renewable energy sources, as well as on the obligation to confirm the data on the amount of electricity produced from a renewable energy source".

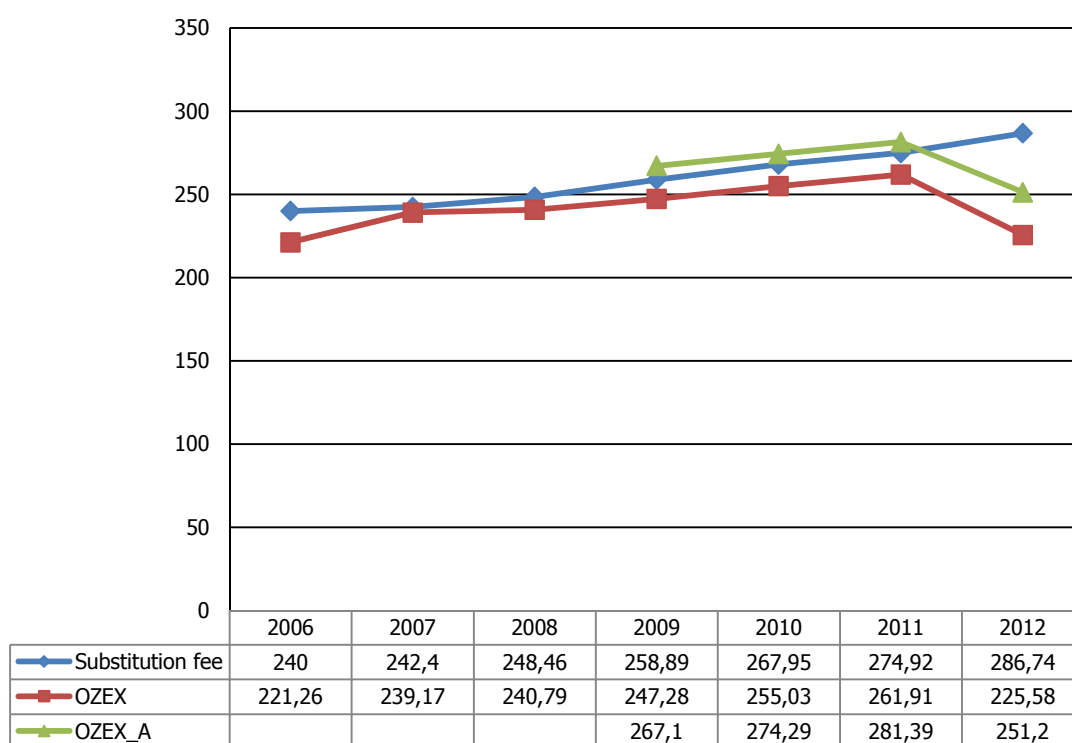
According to the assumptions of the support mechanism for 2005-2013 the producers of energy from renewable sources may receive additional support:

- reduction by 50% of the real costs of connecting to the grid up to 5 MW of renewable energy sources,
- obligation to provide by the power system operator the priority in providing transmission services related to renewable energy,
- exemption for the energy companies producing electric energy from renewable sources (up to 5 MW) from the payment of the licence fee and other fees associated with obtaining and registering the certificates of origin confirming the generation of electric energy from renewable sources.

Registration and trading of certificates resulting from the registered certificates of origin is carried out by the Towarowa Giełda Energii S.A. (Energy Commodities Exchange). This entity is also in charge of the property rights market on which the property rights to certificates of origin for the energy produced from renewable sources are traded.

In 2009-2012 the average weighted OZEX_A⁴² index reached the values of: 267.10 PLN/MWh (2009), 274.29 PLN/MWh (2010), 281.39 (2011), 251.20 (2012)⁴³, what is presented in Diagram 15.

Diagram 15. Prices of property rights resulting from green certificates and the value of the substitution fee in 2006-2012



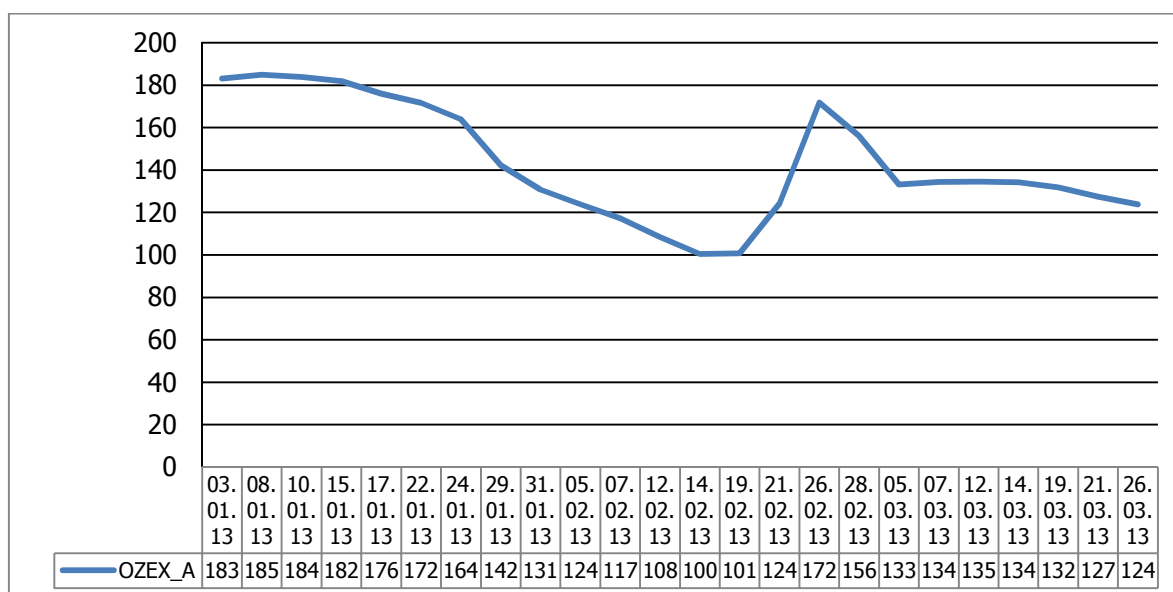
Source: Towarowa Giełda Energii S.A.

In 2013 a serious drop of prices of green certificates was observed at the Energy Commodities Exchange. The price for certificates of origin in the first quarter of 2013 dropped in comparison to the index value in the same period in 2012. The current market situation is caused by the increasing excessive supply of the certificates of origin. The surplus is caused by the increase of energy produced by the co-combustion installations and by the fact that not all of the producers of renewable energy decided to cancel their certificates in the year of their issuance, because they waited for the price of the certificates to rise.

⁴² OZEX_A (PMOZE_A) - volume adjusted average price of all PMOZE_A transactions at a trading session; PMOZE - property rights to certificates of origin which confirm the production of energy from renewable source up to February 28, 2009.

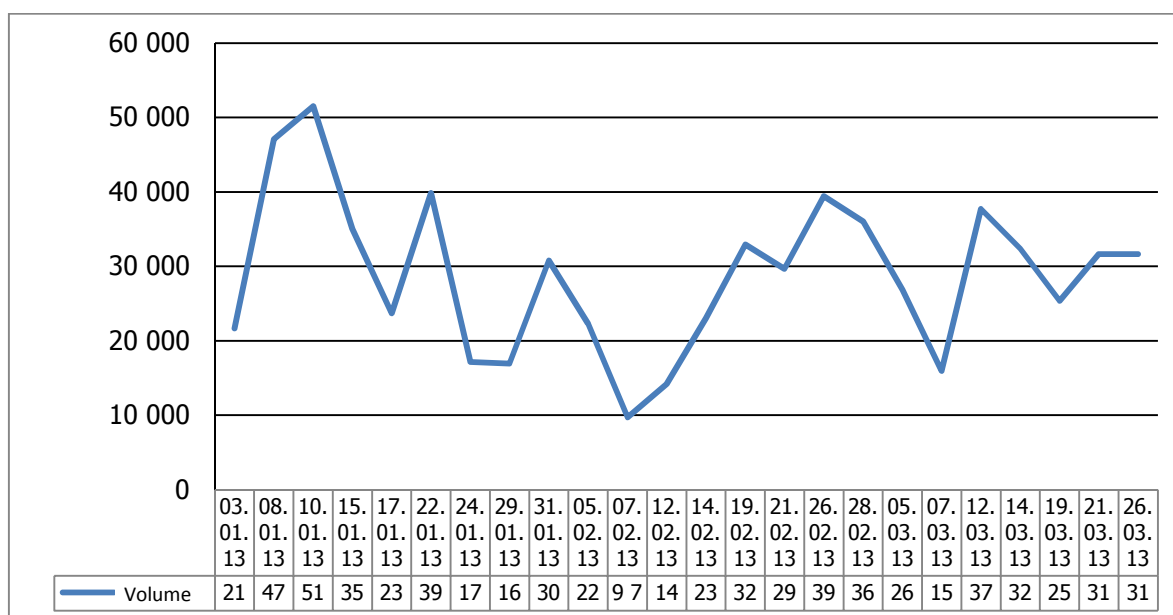
⁴³ Source: Towarowa Giełda Energii S.A.

Diagram 16. OZEX_A in the Q1 2013



Source: Towarowa Gielda Energii S.A.

Diagram 17. The number of green certificates in the first quarter of 2013



Source: Towarowa Gielda Energii S.A.

Despite the fact that on the Energy Commodities Exchange only ¼ of the green certificates are traded (in 2012 there were 3.5 TWh in comparison to 12.3 TWh of the total energy production in Poland) and the majority of energy is sold on the basis of long-term contracts. In case of a collapse of the green certificates market the re-negotiation of the contracts is assumed, along with the further reduction of prices.

In case of an excessive extension of the period of works on the draft Act on RES containing the new support mechanism which limits the surplus support for co-combustion and according to which the more expensive technologies will be promoted as those may diversify the Polish energy mix, then the investments in the renewable energy sector may be blocked and in extreme cases many entities operating in this sector may even go bankrupt or withdraw from the already initiated investment projects.

New draft Act on Renewable Energy Sources

Due to the increasing number of installations based on the renewable energy sources in Poland and a disproportionate development of technologies, the legislator decided that maintaining an equal level of support for all RES is no longer justified. According to the assumptions of the authors of the draft Act on RES, the major proposed amendment to the Act will be the modification of the current support mechanism for renewable energy sources. It would involve the introduction and adjustment of the correction ratio, which would regulate the number of certificates of origin granted for each 1 MW of energy generated from a renewable source in relation to the costs of technology. According to the assumptions, the technologies which have higher investment costs will receive a higher support (all technologies were previously receiving 1 certificate of origin⁴⁴ per 1 MWh energy) and less expensive technologies will be granted lower support (less than one certificate of origin).

This would lead to an increased interest in the investments in new energy generating sources and would optimise the costs of the support mechanism due to a more efficient donation of investments requiring higher financial aids and eliminating the excessive support for less expensive technologies.

The consequences of an excessive support for particular technologies include *e.g.* an inefficient use of locally available resources, blocking of connection capacities for other technologies and limitation of economic development and creation of new jobs. Due to the fact that investment, operating and unit costs of energy generation for are different for each of the technologies, a need arose to optimise the system by adjusting the level of support to the specificity of the investment process related to each of the technologies applied for the generation of energy from renewable sources.

In order to optimise the support an assumption was made that it is necessary to modify the mechanism of certificates of origin in such a way to determine a different minimum guaranteed level of financial support for each of the technologies. The support is to be granted for 15 years from the moment of commissioning the installation. The correction ratio will be determined for 5 years in an ordinance of the Minister of the Economy in order to verify its level on the basis of current investment and operating costs of particular technology⁴⁵.

In case of an offshore wind farm the ratio was specified at the level of 1.8 certificates of origin per 1 MWh of produced energy and no decrease of the ratio was assumed to occur in 2013-2017.

Apart from the changes in the specification of correction ratios other amendments were suggested in the draft Act on RES, which will regulate and condition the profitability of production of energy from renewable sources:

1. the obligation to sell energy for the maximum price of 198.9 PLN/MWh in 2013; the price will be indexed by reference to the inflation,
2. energy selling price cannot exceed 105% of the purchase price paid by the obliged seller; sales of energy for a higher price will result in the cancellation of the certificates of origin,
3. the amount of a unit substitution fee was determined at the level of 286.74 PLN/MWh and it is assumed that the fee will not be indexed⁴⁶,
4. In case of a decrease of the value of certificates of origin below 75% of the value of the substitution fee during two quarters, the Minister of the Economy is obliged to take actions aimed at increasing the threshold for the obtaining and cancelling of the certificates of origin.

Pilot OWF projects in the new draft Act on RES

According to the assumptions made by the authors of the draft Act on RES, the support for all technologies based on the renewable sources of energy will be determined in the ordinance of the Minister of the Economy every 3 years for the period of 5 years. The first coefficient for 2013-2017 was specified in the act introducing the energy package. After 2017 the value of the coefficient will be redetermined for the next 5 years in an implementing regulation to the Act on RES.

⁴⁴ Certificate of origin.

⁴⁵ The correction ratios for the first period - *i.e.* 2013-2017 - were suggested in the act introducing the package of energy acts.

⁴⁶ Lack of indexation of the substitution fee is one of the major changes proposed for the first time in the draft Act on RES of July 26, 2012. It seriously negatively affects the possibility to obtain the required level of support in 2013-2025, because the level of the substitution fee has a significant impact on the prices of the certificates of origin. Maintaining the indexation mechanism for the substitution fee will allow for a faster decrease of the correction ratio.

In the new draft Act on RES it is assumed that the financial conditions for the RES investments may change in 5-year intervals. The mentioned mechanism is efficient only for those investments which development and execution period does not exceed 5 years, *i.e.* majority of RES investments. The considered solution should be deemed favourable, because it leads to the correlation of the value of support depending on the current investment and exploitation costs of particular technologies.

In case of offshore wind energy the investment process takes 6-9 years and the solution based on the determination of the correction ratio every 5 years is unfavourable and does not guarantee stable financial conditions for the projects.

What is more, the OWF execution cost is spread over a relatively long period of time and also during the entire investment development period it is necessary to control and provide financial stability for the entire investment. In the system proposed in the Act on RES, during the OWF investment development the financial conditions will change twice (two ordinances of the Minister of the Economy determining the value of the correction ratio in the period of 6 years), what makes the investment risk too high and does not provide any solid grounds for making rational investment decisions.

Therefore, the conditions for OWF should be similar to other technologies, which during the entire investment development period will know the value of the correction ratio valid for the date of project commissioning. This requires the implementation of special legal solutions for offshore wind farms, which will *e.g.* make an exception for the installations which use wind power at sea and allow for the maintenance of a fixed value of the correction ratio throughout the two following periods.

3.2. Market conditions

3.2.1. Current stage of OWF projects development

The real beginning of the development of the OWE sector in Poland may be associated with the amendment to the Act on maritime areas of the Republic of Poland and maritime administration, introduced in 2011. Pursuant to the provisions of the amendment to the said Act, the minister in charge of the maritime economy (Minister of Transport, Construction and Maritime Economy - "MTBiGM") up to September 21, 2011 was announcing the possibilities of applying for the issuance of the permit to erect artificial islands (PSZW) for subsequent locations.

On the basis of current experience we can state that the preparation (and then the execution and commissioning) of one OWF project may take even 6-9 years.

Up to May 2013 there have been 70 applications submitted for the issuance of PSZW and ca. 20 projects have already obtained the permit. Part of those PSZW expired due to the failure to pay the first instalment of the fee within 90 days, pursuant to Art. 27b of UOM. Hence, only 14 PSZW were still valid in May. The fee was paid for 7 projects and the fee for the remaining half should still be paid⁴⁷. By May 2013 the connection conditions were issued for 2 OWF for the total capacity of 2.2 GW, however the process will be carried out in stages, *i.e.* by 2020 0.9 GW will be connected and then the remaining 1.3 GW in 2025⁴⁸. The connection points for OWF set in GPZ Słupsk Wierzbęcino and in GPZ Żarnowiec (Pomeranian Voivodeship).

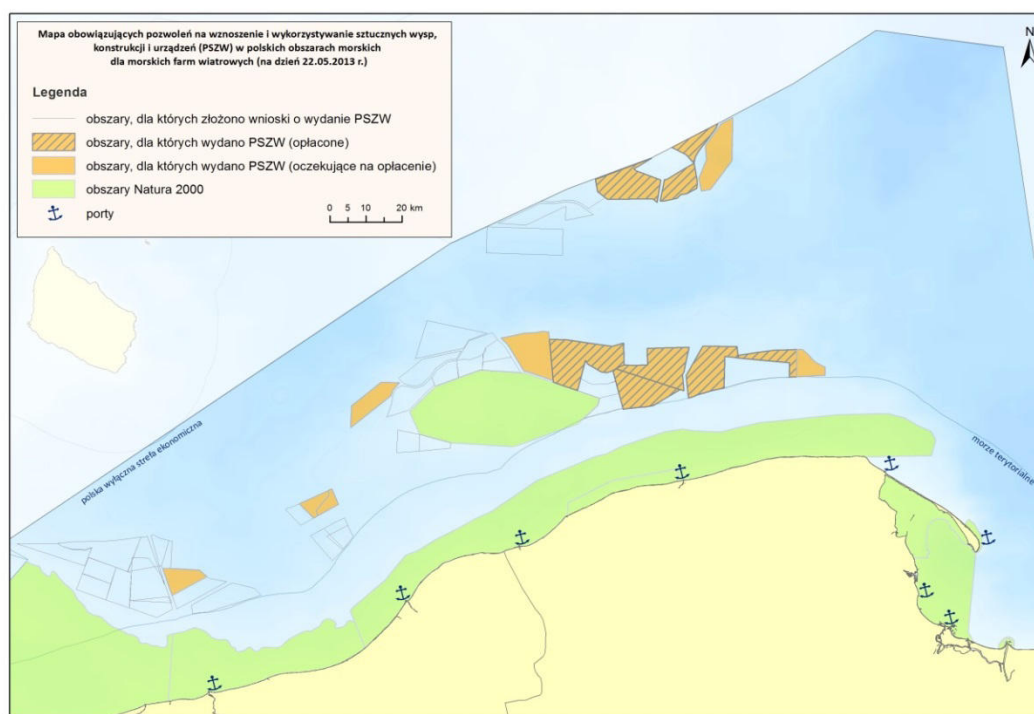
Several investors have already lodged their applications for DSU. By March 2013 there have been 12 decisions issued related to the scope of the report. The programmes for marine environmental research have also been initiated for the selected OWF and to a limited extent within the area of the Słupsk Bank.

The majority of projects for which the PSZW have been issued are located to the north and to the east of the Słupsk Bank. The other projects are located within the area of the Middle Bank, near the border of the Polish and the Swedish EEZ and to the west of the Słupsk Bank.

⁴⁷ Correspondence with MTBiGM of May 22, 2013.

⁴⁸ Presentation by M. Stryjecki during the conference "Morska energetyka kołem zamachowym rozwoju przemysłu i regionów nadmorskich" (*Offshore energy as the driving force behind the development of coastal industry and regions*). 2013.

Map 2. Map of issued and valid PSZW for OWF within the Polish maritime areas (as of May 22, 2013)



Source: own work

Characteristics of the market of developers and investors

Among the companies interested in the development of OWF projects, which have already submitted their PSZW applications, there are foreign companies (*i.e.* DEME, Dong Energy, EDPR, Generpol, Iberdrola), as well as domestic ones (*i.a.* Polska Grupa Energetyczna (PGE), Kulczyk Investments, Energa, PKN Orlen). Till now, the PSZW have been issued for the following companies (not all of the fees were paid within the deadline):

- DEME,
- EDPR,
- Energetyka Polska,
- Generpol,
- Kulczyk Investments,
- PGE Energia Odnawialna S.A.,
- PKN Orlen.

Most of the companies, which have already received their PSZW, are Polish companies, which do not have any experience in executing OWF projects. The largest Polish energy company - Polska Grupa Energetyczna - is among them, followed by the petroleum corporation PKN Orlen and a private energy company - a member of the Kulczyk Investments investment group. Only EDPR, a Portuguese energy company and DEME - Belgian holding operating in the offshore engineering sector and specialised in underwater works, have the experience to execute such projects, but those two companies are not among the leaders of this sector in Europe.

That is why the developers will be searching for partners with the experience in developing and executing OWF projects and with reliable tools, but also those who have sufficient financial resources necessary for such projects. The leaders of the European OWE sector include: Dong Energy, Vattenfall, E.ON or RWE, who are the owners of 58% of all MFW in total⁴⁹.

⁴⁹ EWEA. 2012. The European offshore wind industry - key trends and statistics 2012.

3.2.2. Investment costs

The costs of electric energy production in OWF may be divided into two categories:

- capital expenditures associated with the construction and commissioning of the OWF (CAPEX),
- operating expenditures associated with the exploitation of the OWF (OPEX),
- costs associated with the provision of an appropriate rate of Return on capital employed ("RCE").

The impact of location conditions on CAPEX and market competition

Basic parameters affecting the CAPEX in OWF is the distance of the project from the connection points and the logistics and maintenance facilities, as well as the depth at which the wind power plants are installed. Within the Polish maritime areas the OWF projects are planned to be constructed in 4 location groups:

- a) Western Group - within the area of the Oderbank, at a distance of 22-50 km from shore,
- b) Central Group - along the northern border of the area of the Słupsk Bank, at a distance of 35-60 km from shore,
- c) Eastern Group - to the east of the Słupsk Bank, at a distance of 22-40 km from shore,
- d) Northern Group - along the southern slope of the Middle Bank, at a distance of 80-100 km from shore.

Assuming that the major connection points are: Dunowo and Żydowo for the Western Group, Słupsk-Wierzbęcino and Żarnowiec for the Central, Western and Northern Groups, then only for the Northern Group the costs associated with the connection will be larger (almost twice) in comparison to the other projects.

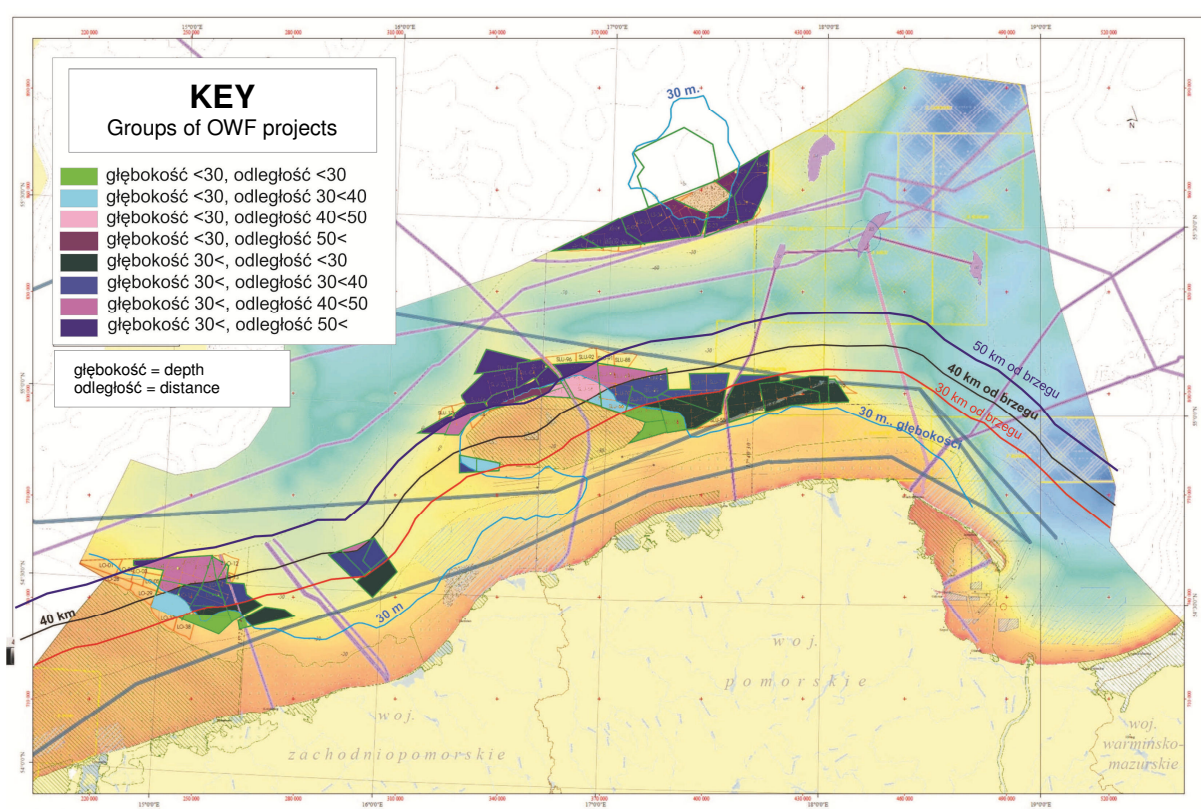
If we assume that the major logistics centres for projects belonging to the Western and some of the Central Group will be Świnoujście and Szczecin, for the Western Group and some projects from the Central Group it will be Gdańsk and Gdynia, then only for the support of the projects from the Northern Group and some projects of the Central Group (located further than 50 km from shore) the costs will be higher in comparison to the other projects.

The distance between the connection points and particular groups and their potential domestic logistics facilities are proportionate to the distance of those projects from the nearest shoreline, therefore, to simplify and average the calculations, an analysis of the impact of the distance factor on CAPEX was carried out for 4 distance categories (in straight line from the shore): installations up to 30 km from shore, installations within 30-40 km, 40-50 km and further than 50 km from shore.

In subsequent analyses the major emphasis was placed on the distance from shore, not on the depth of foundation, because for each of the groups of projects in particular distance categories, the distribution of the depth parameter is very proportionate. The majority of installations will be located within the maritime areas with the depth of 30-40 m (75-80%) and only 20-25% within areas shallower than 30 m. We assumed that the projects located in shallower waters will be preferred due to their lower CAPEX and therefore will be executed in the first run. Projects from particular distance groups to be located in deeper waters will be executed in subsequent years or as the following stages of investments, or when the technology for the foundation of OWF in deeper waters becomes more available and cheaper.

The relation between the two was presented below.

Map 3. Map of groups of projects by depth of foundations and distance from shore



Source: own work

The above described distance and depth conditions in Polish maritime areas intended for the development of offshore wind energy are of fundamental significance for the proper determination of investment expenditures of particular projects. The impact of the depth and distance from shore on the unit cost of installing 1 MW of OWF is presented in Table 3.

Table 3. CAPEX growth multiplier depending on the distance from shore and depth of foundation of an OWF

| Depth [m] | Distance from shore [km] | | | | | | | |
|-----------|--------------------------|-------|-------|-------|-------|--------------|---------|-------|
| | 0-10 | 10-20 | 20-30 | 30-40 | 40-50 | 50-100 | 100-200 | >200 |
| 10-20 | 1.000 | 1.022 | 1.043 | 1.065 | 1.086 | 1.183 | 1.408 | 1.598 |
| 20-30 | 1.067 | 1.090 | 1.113 | 1.136 | 1.159 | 1.262 | 1.501 | 1.705 |
| 30-40 | 1.237 | 1.264 | 1.290 | 1.317 | 1.344 | 1.464 | 1.741 | 1.977 |
| 40-50 | 1.396 | 1.427 | 1.457 | 1.487 | 1.517 | 1.653 | 1.966 | 2.232 |

Source: own work on the basis of Europe's onshore and offshore wind energy potential, European Environment Agency, EEA Technical Report, 2009

When estimating CAPEX for OWF in Polish maritime areas, the analysis of investment expenditures of European OWF projects executed by the end of 2011 was carried out on the basis of 40 different sources. The basic cost of installing 1 MW of OWF project located within 10 km from shore and at a depth of up to 20 m (multiplier 1) was determined to be EUR 2.76 million. Then the correction was performed with the application of multipliers determined in the above presented table.

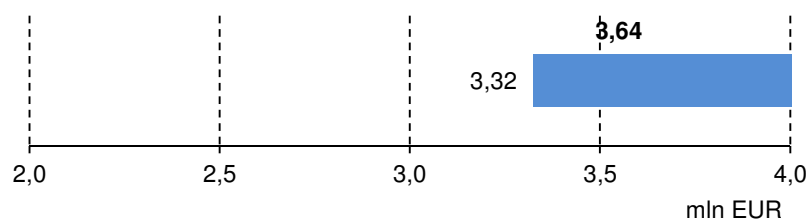
The lowest multiplier is 1.113 and the highest 1.464. An average multiplier for the Polish maritime areas is 1.260. The lowest CAPEX value is EUR 3.07 million and the highest - EUR 4.04 million. The average value is EUR 3.48 million. Those simplified calculations do not reflect the percentage share of projects in particular distance and

depth categories. Within the Polish maritime areas the OWF projects will be executed in intervals, according to the following quantitative proportions:

- 1) projects within 20-30 km from shore, at the depth of 20-30 m - ca. 10% of potential wind power plants,
- 2) projects within 30-40 km from shore, at the depth of 20-30 m - ca. 5% of potential wind power plants,
- 3) projects within 40-50 km from shore, at the depth of 20-30 m - ca. 5% of potential wind power plants,
- 4) projects within 50-100 km from shore, at the depth of 20-30 m - ca. 5% of potential wind power plants,
- 5) projects within 20-30 km from shore, at the depth of 30-40 m - ca. 25% of potential wind power plants,
- 6) projects within 30-40 km from shore, at the depth of 30-40 m - ca. 15% of potential wind power plants,
- 7) projects within 40-50 km from shore, at the depth of 30-40 m - ca. 15% of potential wind power plants,
- 8) projects within 50-100 km from shore, at the depth of 30-40 m - ca. 20% of potential wind power plants.

If we take the above presented proportions and the fee for the issuance of the location permit (1% of the value of the investment, such a fee is only imposed in Poland), then the lowest CAPEX is EUR 3.32 million, the highest is EUR 4 million and the average CAPEX is EUR 3.64 million.

Diagram 18. Median and the range of investment expenditures per 1 MW of installed capacity in OW in Poland for the conditions of 2011



Source: own work

Taking into account the fact the difference between the extreme values is 20% and between the extreme values and the mean value - 10%, it seems that for the purpose of establishing the support mechanism it will be necessary to optimize the amount of support so that the least expensive projects are not excessively promoted and to give a chance to the projects of slightly higher costs, but still attractive as investments (*i.e.* weak environmental and social impact, good wind parameters). Therefore, in further analyses an attempt was made to average the CAPEX value for 2 groups of projects for which the cost parameters are similar.

Therefore, we assumed that if in each of the 4 distance groups (up to 30 km, 30-40 km, 40-50 km and over 50 km) 75%-80% of installations will be constructed at a depth exceeding 30 m, then the depth factor will have smaller significance for the diversification of investment costs than the distance factor.

The CAPEX for projects located within max. 40 km and above 40 km were averaged. CAPEX in those groups of projects will be different by over 7.6%:

- projects from the group up to 40 km - CAPEX = EUR 3.39 million,
- projects from the group above 40 km - CAPEX = EUR 3.65 million.

Alternatively, the CAPEX for projects located within max. 50 km and above 50 km were averaged and it was determined that the CAPEX in those groups of projects will be different by over 12.7%:

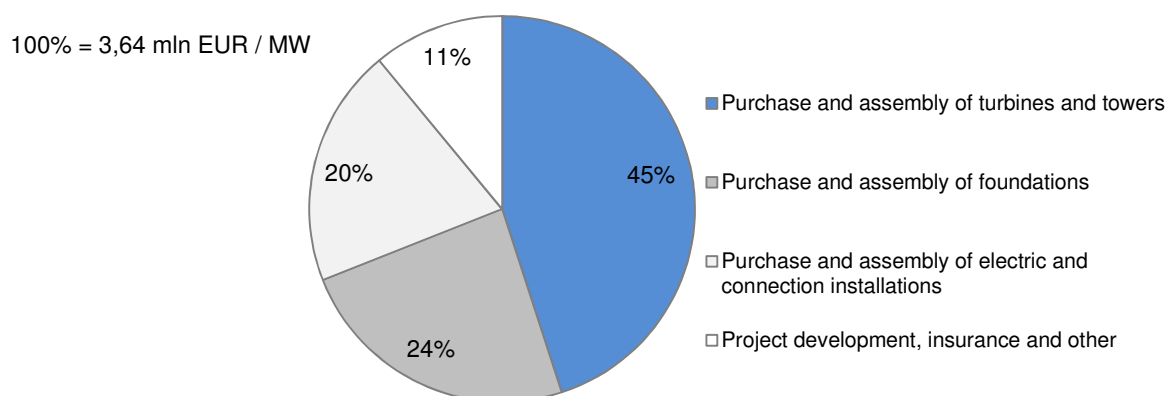
- projects from the group up to 50 km - CAPEX = EUR 3.52 million,
- projects from the group above 50 km - CAPEX = EUR 3.97 million.

Such a big difference in the investment costs will not be balanced to a sufficient extent with an expected higher productivity of OWF located further from shore, as in case of those projects the maintenance costs will be higher.

Therefore, it seems justified to determine a separate value of the support for OWF located within a distance not exceeding 50 km from shore and a separate value for other projects.

On the basis of the analyses we can state that in terms of the structure of a unit investment cost the costs associated with the purchase and assembly of turbines and towers have the largest share (45%), followed by the costs associated with the foundation construction (ca. 24%). Costs of the purchase and assembly of electric installations (inter-array installations and those for the connection to the power system) cover only 20% of investment expenditures and the remaining 11% is associated with the costs of the project development phase. Detailed data were presented in the diagram below.

Diagram 19. Structure of OWF investment costs



Source: own work

Operating expenditures (OPEX) associated with the functioning of OWF in Poland

Relying on the source data the potential fixed operating expenditures OPEX_s associated with the exploitation of OWF in 2013 in Poland were estimated. The cost estimation was based on the calculation of average values for particular categories of costs, *i.e.*:

- maintenance and repairs,
- fixed service charges,
- management and other fixed charges,
- insurance,
- own energy consumption.

On the basis of source data estimated for 2013 the fixed part of the operating costs should be at the level of 250,000 PLN/MW. The key component (ca. 45%, *i.e.* 115,000 PLN/MW) are the costs associated with the maintenance and repairs of OWF and the service charges, which amount to 32% of all fixed operating costs. Detailed data in terms of the value of particular components of OPEX_s were presented in the table below.

Table 4. Estimated value of fixed OPEX (OPEX_s) for OWF operating in Poland in the conditions of 2013

| Fixed operating expenditures (OPEX _s) | | 2013 |
|---|--------|---------|
| 1. Maintenance and repairs | PLN/MW | 115,000 |
| 2. Fixed service charges | PLN/MW | 77,000 |
| 3. Management and other fixed charges | PLN/MW | 33,000 |
| 4. Insurance | PLN/MW | 23,000 |
| 5. Energy consumption (with the assumptions):* | PLN/MW | 2,000 |
| 5.1 Downtime | | 5.00% |

5.2 Power consumption

0.70%

| | | |
|----------------------------------|---------------|----------------|
| OPEX_s in total | PLN/MW | 250,000 |
|----------------------------------|---------------|----------------|

* classified as fixed costs due to the assumption that regardless of the volume of production the OWF will have the same downtime
 Source: own work

The above presented estimation of costs serves only as an example and was used as the basic value for the forecast of operating costs in 2013-2025 associated with the development of offshore wind farms in Poland. In case of particular investment projects the value of fixed operating costs may vary significantly, depending on the specificity of a given project.

The variable share of operating costs associated with the functioning of OWF in Poland in 2013 was estimated at the level of 30 PLN/MWh and it is composed of:

- charges of services exceeding the fixed service charge,
- the costs of balancing the production of electric energy.

Detailed data in terms of the value of particular components of variable operating costs were presented in the table below.

Table 5. Estimated value of variable OPEX (OPEX_z) for OWF operating in Poland in the conditions of 2013

| Variable operating expenditures (OPEX_z) | | 2013 |
|---|----------------|-------------|
| Floating service charges* | PLN/MW | 20 |
| Balancing costs | PLN/MW | 10 |
| OPEX_z in total | PLN/MWh | 30 |

* included in the surplus over the fixed charged
 Source: own work

Costs associated with the provision of a proper rate of return on capital employed (RCE)

Value of the expected return on capital employed from the investments in offshore wind farms in Poland was estimated at the level of 12% in the basis of the profitability analysis of functioning OWF projects in Europe and with the consideration of the premiums for the specific risk in the country where the investment was executed. What is more, part of the costs associated with the capital was included in the coefficient reflecting the necessity to finance the investment. The assumptions included a 2-year construction period and the average weighted costs of raising funds for the investment at the level of 10% (fixed for the period of the forecast).

3.2.3. OWF energy reception and transmission conditions

One of the basic market conditions determining the development of offshore wind energy sector is the access to the power grid. In most European countries, where the offshore wind energy is developed, the obligation and costs associated with the connection of an offshore wind farm (which has obtained the required location permits) to the power grid is charged to the grid operator. This helps the investors because it not only reduces the investment risk, but also significantly reduces the investment costs as the connection infrastructure takes up to 20% of those costs. Unfortunately, such solutions cause problems - especially the delays in the execution of the connection, most often observed in Germany.

In Polish conditions the operator of the transmission system indicated only on the "connection conditions" the onshore connection point to which the owner of the OWF should connect the wind farm by constructing appropriate connection infrastructure at their own expense. Up till now, the system operator has issued the connection conditions only for two OWF projects with the total capacity of 2.2 GW. Up to 2020 it will be possible to connect 600 MW from one of those projects and 300 from the other. The remaining 1.3 GW will be divided into two groups - 600 MW and 700 MW and it will be available in 2025. When this Programme was being prepared the operator excluded the possibility to issue any other connection conditions of the remaining OWF projects, but did

not exclude the distribution of the capacity included in the already issued conditions over the other projects developed by the same investors within close vicinity.

A major factor affecting the conditions of the further development of OWF in Polish maritime areas is the fact that the issued connection conditions indicate two different connection points although those conditions refer to projects located within the same region. Both projects are to be executed by two investors, but are located on the eastern slope of the Słupsk Bank and are next to each other. One of those projects is to be connected to the Słupsk-Wierzbęcino transformer station and the second to Żarnowiec station. The result of those decisions will be the necessity to lay separate seabed cables, which will receive energy from neighbouring projects and evacuate it to two different connection points of the National Power System. This creates the chance for the construction of an offshore grid connecting the Słupsk-Wierzbęcino GPZ with Żarnowiec GPZ, what could become the first stage of the development of offshore transmission system - the "Baltic Power Rail", what could allow for the creation of an offshore connection point for all OWF and could increase the connection capabilities of the National Power system and the possibilities to distribute the energy from OWF. This idea will be described in detail in the chapter on the executive actions associated with the Programme.

Construction of the offshore grid which could receive energy from OWF is currently the subject of international cooperation of 10 European states from the North Sea area with the European Commission. **The North Seas Countries' Offshore Grid Initiative („NSCOGI”)** is a common initiative of the EU member states (Belgium, Denmark, France, the Netherlands, Ireland, Luxembourg, Germany, Sweden and the UK) and Norway⁵⁰, which aims at creating a common, supranational power grid connecting offshore wind farms in the North Sea. In order to execute the project the representatives of the mentioned states and the European Energy Commissioner signed the **Memorandum of Understanding („MoU”)**⁵¹ which contains the general plan for this initiative. In the MoU the major barriers and threats to the integration of energy markets and power grid were indicated and a Steering Committee and the Programme Council were appointed. The partners of the Initiative undertook to publish reports containing information on the cooperation of experts from all countries involved in the NSCOGI. Due to the proactive attitude of the governments and the non-governmental institutions such as the European Network of Transmission System Operators for Electricity („ENTSO-E”) the **North Seas Countries' Offshore Grid Initiative** was given priority and there is a chance that the Initiative will also cover the Baltic Sea and the Polish maritime areas.

3.2.4. Supply market

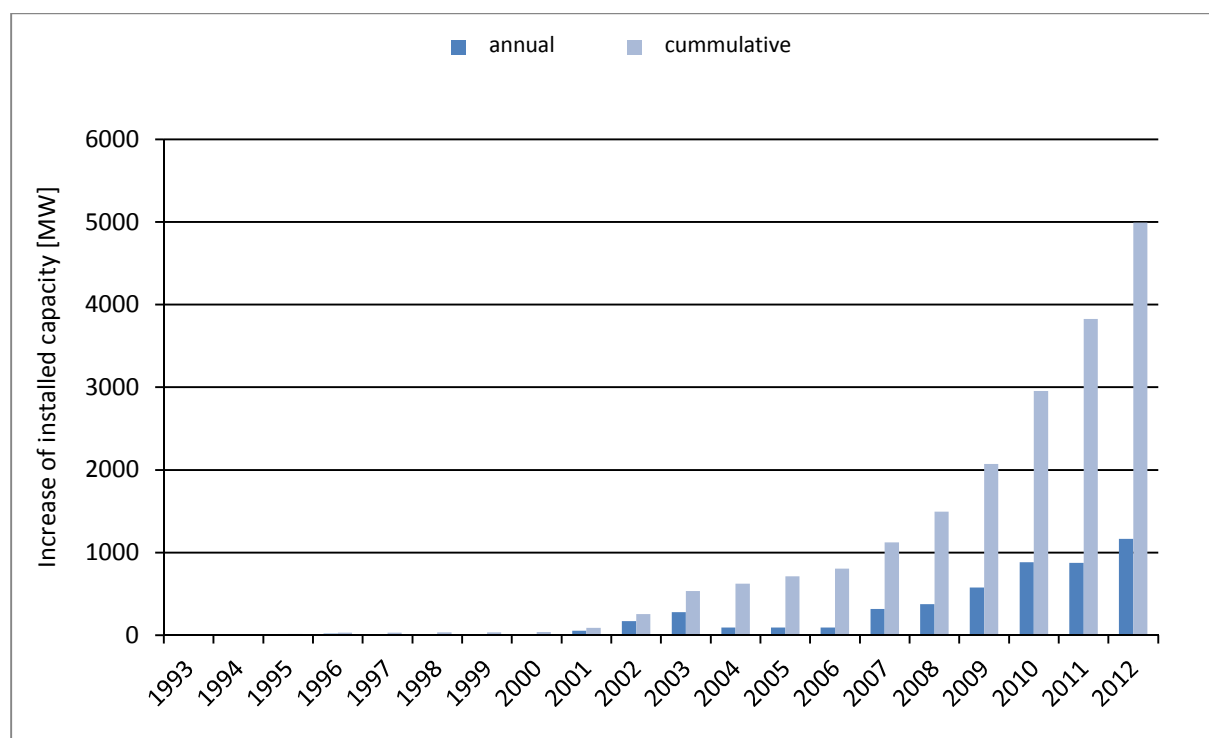
Market outlook

The OWF market is the most dynamically growing sector in the world and Europe plays a vital role on this market. A constant growth of the installed capacity in OWF is observed and about 90% of that capacity (ca. 5 GW) is currently located in Europe. The next two positions in the ranking are taken by China (9%) and Japan (1%).

⁵⁰ North Seas Countries' Offshore Grid Initiative, *Memorandum of Understanding*, [dokument elektroniczny], http://ec.europa.eu/energy/renewables/grid/doc/north_sea_countries_offshore_grid_initiative_mou.pdf, accessed on [October 5, 2011].

⁵¹ Ibid.

Diagram 20. Cumulative and annual increase of OWF installed capacity



Source: EWEA

Among European states the UK has the largest amount of installed offshore wind capacity (59%) followed by Denmark (18.4%), Belgium (7.6%) and Germany (5.6%). Dynamic growth of OWE anticipated in Europe by 2025 results mostly from the strategy of developing this technology in France, Germany, Spain, Netherlands, Ireland and the United Kingdom. According to EWEA, 38% of OWF - which have already obtained their permits - are located in Germany, 15% in the Netherlands and 10% in the UK. Special attention should be paid to Germany, where the supply chain for OWF sector is very well developed, therefore a large number of projects can be launched there⁵². According to the National Renewable Energy Action Plans in Germany 10 GW in OWF are planned to be installed by 2020 and in 6 GW in France. The United Kingdom, according to their RES strategy, up to 18 GW are to be installed by 2020. The Polish NREAP refers only to 0.5 GW installed in OWF by 2020.

For Poland the location of projects is of great significance. The majority of OWF are located within the North Sea (65% of installed capacity) and only 16% within the areas of the Baltic Sea⁵³. However, due to the limited maritime areas and ambitious plans of OWE development in Germany, we may anticipate that the number of OWF projects located in the Baltic Sea will grow. This is important due to the necessity to extend the supply chain for the area. **Total capacity of planned OWF to be constructed within the Baltic Sea (projects at different stages, from the conceptual phase up to those which have already obtained their permits) is ca. 19 GW⁵⁴, not including the projects within the Polish maritime areas.**

Characteristics of the market of suppliers

The OWE supply market is specific due to the great number of large size components required for the construction of an OWF. In case of such elements as the foundations, which are not very complicated constructions in terms of technology, the crucial is the location of production facilities, therefore the network of plants producing those components is very decentralised. In case of wind turbines and the connection infrastructure the situation is different due to the high level of technological advancement. Production of those components is focused around large companies and establishing new production plants requires very positive forecasts of stable demand.

⁵² EWEA. 2012. The European offshore wind industry - key trends and statistics 2012.

⁵³ Ibid.

⁵⁴ Baltic Offshore Wind Energy Map. Baltic sea Transport, 6/2012, p. 28-29.

In order to systematise the OWE supply chain, it should be divided into 4 categories, which make for the major share in the execution of OWF projects. The supply in those categories is crucial for the liquidity of the execution of those projects:

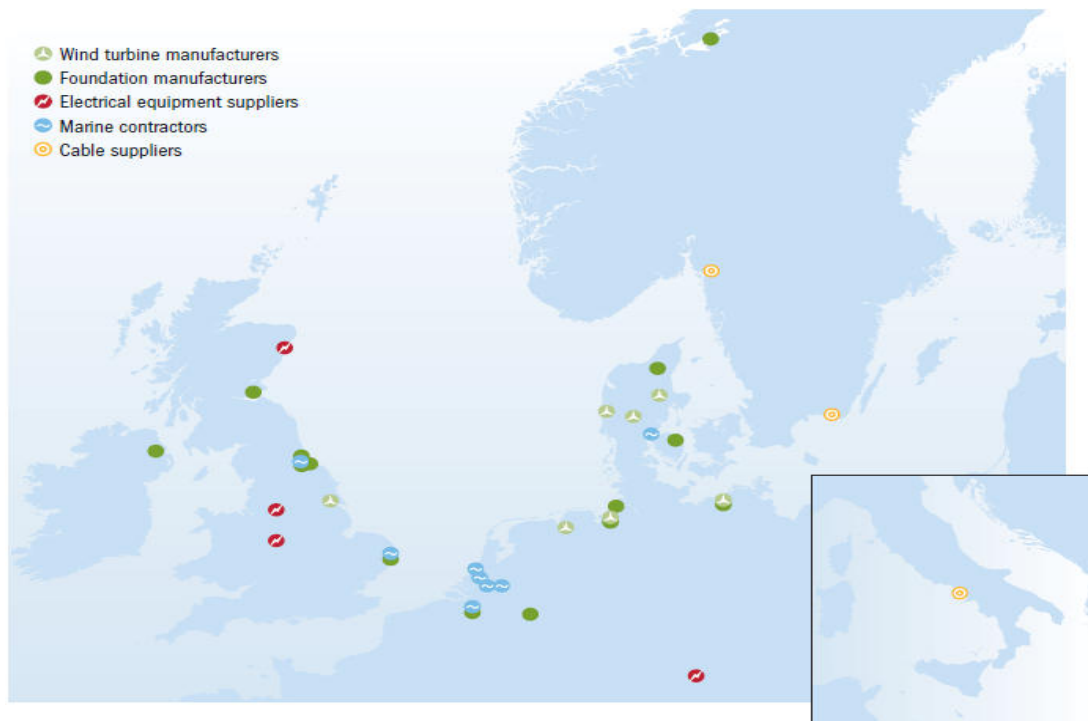
1. wind turbines,
2. foundations,
3. connection infrastructure,
4. vessels.

Each of those elements was described in detail, further in this chapter.

The suggested division shows also the share of costs of particular OWF components, including the purchase and assembly of wind turbines and towers - 45%, foundations - 24% and power installation and connection - 20%⁵⁵ (transport costs and the use of specialist vessels were included in each category).

Below we present the major plants producing the OWF components in Europe.

Fig.2. Location of major OWF components production plants⁵⁶



Source: EWEA

Wind turbines

The supply markets of particular components of wind turbines: towers, blades, powertrain, frames and other structural elements are characterised by various conditions:

- towers are a rather simple element, therefore the production of towers is decentralised and the creation of new production plants is possible without a developed OWE market in a given country (such structures are also manufactured in Poland),
- the production of blades for offshore turbines requires specific construction knowledge due to considerably larger sizes than in the blades for onshore wind power plants, hence completely different construction solutions must be applied,

⁵⁵ See Diagram 19.

⁵⁶ EWEA. 2011. Wind in our sails.

- powertrain - including the gear, bearings and generators, is the key element of an offshore wind turbine value chain and the production of this component is very centralised,
- structural elements such as frames, hubs, gear casings, etc. are generally available, however due to larger sizes of the offshore wind turbines the availability of these elements may drop.

Among the leaders of wind turbine suppliers the following companies may be listed: Siemens (58% of installed capacity turbines in Europe), Vestas (28%), Repower (8%) and Bard (3%). This element is quite strongly centralised among larger suppliers, mostly from Europe. However, a significant increase in the number of new models available on the market is anticipated in the 2014-2016, when the new models produced by the following companies are to be launched: Vestas, Gamesa, Alstom, XEMC, Samsung and Mitsubishi. What is more, we may expect a serious pressure from the Chinese companies such as Sinovel⁵⁷. By the end of 2012 31 companies have announced their plans to introduce 38 new models of wind turbines, out of which 52% were European companies. The capacity of 76% of the planned new models of wind turbines exceeds 5 MW. According to EWEA, 4-12 new turbines will reach their market maturity in the next 10 years⁵⁸.

Major wind turbine production plants are located in Denmark and in Germany. The UK has not been playing the major role in wind turbine supply chain so far, however, new investments and the planned development of OWF stimulates the creation of new production plants in the UK⁵⁹.

On the basis of the experience of turbine manufacturers we can assume that the anticipated sales at the level of 1 GW of turbine capacity/year justifies the launch of investments of EUR 100 million (PLN 400 million) for the development of a new product, the creation of supply chains and construction of new assembly buildings. These values have been based on the experience of Siemens - the leading manufacturer of 3.6 MW turbines. 1 GW equals ca. 280 turbines/year. Therefore, we can assume that to establish new production plants in Poland the provision of a stable demand at the above mentioned level will be required.

According to estimates made by EWEA, the European demand for offshore wind turbines will reach the value of 6,500 MW per year 2020 and the supply may be between 7,000 MW and 17,000 MW per year (the latter being an aggressive scenario). We can anticipate that the supply can satisfy the increasing demand for such constructions in Europe and in some parts of North America. Supply limitations, if any, will be associated mostly with the assembly plants. Limitations occurring further along the supply chain and referring to particular components have already been solved and should not cause any more problems⁶⁰.

Supporting structures

The major component of the supporting structures are the foundations, followed by the connecting elements, which fix the wind turbine with the foundation. Today there are several different technologies available for the construction of the foundations of offshore wind turbines. Their application depends on the depth and geological structure of the seabed in a given location. Among the basic foundation types there are: monopiles, gravity-based foundations, tripods, quatrropods and jacket foundations.

The increase of demand for the supporting structures in the next decade will require a serious development of the capabilities of the foundation production plants. Minor technical barriers, short time needed for the establishment of new production plants and benefits from a local production make it easy to anticipate that there will be no downtimes during the supply of those components. This will definitely be the chance for the development of the industry in new countries oriented at establishing their own OWE sector.

The monopile foundations and gravity-based foundations have the largest share among the commissioned OWF - 74% and 16% respectively. It is related to the primary execution of projects at shallow waters, where those types of foundations are preferred. However, along with the expansion of the market and the possibilities to take

⁵⁷ IHS. 2012. Global Offshore Wind Energy Markets and Strategies: 2012-2025.

⁵⁸ EWEA. 2012. The European offshore wind industry - key trends and statistics 2012.

⁵⁹ EWEA. 2011. Wind in our sails.

⁶⁰ Ibid.

the OWF further from the shore and deeper, the use of more advanced structures will increase, such as tripods or jacket foundations, which are more stable^{61,62}.

Mean annual demand of the European market for the supporting structures in 2020 will reach ca. 1000 items. Only for the German market there will be ca. 950 items required by 2015⁶³. The major suppliers of the supporting structures for the European market are: Bladt (40% of installed structures), EEW (18%), SIF Group (18%).

Connection infrastructure

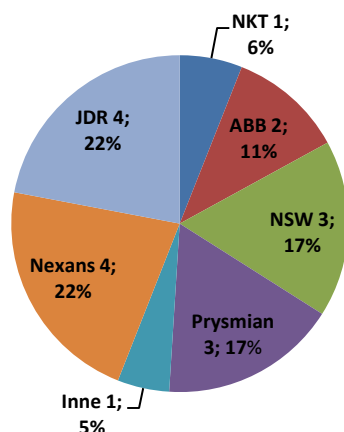
When it comes to the connection infrastructure, there are 3 major elements important in the context of the supply chain: offshore substation, export cables and cables connecting particular wind power plants.

OWE uses mostly the supply chains for the onshore wind farms. However, due to plans of constructing offshore wind farms, which will be located at a greater distance from shore and will have to rely on higher voltage and other technological solutions, some problems may occur in a fluent supply of those components. The limiting factor is here the supply of HV cables. Currently, it is estimated that the supply capacity is 1000 km of cables per year (HVDC technology) and 700 km of cables per year (HVAC technology)⁶⁴.

The waiting time for the production of HV cables may reach even up to 4 years, therefore it will be necessary to establish new cable manufacturing plants. Most probably the major part of the cables will still be supplied by the existing manufacturers⁶⁵.

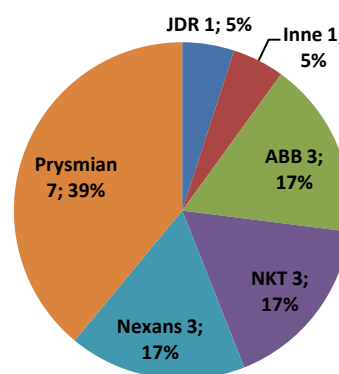
Among the MV cables, which are usually used for the inter-connection of wind power plants in a wind farm (inter-array cables), the supply chain is quite developed, but if a demand for the transmission of higher voltage inside the OWF occurs (*i.e.* 45-66 kV), then some serious problems in supplies may arise.

Fig.3. Market share of the internal OWF infrastructure cables suppliers (number of wind farms)



Source: EWEA

Fig.4. Market of export cables suppliers (number of farms)



Source: EWEA

In terms of the substations, the market is dominated by 3 major companies: ABB, Alstom Grid and Siemens Energy. C&C and Fabricom are also entering the market. The waiting time for the execution of an order is 3 years.

We can also expect the development of DC technology, what may be associated with a limited supply due to the insufficient number of suppliers of this technology in the supply chain.

⁶¹ EWEA. 2012. The European offshore wind industry - key trends and statistics 2012.

⁶² EWEA. 2011. Wind in our sails.

⁶³ Presentation by POWES. 2013. Morska energetyka kołem zamachowym rozwoju przemysłu i regionów nadmorskich (*Offshore energy as the driving force behind the development of coastal industry and regions*).

⁶⁴ BVG Associates. 2010. Towards Round 3: Building the Offshore Wind Supply Chain.

⁶⁵ EWEA. 2011. Wind in our sails.

Vessels

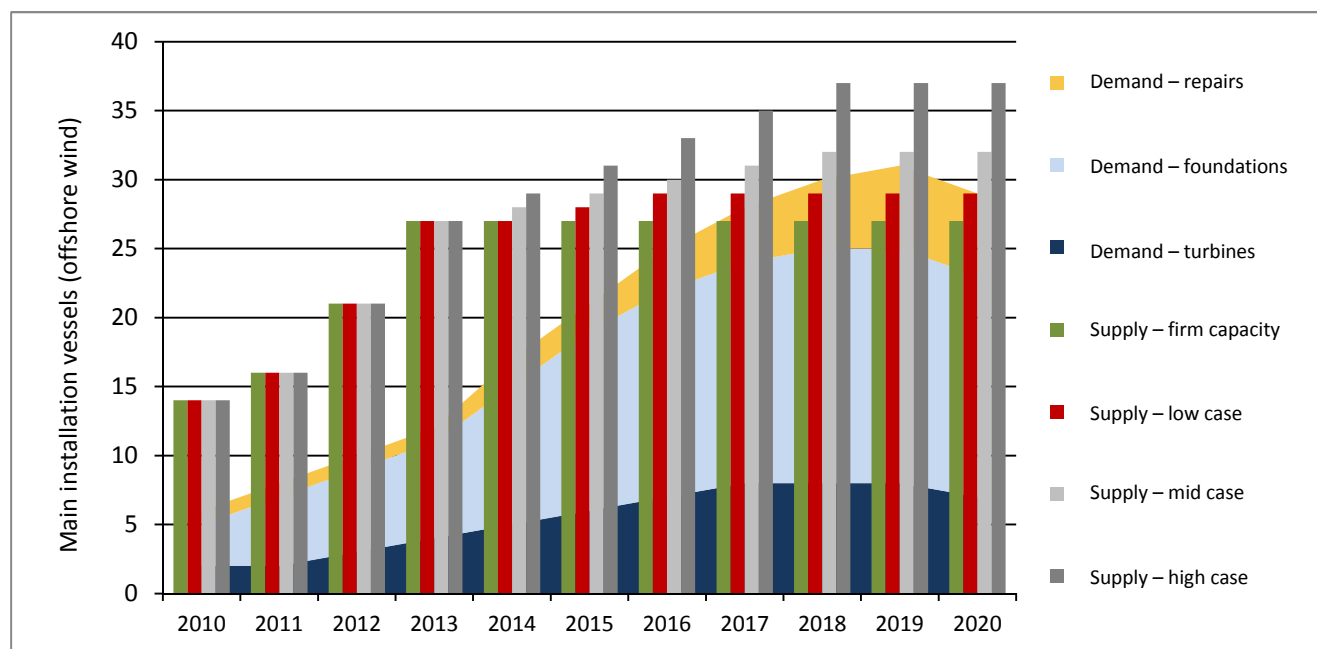
OWE sector requires various types of vessels for transportation, installation of particular components and OWF operation and maintenance. Taking into account the dynamic growth of the sector and the execution of future OWF in more demanding locations, the need for specialist vessels may become the key element of the dynamic development of the sector.

Waiting time for vessels (from the moment of placing an order to the delivery date) was in 2011 between 24 and 36 months, depending on the type of vessel.

At various stages different vessels are used:

- project development - vessels used for the environmental and geo-technical research,
- construction - installation vessels equipped with cranes with special capabilities: load capacity, speed, size, weather conditions, market availability, efficiency, etc.; additionally, vessels with lower parameters are used as supporting crafts to transport equipment or workers,
- exploitation - at this stage the installation vessels are also required, but lower parameters of the crafts are sufficient; moreover, the vessels are used for transporting the maintenance teams, usually the ships can take up to 12 passengers, but for projects located at a greater distance from shore larger vessels and helicopters are used,
- decommissioning - similar vessels are used as during the construction phase.

Diagram 21. Demand and supply in terms of installation vessels (vessels/year)



Source: Garrad Hassan

According to the estimations made by EWEA, the supply of installation vessels will seriously exceed the demand in 2015, although there may be situations in case of specialist vessels (*i.e.* for laying cables) where some problems with the supply may occur. After 2015, due to the rapid increase of demand, some shortages in the supply of vessels may occur if the shipowners fail to or insufficiently respond to the demand. It may be necessary to use the resources of the oil & gas sector.

Supply market in Poland

Despite the initial phase of the development of OWF sector in the Polish economic zone, we already have companies working for the OWE sector in the North Sea and in the Baltic Sea. Currently the key companies providing services for the OWF sector are:

Equipment or component manufacturers:

- CRIST S.A. shipyard - specialised in the production of vessels for OWF,
- Energomontaż-Północ Gdynia Sp. z o.o. - prefabrication of steel structures (transformer stations, foundation protection structures and foundation elements), adjustment of transport vessels, service platforms and temporary foundation protection,
- GSG Towers Sp. z o.o. - wind power plant tower manufacturer,
- AARSLEFF Sp. z o.o. - specialised in designing and performing offshore hydro-technical works,
- Szczecińska Stocznia Remontowa GRYFIA S.A. - manufacturer of steel structures.

Port infrastructure:

- DB Port Szczecin Sp. z o.o. - the handling of wind turbine components,
- Gdynia Container Terminal S.A. - the handling of wind power plant components.

Estimated value of orders for the offshore wind industry in the Polish shipbuilding sector may reach the amount of 150 million EUR/year (ca. 600 million PLN/year) and the anticipated value of orders in 2018-2025 may reach even up to 700 million EUR/year (2,800 million PLN/year)⁶⁶.

3.2.5. Port facilities

Major Polish seaports are located in Gdańsk, Gdynia, Szczecin and Świnoujście. Those are ports of fundamental significance for the national economy. Moreover, along the Polish coast there are several dozen of ports and harbours of regional significance. Major regional ports are located in Police, Kołobrzeg, Darłowo and Elbląg⁶⁷.

Polish port facilities in the context of OWE development should be considered not only from the perspective of projects executed abroad, but also the ones to be implemented in Poland. In the first case - foreign projects executed abroad - the Polish port infrastructure could be used as the centres for export production of components for foreign OWF and as construction ports for OWF constructed near the border of the Polish maritime areas. But when it comes to Polish OWF projects we should search for the possibilities to create production, logistics, operation and maintenance centres which could support those projects.

Criteria for the selection of port facilities

First of all, it is important to characterise the requirements which are imposed on ports, in relation to functions performed by those ports. As described in sec. 1.2.3 the ports may be divided into three categories, depending on their role: production ports, construction ports and service and maintenance ports. Below we present the examples of basic requirements of the OWE sector imposed on the selected group of Polish ports. It should be noted that the requirements are not complete and final, but only exemplary and based on the experience of foreign ports. The list contains also the major elements of the port infrastructure which may seem vital:

- Construction ports (for the capacity of 100 turbines/year):
 - at least 8 ha of storage and assembly areas,
 - 200-300 m of wharf with a high load bearing and with an appropriate access from shore,
 - possibility to accept vessels 140 m long and 45 m wide, with the draught up to 6 m, without any limitations to the access to ports, *i.e.* associated with the tides,
 - lack of load height limits,
 - convenient railway and road connection,
 - day & night operational availability of ports, 7 days a week^{68,69}.

⁶⁶ POWES. 2012. Perspectives for Offshore Wind Energy development in Poland. Presentation for the conference: "Inwestycje w morskie farmy wiatrowe" (*Investments in offshore wind farms*). Warsaw.

⁶⁷ Seaports development strategy up to 2015.

⁶⁸ Massachusetts Clean Energy Center. 2010. Port and Infrastructure Analysis for Offshore Wind Energy Development.

- Production ports (the same criteria as for the construction port, plus additionally):
 - up to 500 ha of available area for the construction of a production plant and as storage and manoeuvring areas,
 - direct access to wharfs (quays) with the minimum length of 500 m and a high load resistance and large depth near the wharf,
 - convenient logistics infrastructure accessible from shore⁷⁰.
- Operation and maintenance ports:
 - favourable location in relation to OWF sites,
 - access for vessels and service helicopters during day & night, throughout the whole year,
 - availability of storage areas and office and service areas (for and OWF with 140 turbines - 1,700 m² of office and service areas and 1,500 m² of storage areas),
 - available wharf area (for an OWF with 140 wind turbines ca. 100 m of wharf is required),
 - access to HR resources,
 - helipad in the port (significant in case of services for distant OWF)⁷¹.

The following soft criteria should also be taken into account as these may have a significant impact on the final selection of a port:

- availability of HR resources in the region,
- availability of training and education centres,
- social and political acceptance for the development of ports related to the support for OWE heavy industry,
- favourable legal conditions allowing for the extension and modernisation of ports and future support of the OWE industry.

The supplier of wind turbines plays a vital role in the selection of ports.

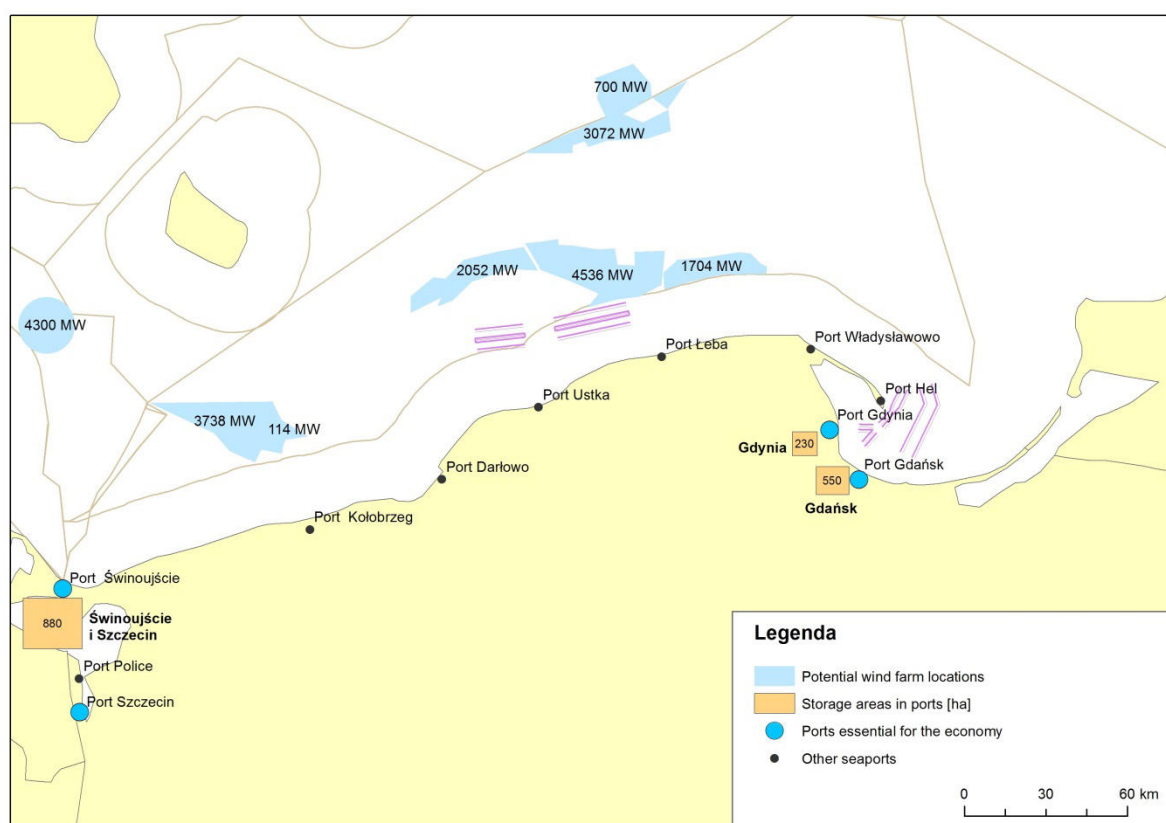
4 major seaports (with indicated storage areas) and regional ports were marked on the map below.

⁶⁹ Department of Energy and Climate Change. 2009. UK Ports for the Offshore Wind Industry: Time to Act.

⁷⁰ Ibid.

⁷¹ Highlands & Islands Enterprise. 2010. Offshore Wind operations & maintenance.

Map 4. Map of potential construction ports in relation to potential locations of OWF



Source: own work

Below we present the most important parameters of the major seaports in Poland in the context of OWE development.

Table 6. Characteristics of ports of fundamental significance for Polish economy

| Criterion | Gdańsk | Gdynia | Szczecin | Świnoujście |
|-----------------------------------|--|---|--|--|
| total length of wharfs | 23.70 km | 17.70 km | 23.38 km | 5.63 km |
| port area | 652 ha (land) 412.56 ha (water) | 755.4 ha including 508 ha of land | 1,606.4 ha | 1,453 ha |
| storage and assembly areas | 107 022 m ² (warehouse area) 549 525 m ² (storage area) | 230,000 m ² | 860.047 m ² (open storage areas) 201.308 m ² (covered warehouse areas) | |
| maximum width of vessels | no limits (max. length - 350 m) | no limits | 31 | 42 |
| maximum draught | 10.2 (internal port) 15.0 (external port) | 13 | 9,15 | 13,2 |
| convenient road connection | Cable-stayed bridge over the Vistula river estuary. | Expressway (ring road of Tricity) leading to A1 motorway. | National road no. 10 connecting the port with A6 and A11 motorways to Berlin and further with the western Europe. Through national road no. 3 (E-65) with the south of | National road no. 10 connecting the port with A6 and A11 motorways to Berlin and further with the western Europe. Through national road no. 3 (E-65) with the south of |

| | | | | |
|--------------------------------------|---|---|--|--|
| | | | Poland, the Czech Republic, Slovakia and further with the southern Europe. | Poland, the Czech Republic, Slovakia and further with the southern Europe. |
| convenient railway connection | Two main railway lines connecting Gdańsk with the south of Poland through Łódź/Warsaw to Katowice/Cracow. Two electrified railway lines connections with Poznań and Wrocław and electrified connection with Szczecin and Kaliningrad. | Connection with Warsaw, Gliwice, Kutno, Radomsko, Sławkowo, Gądk near Poznań and other 15 less regular connections with other cities in Poland. | Main railway line E59 and EC 59 connects the port with the industrial centres of the western and southern Europe. Szczecin Central Port - major freight depot. The depot is connected with the railway line no. 273 from Wrocław, through Zielona Góra and Kostrzyn. The larger part of southern area of the port has the access to railway transport. | Main railway line E59 and EC 59 connects the port with the industrial centres of the western and southern Europe. Szczecin Central Port - major freight depot. The depot is connected with the railway line no. 273 from Wrocław, through Zielona Góra and Kostrzyn. The larger part of southern area of the port has the access to railway transport. |
| office space availability | 14 office and social buildings | no information | 15 office and social buildings for rent | 5 office and social buildings for rent |

Source: Seaports development strategy up to 2015; own work

Potential production and construction ports in Poland

Major Polish ports meet the basic criteria set for the production ports, however, the investors may require certain adjustments, which may be associated with serious investment expenditures. At the initial stage of OWE development in Poland we should rather expect the import of OWF components (apart from the supporting structures), but along with time it should be possible to establish turbine, cable and blade manufacturing plants also in Poland. **Due to the investment expenditures associated with the modernisation and adjustments of production ports and the expected gradual execution of OWF projects, it seems justified to identify one centre, which could become the production hub for Polish and foreign projects. Such an approach should allow for the concentration of financial resources for the modernisation and should increase the competitiveness of Polish locations.**

At the current stage the location of a production hub in the port of Świnoujście or Szczecin should be taken into account due to several reasons. First of all, those ports are managed by one Board and have in total the largest storage area, which is the key factor for the location of production facilities. Secondly, the location of ports in Świnoujście and Szczecin is better than that of ports in Gdynia and Gdańsk due to the vicinity of planned projects in Germany, Denmark and Sweden and a convenient land connection with Germany.

Along with the development of OWF projects and an increased demand for port services it may be necessary to adjust regional ports. It may occur crucial to establish another construction and service hub on the basis of a modernised and extended port facilities in Darłowo and Ustka and the industrial and educational facilities in Słupsk.

In the Seaports development strategy up to 2015 the SWOT analysis of ports of fundamental significance for the national economy and regional ports was presented. Below we present the strengths, weaknesses, opportunities and threats associated with ports and significant due to the development of OWE:

Table 7. SWOT analysis of ports of fundamental significance for the national economy

| Ports of fundamental significance for the national economy | |
|--|--|
| Strengths | Weaknesses |
| <ul style="list-style-type: none"> ▪ experience in supporting international trade and long-term commercial contracts, ▪ versatility of ports providing a wide range of services, | <ul style="list-style-type: none"> ▪ high costs associated with the execution of port investments, ▪ poor coordination of investment plans executed by particular ports, |

| | |
|--|---|
| <ul style="list-style-type: none"> ▪ investment policy of the port managements aimed at developing the potential of ports, ▪ wide range of areas available for investors, ▪ qualified port personnel. | <ul style="list-style-type: none"> ▪ insufficient lobbying in raising funds from the EU resources. |
| Opportunities | Threats |
| <ul style="list-style-type: none"> ▪ forecasts of the economic growth in Poland and the increase of trade in the area of the Baltic Sea, ▪ possibility to use the EU funds and resources of international financial organisations. | <ul style="list-style-type: none"> ▪ low profile of maritime economy in the economic policy of the state, ▪ competition from other ports of the Baltic sea and the development of transport infrastructure providing the access to competitive ports, ▪ delays in the development of transport infrastructure providing the access to Polish seaports. |

Source: Seaports development strategy up to 2015

Table 8. SWOT analysis of regional ports

| Regional ports | |
|--|---|
| Strengths | Weaknesses |
| <ul style="list-style-type: none"> ▪ performing various economic functions: tourist, fishing, shipbuilding, transport, trade, ▪ favourable geographic location for the development of maritime tourism, ▪ tourist nature of coastal cities and regions, ▪ available areas allowing for the development of various economic functions of ports, ▪ successive modernisation of port infrastructure, ▪ economic initiatives of port users, ▪ close relations between the ports and port communes, ▪ qualified port personnel. | <ul style="list-style-type: none"> ▪ poor transport infrastructure within the ports, ▪ limited access in terms of transport from the sea and from shore, ▪ complex legal nature of the ownership of port land properties, ▪ low efficiency of current management model (in most ports the management function are performed by maritime offices), ▪ insufficient promotion of ports, ▪ seasonal nature of maritime tourism. |
| Opportunities | Threats |
| <ul style="list-style-type: none"> ▪ possibility to use the EU funds and resources of international financial organisations, ▪ engagement of communes in the development of ports. | <ul style="list-style-type: none"> ▪ poor capital resources of communes, ▪ low activity of port communes in using the ports as local growth poles, ▪ delays in the development of transport infrastructure providing the access to Polish seaports. |

Source: Seaports development strategy up to 2015

Significance of foreign ports

Despite the significance of port location in relation to OWF, we should expect a serious competition among foreign ports. Larger sizes, loading capacity, turbine installation speed and the improved drive in new generation installation units makes the distance from the port less important in comparison to the convenient port infrastructure. Therefore, it is necessary to take specific actions aimed at providing the competitive advantage of Polish ports over foreign ports. Particular attention should be paid to ports in Germany, *i.a.*: Sassnitz (German construction port for Baltic 1 OWF) and Rostock (production port in Germany).

3.2.6. Service facilities

OWF project require the engagement of numerous auxiliary services, specific for each stage of project implementation. The examples of various types of services required at different stages are given below:

- Development stage:
 - research services - environmental research, geotechnical research,

- advisory services - project management, conducting administrative procedures, supervision over research,
- legal services,
- design services - designing support structures, turbines, connection infrastructure,
- assessment of wind conditions - installation of met-masts, wind measurements, productivity analysis.
- Execution stage:
 - onshore and offshore transport services,
 - onshore and offshore installation services,
 - port services,
 - trainings - educating the personnel involved in the installation of OWF, trainings on the occupational health and safety in marine conditions,
 - certification of projects and particular components,
 - advisory services - project management, supervision over the installation processes,
 - IT services - IT solutions for the OWE sector.
- Exploitation stage:
 - onshore and offshore transport services,
 - OWF operation and maintenance services,
 - trainings - educating the personnel involved in the operation and maintenance of OWF, trainings on the occupational health and safety,
 - advisory services - project management.

Some part of those services is not directly associated with the OWE sector and may be ordered from the Polish companies. Other have to rely on the experience of foreign companies, at least during the initial OWE development phase.

At the current stage of execution of OWF projects the major demand refers to the consulting companies specialised in OWF projects, as well as to Polish companies, which are familiar with the Polish market. There are several companies in Poland, which provide consulting services associated with the OWF sector. We should expect a stronger competition in this field in the near future.

The research services are also an important element. Those services are currently provided for selected projects to be executed in Polish maritime areas as parts of the environmental procedures. The capabilities of Polish research companies are still limited due to an insufficient number of properly equipped research vessels. If the execution of several OWF projects overlaps, then this might be the factor slowing down the implementation of those projects.

At this point special dedicated educational and training programmes should be launched in order to properly prepare the executive staff. The training of management staff will play the fundamental, followed by the appropriate trainings for designers and engineers for the construction, operation and maintenance of the OWF. The trainings and education will be carried out at foreign centres during the first phases, but later on along with the development of the sector it will be possible to establish autonomous Polish education and training facilities based on the existing Polish universities and academies, as well as on new education centres.

3.2.7. Science and research facilities

Poland has a great scientific and research potential related to the OWE sector, relying mostly on public universities and research institutes and partly on private companies. We should expect the occurrence of new directions in research and development following the growth of the OWE sector in Poland, focused on innovative technologies and broadening of knowledge on the current condition of the environment. Polish companies and

institutions are already engaged in series of research activities, both in relation to the development of OWF in Poland and to the performance of orders for foreign entities. Among the most important initiatives the following should be mentioned:

- establishing the Maritime Centre for Eco-energy and Eco-system (MORCEKO) which would work on creating the research potential allowing for the selection of the best technologies and for the development of new technologies to be used by future investors,
- concluding a contract in December 2012 by the Ship Design and Research Centre for the financial donation for the specialist offshore laboratory equipment to carry out hydrodynamic and aerodynamic model research,
- launching the Aquilo project financed by the National Research and Development Centre, aimed at the elaboration of a method for the selection of support structures for offshore wind farms in Polish maritime areas,
- launching the MARE-WINT project with the participation of Polish units, aimed at the reduction of OWE costs by increasing the reliability of OWF,
- environmental research carried out by Polish entities for foreign OWF projects.

If we look at the current development of the sector of research and development in Poland in the OWE sector, we can expect that the considerable growth of this sector in Poland will allow for the increase of the innovative potential of Polish companies.

3.2.8. HR resources

The development of offshore wind energy in Poland will require training and educating qualified personnel involved in the processes of project development, installation and operation. It will not be possible without the development of new programmes and courses at higher education facilities. Education, research and development facilities for the offshore industry, along with the HR potential, are located at the universities and academies of the Pomeranian and West Pomeranian Voivodeships. The following public education facilities were identified as the most appropriate and ready to adjust their education programmes in order to educate and train the qualified staff for OWE industry. There are ca. 30,000 students attending courses at those universities and academies:

Polish Naval Academy in Gdynia (ca. 666 students)

- Faculty of Navigation and Armament of Ships (465)
 - majors: navigation (301), computer science (164), ocean engineering (0)
- Faculty of Mechanical and Electrical Engineering (ca. 201 students)
 - majors: mechanics and machine building (159), automatics and robotics (24), mechatronics (18)

Gdynia Maritime University (ca. 2934 students)

- Faculty of Navigation (ca. 1293 students)
 - majors: navigation (918), transport (375)
- Faculty of Mechanical Engineering (ca. 746 students)
 - majors: mechanics and machine building (746), safety engineering (8)
- Faculty of Electrical Engineering (ca. 895 students)
 - majors: electrotechnical engineering (537), electronics and telecommunication (358)

Maritime University of Szczecin (ca. 3710 students)

- Faculty of Navigation (ca. 1870 students)
 - majors: geodesy and cartography (353), computer science (104), navigation (1309), transport (104)
- Faculty of Mechanical Engineering (ca. 742 students)
 - majors: mechanics and machine building (638), mechatronics (104)
- Faculty of Transport Engineering and Economy (ca. 1098 students)
 - majors: transport (333), production management and engineering (486), logistics (279)

Pomeranian University in Słupsk (ca. 480 students)

- Faculty of Mathematics and Life Sciences
 - majors: technical physics (26), geography (287), biology (113), environmental protection (54)

Gdańsk University of Technology (ca. 10966 students)

- Faculty of Electronics, Telecommunication and Computer Science (ca. 2648 students)
 - majors: automatics and robotics (428), electronics and telecommunication (880), computer science (1340)
- Faculty of Electrotechnics and Automatics (ca. 1673 students)
 - majors: automatics and robotics (681), electrotechnics (693), power engineering (299)
- Faculty of Civil Engineering and Environment (ca. 4710 students)
 - majors: civil engineering (2837), environmental engineering (999), transport (458), geodesy and cartography (416)
- Faculty of Ocean Engineering and Shipbuilding (ca. 1935 students)
 - majors: ocean engineering (1167), power engineering (347), transport (421)

Koszalin University of Technology (ca. 3387 students)

- Faculty of Civil Engineering, Environmental and Geodetic Sciences (ca. 2036 students)
 - majors: civil engineering (885), environmental engineering (494), environmental protection (70), geodesy and cartography (587)
- Faculty of Electronics and Computer Science (ca. 617 students)
 - majors: electronics and telecommunication (148), computer science (446), technical and IT education (23)
- Faculty of Mechanical Engineering (ca. 734 students)
 - majors: power engineering (60), industrial investments and implementations (6), mechanics and machine building (297), transport (310), production management and engineering (61)

University of Gdańsk (ca. 3304 students)

- Faculty of Biology (ca. 1029 students)
 - majors: biology (582), life sciences (122), environmental protection (325)

- Faculty of Mathematics, Physics and Informatics (ca. 692 students)
 - major: physics (83), informatics (609)
- Faculty of Oceanography and Geography (ca. 1583 students)
 - majors: geography (567), spatial management (425), oceanography (452), geology (139)

Szczecin University (ca. 128 students)

- Faculty of Biology (ca. 128 students)
 - majors: biology (62), environmental protection (66)

The West Pomeranian University of Technology (ca. 5232 students)

- Faculty of Civil Engineering and Architecture (ca. 2234 students)
 - majors: civil engineering (327), environmental engineering (1907)
- Faculty of Electrical Engineering (ca. 1016 students)
 - majors: automatics and robotics (346), electronics and telecommunication (159), electrotechnics (511)
- Faculty of Mechanical Engineering and Mechatronics (ca. 1386 students)
 - majors: power engineering (94), material engineering (125), mechanics and machine building (450), mechatronics (163), transport (180), production management and engineering (374)
- Faculty of Offshore Engineering and Transport (ca. 596 students)
 - majors: exploitation of seas and oceans (0), safety engineering (140), ocean engineering (66), transport (341), construction of yachts (49).

4. Compliance of the Programme with national policies and strategies

4.1. Energy Policy of Poland until 2030

In accordance with the strategic document "Energy Policy of Poland until 2030" of November 2009 is one of the basic directions of the Polish energy policy is the "development of methods for the use of renewable energy sources"⁷². The major exogenous goal is to meet the assumptions of the European energy policy related to the increase of the share of renewable sources of energy and the reduction of emissions in the energy sector. An endogenous goals of the development of RES in Poland is the "improvement of the state energy safety while observing the principles of sustainable development"⁷³. However, it is quite easy to notice that even the basic trends presented in the "Energy Policy of Poland until 2030" are completely in line with the objectives of the Programme.

The Programme systematises and presents solutions, which are described in detail and adjusted to the specificity of the technological and investment process of the OWF sector. The tools demonstrated in the Programme for the achievement of the objectives stated herein are also in line with the RES development tools described in the "Energy Policy...".

- Support mechanisms for the performance of actions aimed at the achievement of basic goals of the energy policy, which currently are not profitable in commercial terms (*e.g.* the market of "certificates",

⁷² Ministry of the Economy, 2009. Energy Policy of Poland until 2030.

⁷³ Ibid.

discounts and tax exemptions) - the Programme contains specific solutions referring to the support mechanism for the offshore wind energy, which will allow for the execution of investments in Polish maritime areas.

- Activities within the European Union, especially leading to the creation of a common energy policy of the EU and the common environmental protection requirements taking into account the conditions of Polish energy sector and leading to the improvement of the energy safety of Poland - we suggested in the Programme certain solutions related to the international power grid and the possibilities of their development and functioning within the Baltic Sea.
- Support from public financial resources, including EU funds, execution of energy projects crucial for the state (*e.g.* investment projects, R&D projects) - the Programme indicates the possibilities of financing all the elements of the offshore wind energy sector (offshore wind farm projects, offshore industry, offshore grid, personnel, marine environmental research) and described particular financial instruments and European funds, which could be used for those purposes.

Offshore wind energy is one of few technologies which are listed in the strategic document. The authors of the "Energy Policy..." state that one of the key actions for the development of methods for the use of RES is the "creation of conditions facilitating the decision-making process in terms of investments in offshore wind farms"⁷⁴.

Despite the fact that offshore wind energy holds an important place in the "Energy Policy...", the key action today should be the updating and expanding of the programme of executive actions. In 2009-2012 serious actions were taken (*e.g.* amendments to the Act on the maritime areas of the Republic of Poland and maritime administration), however the condition for further development of offshore wind energy is the completion of subsequent, very ambitious tasks. Among the executive actions allowing for the further development of OWE in Poland, which should cover the next perspective described in the "Energy Policy..", the following should be listed:

- schedule for the offshore wind energy development:
 - I phase of development, 2020 - 1 GW,
 - II phase of development, 2025 - 3 GW,
 - III phase of development, 2030 - 6 GW.
- determination of tools necessary for the development of OWE as a crucial component of the Polish energy mix in the 2020-2030 perspective:
 - adoption by the end of 2013 of new system solutions providing solid grounds for the stable and efficient development of OWF,
 - provision of state and local government patronage and support for the first pilot OWF project,
 - indication of possibilities to connect OWF in the 2030 perspective, determination of chances for the development of energy sources balancing the energy system in Poland and of transboundary connections,
 - amending the Act on maritime areas in terms of the validity of PSZW for projects, which are waiting for the issuance of the connection conditions.

One of the elements of the "Energy Policy..." is the "stimulation of growth of the manufacturing industry involved in the production of devices for renewable energy, including the use of the EU funds"⁷⁵ (Action 4.8). Among the solutions, which should be included in the updated version of the "Energy Policy..." the following should occur:

- creation of a special-purpose fund for the development of offshore industry and energy financed with the fees for the location permits; the fund should support the development of the shipbuilding and port infrastructure, as well as the electricity infrastructure located at sea,
- elaboration of a programme for the modernisation of Polish ports and shipyards for the purpose of organising the logistics and manufacturing facilities for the Baltic offshore wind energy market.

⁷⁴ Ministry of the Economy, 2009. Energy Policy of Poland until 2030.

⁷⁵ Ministry of the Economy, 2009. Energy Policy of Poland until 2030.

The Polish offshore wind energy and maritime industry development programme is compliant with the idea and the objectives of the "Energy Policy of Poland until 2030". "Energy Policy..." indicates the necessity to develop certain elements, which will create the chances for the execution of the first offshore wind farm projects in Poland (support mechanism, connection infrastructure development, including transboundary projects, growth of the offshore industry). Due to the fact that the Programme contains specific tools allowing for the achievement of goals stated in the "Energy Policy..." it seems advisable to use the solutions given in the Programme during the future works on the updated version of the "Energy Policy of Poland until 2030".

The status of implementation of tasks related to OWF described in the "Energy Policy of Poland until 2030"

- Identification of legal barriers preventing or hindering the construction of offshore wind farms - the first barriers were eliminated, continuation is required.
- Preparation of amendments to legal provisions which could eliminate the identified barriers, in particular - amendments to the Act on maritime areas of the Republic of Poland and maritime administration - completed.
- Decisions in terms of the Polish engagement in the construction of the international offshore power grid ("Supergrid") essential for the development of offshore wind farms - required continuation.
- Indication of potential locations for OWF within Polish maritime areas - required continuation.

4.2. National Renewable Energy Action Plan

The National Renewable Energy Action Plan of December 2010, next to the "Energy Policy of Poland until 2030" is the second key strategic document in shaping the development of the renewable energy sector in Poland. It seems, however, that in comparison to the "Energy Policy..." the NREAP document insufficiently covers the subject of the offshore wind energy sector.

In the considered document the development of offshore wind energy was presented as one of the significant elements necessary for the improvement of the energy safety of Poland. Additionally, it was stated that the development of offshore wind energy should be compliant with the assumptions of the "Energy Policy of Poland until 2030", in which the key elements of the OWE development in Poland were listed:

- the issues of locating offshore wind farms and the transmission and distribution grids within the selected areas of the internal waters,
- the need for the research to determine the best areas for their location, with particular focus on the impact of the investments on the environment and marine ecosystems and with special consideration to the costs of investment, exploitation and marine safety,
- necessity to improve the procedures for the issuance of the permit to erect structures in Polish maritime areas.

The major drawbacks of the considered document are:

- assumption of an insufficient quantitative objective for the offshore wind energy (500 MW by 2020),
- taking wrong productivity parameter as the basis for the functioning of the offshore technology within Polish maritime areas (average period of operation of offshore wind turbines is 3000 hours/year in 2011-2020)⁷⁶.

The assumptions of the Polish offshore wind energy and maritime industry development programme are compliant with the NREAP. Drawing the attention to the necessity to optimize the location of offshore wind farms, conducting research in marine environment and improving the process of issuing the location permits for OWF are the three common elements of the two documents.

⁷⁶ According to the "Study of the wind potential and the productivity of selected offshore wind farms in Polish maritime areas" this value is between 4,000 and 4,700 hours/year.

However, both the quantitative objective of the OWE development and the productivity parameters stated in NREAP should be corrected. In 2010 and earlier, when the NREAP was being elaborated the new expert opinions and research on the quantitative objectives allowing Poland to exceed the critical threshold in the OWF sector were not known (*i.e.* 1 GW in 2020, 3 GW in 2025 and 6 GW in 2030). Similar to the case of the productivity parameters - full research has been carried out in 2013. Therefore, it is advisable to use this Programme during the works on the updated version of the NREAP so that the Action Plan could be based on the latest available research results and expert opinions.

4.3. Maritime policy of Poland up to 2020

The Polish offshore wind energy and maritime industry development programme is compliant with certain objectives of the "Maritime policy of Poland up to 2020":

- **Objective:** use of maritime areas for the production of energy and supply of energy resources

Actions:

- creation of conditions for the construction of offshore wind farms,
- construction and modernisation of offshore energy transmission and storage infrastructure allowing for the diversification of supply of energy resources,
- implementation of innovative programmes using the renewable energy sources available at sea, *i.e.* wind, tides and waves.

- **Objective:** improving the competitiveness of Polish seaports

Actions:

- modernisation and extension of the port infrastructure and the access to ports from the sea and from shore,
- development of the range of services provided in ports by improving the distribution and logistics function and the passenger traffic,
- supporting smaller ports as regional centres for entrepreneurship.

- **Objective:** development of marine science and research

Actions:

- providing integration and coordination of marine research, with particular focus on the ecological and innovative aspects,
- making available the collected data to a wide group of potential recipients, including the possibility to use the information from the public sector regarding this subject and the reduction of costs associated with the access to the information.

In relation to the impact of the development of the OWE sector on other sectors it will be necessary to achieve the other goals stated in the document, *i.e.*:

- providing standards for the safe navigation of marine vessels,
- rational management of resources living in marine waters and the improvement of the efficiency of the fishing sector,
- developing the maritime and coastal tourism.

4.4. Seaports development strategy up to 2015

The Seaports development strategy up to 2015 is a document elaborated in 2007 which supplements the "National Development Strategy for 2007-2015".

The development of OWE based on the Polish port facilities is compliant with the major objective of the considered Strategy, *i.e.* the improvement of competitiveness of Polish seaports and the increase of their share in the social and economic development of Poland, and the raising the profile of the Polish seaports in the international transport network. Furthermore, the development of OWE is in line with the following priorities listed in the Strategy:

- improvement of port infrastructure and the access to ports,
- development of the range of services provided in ports,
- building the image of Polish ports as crucial points of the sustainable development of coastal regions and communes.

The Strategy assumes the performance of the following actions, which will positively affect the development of OWE:

- financial support from the state budget and the maintenance of roads leading to the major ports in Gdańsk, Gdynia, Szczecin, Świnoujście and Police,
- implementation by the minister in charge of maritime economy of the policy aiming at the increase of funds from the EU budget intended for the co-financing of the investments in Polish seaports in the future programming period,
- active participation of Poland in international projects related to the development and promotion of seaports,
- promoting initiatives aiming at informing the society about the positive impact of the development of ports on regions and coastal cities, as well as about the development plans and investments related to ports and actions associated with environmental protection.

Execution of OWF projects in Poland will become a significant stimulus for the modernisation and extension of Polish seaports and will allow for the extension of the range of services related not only to production of component for offshore wind power plants, but also to the assembly and installation of components and operation and maintenance of OWF. The latter is significant because of the regional ports, which due to their location will become the operation and maintenance bases for offshore industry. The increase of employment in coastal regions and new investments will contribute to the achievement of the major objective indicated in the Strategy along with the listed priorities.

Seaports development strategy will be substituted with the document "Programme for the development of Polish seaports", which will implement the provisions of the Transport Development Strategy up to 2020 (including the 2030 perspective). The Programme for the development of Polish seaports is currently being elaborated by the Ministry of Transport, Construction and Maritime Economy.

4.5. Poland 2020

Development of OWF and offshore industry described in the document

"National Development Strategy 2020" constitutes the major development strategy for a medium time horizon. In the document the strategic tasks of the State were indicated, which are necessary in the coming years for the strengthening of the development processes.

The Polish offshore wind energy and maritime industry development programme is compliant with the objectives listed in the "National Development Strategy...". As the authors of the "National Development Strategy" highlight, in the 2020 perspective "(...) the strategic emphasis will be placed on the strengthening of the potentials, which in future can guarantee a long-term development, not only the allocation of resources directly to the fields in which the deficits are the largest."⁷⁷. Building long-term potentials, with particular emphasis on an innovative approach, principles of sustainable development and the support for sectors providing the chances for long-term

⁷⁷ Ministry of Regional Development. 2012. National Development Strategy 2020.

development were highlighted in the analysed document. The priority goals will be achieved when the scenarios presented in the Programme are fulfilled.

Another common element of the two documents is the reduction of ecological and energetic risk associated with the degradation of the environment and insufficient supply of energy resources, respectively. The development of offshore wind energy in Poland, according to the options specified in the Programme, will definitely contribute to the reduction of both - the ecological risk, by limiting the amount of emissions of the Polish economy - and the energetic risk, by diversifying the sources of energy production, restricting the dependencies on the unfavourable fluctuations on the markets of energy resources and the increase of self-sufficiency of the Polish energy sector.

Furthermore, in the "National Development Strategy..." an emphasis is placed on the idea of restructuring the economy using innovative technologies. The scenario for the revitalisation of the Polish industry, creation of green work places, improving the competitiveness of the Polish economy on the international market - described in the Programme - are the elements, which will guarantee the restructuring of the Polish offshore and shipbuilding industry. By following the said scenario Poland will be able to use more efficiently own energy resources, what is the condition for a stable and dynamic economic growth.

Implementation of solutions presented in the Programme will lead to the completion of tasks assumed in the "National Development Strategy..." in the 2020 perspective, because with the efficient use of tools specified in the Programme the first offshore wind farm projects could even be executed in Poland in the 2020.

The investments in the improvement of the energy and environmental safety along with the diversification of energy supplies are listed among the development priorities, which could be achieved by executing the offshore wind farm projects described in the Programme. Therefore, we can conclude that the Programme is in line with the objectives stated in the "National Development Strategy...".

Additionally, among the strategic tasks of the state in the 2020 perspective the following were listed:

- supporting the development of entrepreneurship (eliminating legal and administrative barriers, improving the access of companies to capital, strengthening the entrepreneurial approach of the society, institutional, organisational and financial improvement of the entrepreneurial environment),
- implementation of a system supporting innovations (preference for innovations - diversification of instruments; combining science with business, increase of financial contributions to R&D⁷⁸, use and orientation of DFI⁷⁹),
- specification and support for new technologies, which may become the competitive advantage of the economy (*e.g.* green technologies),
- improving the efficiency of actions in the field of environmental protection, including the system for adaptations to climate changes and a system for the protection of air against pollution, managing floor risk,
- development of infrastructural projects associated with energy (modernisation of transmission grids, extension of the transmission infrastructure, increase of the share of RES)⁸⁰.

All above mentioned elements were described in the Programme for the Development of Offshore Wind Energy and Industry, along with specific tools allowing for the achievement of stated objectives. It is worth highlighting here that the "National Development Strategy..." and the Programme are documents, which are to interlinked to a certain extent. Correlation of the "National Development Strategy..." and the Programme would lead to the achievement of goals assumed in both documents. The use of the Programme should be one of the key elements of creating new strategic documents related to the development of Poland, because the scale of the investments and their impact on the economic growth, employment and tax revenues cannot be ignored.

⁷⁸ Research & development.

⁷⁹ Direct foreign investments.

⁸⁰ Ministry of Regional Development. 2012. National Development Strategy 2020.

4.6. Programme for the development of the power sector taking into account the renewable energy sources in the Pomeranian Voivodeship up to 2025

In the Programme for the development of the power sector, taking into account the renewable energy sources in the Pomeranian Voivodeship up to 2025, the following targets related to OWE were identified:

Target 1: reduction of dependency on the traditional energy sources by increasing the share of energy generated from renewable sources up to the level of at least 19% in 2025,

Target 2: improvement of regional and local energy safety, energy supply reliability and the efficiency of energy production and use,

Target 3: creation of local energy markets and improving the competitiveness of energy production and supply.

5 power sector development scenarios were presented in the Programme, which assume various investment solutions (*i.a.* maximum investments in conventional sources, maximum investments in RES, etc.). The sustainable development scenario no. IV was selected as an optimum scenario which assumes the execution of OWF at a rate of 150-170 MW in each 5 years. Due to the fact that OWF may become a serious stimulus for the development of the Polish coastal regions, it is assumed that even up to 1200-1500 MW in OWF may be installed by 2025⁸¹.

Implementation of the Programme for the development of OWF and offshore industry is compliant with the objectives stated in the "Programme for the development of the power sector...". It is important to point out that in the latter the OWE was described as a development factor crucial for the coastal regions. What is more, the West Pomeranian Voivodeship will also follow the principles of OWF development in future, by establishing a connection with the international transmission grid, which is currently in the conceptual phase.

4.7. Strategic documents in the energy sector at the EU level

The assumptions of the Polish offshore wind energy and maritime industry development programme are in line with the key strategic documents specifying the directions of the development of the energy sector in the EU. This is the result of the fact that the production of electric energy from renewable sources is one of the pillars of the climate and energy policy of the EU. The major goals in this field were set in 2007 when the European Commission determined that the target of 20% share of renewable energy in the gross energy consumption in all 27 EU member states by 2020. It was clearly stated then that the production of electric energy based on wind power (in particular offshore wind power plants) should be one of the key technologies used for the achievement of the objective.

In November 2008 the European Commission highlighted the role of offshore wind energy by stating in a memo that the offshore wind energy will play an essential role in meeting the EU energy targets⁸². In particular, the Commission emphasised the fact that the construction of OWF in three EU member states has a great potential as: "(...)offshore wind can make a significant contribution to all three key objectives of the EU's new energy policy: reducing greenhouse gas emissions, ensuring security of supply and improving EU competitiveness."⁸³ In relation to that the European Union assigned financial resources in the amount of EUR 565 million by the end of 2010 for the execution of nine projects assuming the construction of large OWF, as well as for the research and development aimed at improving the technological efficiency of the sector and investments in the accompanying sectors.

⁸¹ Programme for the development of the power sector taking into account the renewable energy sources in the Pomeranian Voivodeship up to 2025. 2010

⁸² Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Offshore wind energy: Action needed to deliver on the Energy Policy Objectives for 2020 and beyond. November 13, 2008.

⁸³ Ibid.

Another step stabilising the legal environment for the functioning of renewable energy sources was taken by the Council of the European Union in 2009, when the Council adopted a package of directives related to environmental protection and promotion of renewable sources of energy (the so called third energy package). One of the major elements of the mentioned package was the Directive 2009/28/EC⁸⁴ establishing the target share of renewable energy sources in the gross energy consumption⁸⁵ in the EU at the level of 20% by 2020. It was assumed that the achievement of the target will be settled at the level of member states and on this basis the national targets were established, which fall between 10% (Malta) and 49% (Sweden) of the share of renewable energy sources in the planned energy consumption in 2020. Target for Poland was set at the level of 15% by 2020.

5. Analysis of barriers

5.1. General barriers

5.1.1. I Stage of market development

The analysis of the offshore wind energy market potential in Poland confirms that the development of this sector according to the assumed quantitative and qualitative objectives is possible and should bring significant economic benefits for Poland. The description of legislative and market conditions proves that since 2011 there have been very strong grounds for the initiation of the development of the said market. It is confirmed also by a serious interest of national and foreign investors in this subject, which resulted in the preparation of first OWF projects. On the basis of issued location permits, connection conditions and the initiated environmental procedures we can state that the quantitative objective for the I stage of OWE development in Poland - 1 GW up to 2020 - may be achieved without any substantial changes in the system, on condition that the support mechanism planned by the Government for renewable energy sources will be implemented. **It is worth highlighting that the failure to adopt the new support mechanism for RES in 2013-2014, providing a stable base for the development, execution and exploitation of pilot projects, i.e. those which may be constructed up to 2020, will block the development of the OWE market and will prevent the achievement of the assumed objectives.**

Also the national sector of offshore industry showed a serious interest and demonstrated the capacity to launch production for offshore wind farms, what resulted in the initiation of production of specialist vessels, towers and foundations for foreign OWF markets. The existing port facilities and infrastructure will allow for the support of offshore wind farm construction, provided that some part of the components will be delivered from foreign ports (*e.g.* turbines, cables).

Barriers preventing the achievement of the objective assumed for 2020 may be:

- insufficiently slow decrease of investment costs due to a slower development of technology than assumed,
- instability of the support mechanism for renewable energy sources, variability of political support for the development of offshore wind energy,
- high investment risk of the pilot projects, combined with the lack of engagement of experienced investors and contractors in the development and execution of those projects,
- excessive prolongation of administrative procedures, especially those associated with the decisions on environmental conditions, caused by blocking the investments by environmental organisations and/or administrative incapacity,

⁸⁴ Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

⁸⁵ Gross final consumption of energy means the energy commodities delivered for energy purposes + losses of electricity and heat in distribution and transmission + the consumption of electricity and heat by the energy branch for electricity and heat production.

- lack of financial resources for the execution of investments caused by a prolonged economic crisis,
- difficulties with the organisation of the supply chain due to an insufficient development of domestic production facilities and excessive demand for OWF components on foreign markets.

5.1.2. II stage of market development

Larger problems may be associated with the achievement of objectives of the II stage of development - 3 GW up to 2025. The major barrier here are the connection capacity of the NPS. The system operator believes that there may be a shortage of even up to 800 MW of connection capacity. It seems, however, that the verification of currently issued connection conditions for the onshore wind energy and the verification of feasibility of the investment plans of the conventional and nuclear energy, what is necessary from the NPS perspective may allow for the finding of the expected connection potential for the additional OWF projects. Connection capacity may be increased due to the resignation of certain investments in other energy generating sources, planned in the coastal regions. The increase of the connection capacity may occur also as a result of the development of offshore transmission grids, transboundary connections or energy storage systems.

Another problem for the second group projects may be the financial aspects. The most intensive development of OWF on European markets will most probably fall on the years 2020-2025. This will naturally create a serious competition around the financing sources, especially in the context of quite high investment costs in that period. This means that the Polish support mechanism must be competitive in comparison to the foreign systems, so that the investor would find it profitable to invest in Poland. Creating such a support mechanism requires a strategic approach and pre-emptive actions to create stable and long-lasting grounds for investment planning and constructing financial portfolios.

Another problem for the projects of the II stage of market development may be the availability of delivery and logistics facilities. When the demand for devices and services on foreign markets is high, it seems inevitable to create own domestic potential, which will not only be competitive in comparison to other European markets, but will also provide maximum support for domestic investments.

Barriers preventing the achievement of the objective assumed for 2025 may be:

- EU resignation from the policy to support renewable energy after 2020,
- insufficiently slow decrease of investment costs due to a slower development of technology than assumed,
- instability of the support mechanism for renewable energy sources, variability of political support for the development of offshore wind energy,
- lack of changes guaranteeing the possibility to develop OWF project without the risk of location permit validity expiry if the connection conditions cannot be issued,
- failure to execute investments in onshore grids providing a greater transmission potential from north to south,
- lack of financial resources for the execution of investments caused by a prolonged economic crisis,
- difficulties with the organisation of the supply chain due to an insufficient development of domestic production facilities and excessive demand for OWF components on foreign markets.

5.1.3. III Stage of market development

The installation of 6 GW capacity on offshore wind farms up to 2030 in Polish maritime areas will require a strategic approach to the development of the OWE sector as a significant element of the energy and economic policy of the state for 2020-2050. Lack of strategic planning and shaping the legal system according to the needs of temporary interests and problems may constitute a serious barrier for the achievement of this ambitious objective. A substantial development of offshore wind energy in the next decade requires the making of critical political decisions right now, at the national and local level and the maintenance of those decisions for the next several years. Such a responsible and strategic approach to the development of a new

industry sector is fundamental also for the development of the offshore industry in Poland in order to make it the driving force behind the development of Polish coastal regions.

In order to select projects, which could be executed after 2025 it would be necessary to introduce certain legal changes, which would guarantee the availability of locations along with the connection conditions for investors guaranteeing the largest economic efficiency of their project.

The basic barrier for the achievement of the goal for 2030 will be the possibility to connect the additional 3 GW of capacity to the power grid and to provide the balance of evacuated energy. This problem may be solved by the investments in the offshore transmission systems, including transboundary grids and energy storage systems. The current national energy mix will have a serious impact on the actual connection options for OWF. Unfortunately, due to the lack of a stable investment scenario it is very difficult to forecast.

The development of technology will be a substantial condition for the development of OWE after 2020, as the technologies applied in OWF will become more common along with the development of the domestic production, logistics and service facilities and an increasing experience in executing OWF will lead to the reduction of investment costs and an optimisation of investment schedules.

Barriers preventing the achievement of the objective assumed for 2030 may be:

- insufficiently slow decrease of investment costs due to a slower development of technology than assumed,
- instability of the support mechanism for renewable energy sources, variability of political support for the development of offshore wind energy,
- lack of changes guaranteeing the possibility to develop OWF project without the risk of location permit validity expiry if the connection conditions cannot be issued,
- failure to execute investments in onshore grids providing a greater transmission potential from north to south,
- difficulties with the organisation of the supply chain due to an insufficient development of domestic production facilities and excessive demand for OWF components on foreign markets.

5.2. Specific barriers

5.2.1. Policy

- Low awareness among the national, regional and local politicians in terms of the opportunities, benefits and the conditions for offshore wind energy development.
- Lack of coherent quantitative and qualitative objectives related to the development of OWE included in the national energy policy.
- Marginalization of renewable energy sources as a tool for the stimulation of regional development and for the improvement of energy safety by diversifying the sources.
- Focusing the support mechanism for RES only on the achievement of objectives, which require the least investments, resulting from the climate and energy package in the 2020 perspective.
- Lack of objectives related to the development of OWF and the offshore industry in terms of the delivery and logistics facilities for the sector in the Development strategies for the coastal regions.
- Failure to include the quantitative and qualitative objectives in the seaports development strategy, which could allow for the creation of an efficient logistics base for OWF.
- Lack of coherent policy of the national and local governments in relation to the development of offshore wind energy.

5.2.2. Legal conditions

- Lack support mechanism for renewable energy sources providing solutions dedicated to OWF, providing competitive position of the Polish market and guaranteeing stable conditions for the development of pilot projects.
- Lack of connection between the procedure for issuing location decisions and the procedure for issuing the grid connection conditions.
- The system for the allocation of sites for OWF does not guarantee the selection of the most reliable investors.
- Lack of grid connection conditions verification system in terms of the feasibility of the projects.
- The owner of the OWF is heavily burdened with the costs of connecting the wind farm to the NPS connection point located onshore.
- Lack of incentives for cooperation between the OWF investors with the operator in relation to the development of the offshore grid, creation of energy storage systems and balancing the energy generated by OWF.
- Lack of rules regulating the liability for unjustified blocking of investments by environmental organisations.

5.2.3. Spatial and environmental conditions

- Lack of the spatial development plan for maritime areas, which would indicate the areas intended for the development of OWF, not colliding with the other methods of exploiting the maritime areas.
- Lack of indicated infrastructure corridors, in which the seabed cables connecting the OWF with the shore could be placed.
- Lack of marine environment research standards established and approved by appropriate authorities environmental impact assessment procedure.
- Lack of objective results of marine environment research, which could serve as a reference for the research carried out by investors for the purpose of EIA.
- Poor preparation of the personnel of environmental authorities responsible for the issuance of the decision on environmental conditions for the OWF.

5.2.4. Social conditions

- Low awareness among local communities and groups associated with the use of maritime areas and coastal areas, related to the actual threats and opportunities connected with the development of offshore wind energy.
- Strong opposition of the fishing communities towards the development of OWE, not supported with any reliable information or research.
- Existing and *ad hoc* pseudo-environmental organisations specialised in blocking investments in the energy sector.
- Poor HR resources for the offshore industry and for the management, execution, operation and maintenance of OWF.

5.2.5. Infrastructural conditions

- Blocking NPS connection capacity by virtual investment projects.
- Lack of offshore power grids and NPS connection points located within the maritime areas.
- Poor land transmission grid in the northern areas of Poland.

- Lack of sufficient logistics facilities - ports fail to meet the criteria to support OWF, lack of storage areas, insufficient capacity of production plants, lack of OWF construction vessels.
- Lack of energy storage systems, insufficient capacity of pumped-storage power stations.

5.2.6. Economic and financial conditions

- Excessive investments costs associated with OWF, lack of competitiveness in terms of other RES technologies.
- Limited availability of investment resources, including banks.
- Lack of operational programmes allowing for the support of OWF investments and offshore industry investments with EU funds in the 2014-2020 perspective.
- Lack of mechanisms allowing for the support of OWF investments from the resources of the national ecological funds.

5.2.7. Market conditions

- Decreasing interest of foreign investors in Polish OWF market.
- Strong competitiveness of foreign RES support mechanisms.
- Significant oversupply of certificates of origin and lack of a system for the maintenance of RES support mechanism stability.
- Maintaining excess of demand over supply in terms of technology delivery and services for OWF market, and therefore lack of reductions in the investment costs.

5.2.8. Technological conditions

- Lack of efficient and approved energy storage systems for the excessive energy production by OWF.
- Expensive and not easily available HVDC systems increasing the efficiency of OWF.
- Lack of national wind turbine and seabed cable manufacturers.

5.2.9. Organisational conditions

- Lack of a uniform programme in force for the development of offshore wind energy, industry and personnel.
- Lack of a coherent management system for the investments in energy sector in maritime areas and for the investments in the production and logistics facilities for OWE.
- Distribution of competence related to the development and execution of OWF projects between the national, regional and local institutions.
- Poor cooperation between the government and local self-governments in terms of planning and implementing strategies for the development of maritime areas.
- Poor connection between the education, research and implementation systems with the investors and manufacturers operating in the offshore and energy sectors.

6. Programme for executive actions

The achievement of objectives stated in the Programme requires preparations and implementation of actions in various fields and at various organisational levels - national, local and private. Major tasks were divided into three main executive programmes. The purpose of each of those programmes will be the creation of stable foundations for the development of offshore wind energy and industry in Poland.

6.1. "Investment facilities" - executive programme

Programme objective:

Creating political, system and legal frames in order to provide the attractiveness of the Polish offshore wind energy market for future investors.

Major Programme actions:

1. Provide strategic and political bases for the objectives related to the development of offshore wind energy and industry by adopting the Polish offshore wind energy and maritime industry development programme by competent state and local authorities or by including in appropriate strategies and programmes the objectives and tasks specified in the Programme:
 - a. Energy Policy of Poland
 - b. Seaports development strategy
 - c. Regional development strategies
 - d. Power Grid development strategy
2. Elaboration and adoption of a package of legislative changes providing a stable and competitive - in comparison to foreign markets - bases for the development, execution and exploitation of offshore wind farms:
 - a. the Act on Renewable Energy Sources
 - b. the Act on Energy Law
 - c. the Act on transmission corridors
 - d. the Act on maritime areas of the Republic of Poland and maritime administration
3. Preparation and implementation of operational programmes allowing for the support of investments associated with the execution of offshore wind farms, offshore power grids and the production and logistics facilities using the EU funds in the 2014-2020 perspective and the national and regional special-purpose funds.

Schedule:

Actions should be carried out in 2013-2014.

Responsible authorities: Minister of the Economy, Minister of Regional Development, Minister of Transport, Construction and Maritime Economy, Marshals of the Pomeranian and West Pomeranian Voivodeship.

6.2. "Investment facilities" - executive programme

Programme objective:

Creation of conditions for the development of offshore industry and infrastructure facilities at a scale and within a scope guaranteeing a full support for the domestic offshore wind energy market.

Major Programme actions:

1. Preparation and implementation of the strategy for the development of production, logistics, operation and maintenance centres, covering:
 - a. the creation and development of special economic zones around the national port centres,
 - b. investments in the modernisation of ports and accompanying communication and storage infrastructure,
 - c. extension of the existing and the construction of new plants involved in the production of structural components of offshore wind farms,
 - d. creation of scientific, research and implementation centres combining the national and international scientific and industrial potential.
2. Elaboration and implementation of the "offshore transmission grid" project connecting the Słupsk-Wierzbęcino GPZ with Żarnowiec GPZ with an onshore-offshore DC cable, with an offshore transformer station, which is the connection point for OWF executed within the region of the Słupsk Bank and Middle Bank. The target grid should be connected with a seabed cable with the transboundary grids connecting the Baltic States, as the part of the so called Baltic Supergrid. The project could be executed in accordance with the public-private partnership, in cooperation with investors and the transmission grid operator.
3. Preparation and implementation of the marine environment monitoring programme, based on the construction and exploitation of 2 or 3 permanent offshore research and measurement stations. This programme would allow for the creating of an independent, objective source of knowledge on the condition of the marine environment and the impact of OWF on that environment.

Schedule:

- Preparation of particular projects should be carried out in 2013-2014.
- Actions should be carried out in 2015-2019.
- Authorities responsible for the performance of those tasks:
 - Task 1 - Minister of the Economy, Minister of State Treasury, Minister of Science and Higher Education, appropriate local government authorities,
 - Task 2 - Minister of the Economy, operator of the transmission system,
 - Task 3 - Minister of the Environment, Minister in charge of maritime economy, General Inspector for Environmental Protection.

6.3. "Investment facilities" - executive programme

Programme objective:

Creation of system conditions for a reasonable and efficient performance of development, execution and exploitation actions associated with the offshore wind farm projects.

Major Programme actions:

1. Determination of locations for the OWF projects in the II round - 3 GW to be executed in 2025-2030 by:
 - a. preparing and adopting the spatial development plan for the maritime areas, including the exclusive economic zone, in order to indicate the areas for the second round of OWF location selection and for the infrastructure corridors for the offshore grids,
 - b. carrying out the strategic environmental impact assessment of the spatial development plan for the maritime areas.

2. Associating the locations available for the OWF from the II round with the grid connection conditions by:
 - a. verifying, on the basis of previously adopted amendments to the Energy Law, the already issued connection conditions, cancelling the connection conditions for the projects without any chances for execution,
 - b. determining the connection capacity available for the OWF on the basis of the NREAP or the Energy Policy of Poland,
 - c. specifying the connection conditions for wind farms, which may be executed within the locations of the II round.
3. Tender procedures for location decisions and grid connection conditions for the OWF from the II round, which aim at selecting investors guaranteeing the optimum economic conditions for the execution of the investments within the given locations.

Schedule:

- Action 1 should be carried out in 2014-2015. Authority responsible for the performance of this action: Minister in charge of maritime economy.
- Action 2 should be carried out in 2014-2015. Authority responsible for the performance of this action: Minister of the Economy and the transmission system operator.
- Action 3 should be carried out in 2016-2017. Authority responsible for the performance of this action: Minister in charge of maritime economy.

7. Managing the implementation of the Programme

Preparing a programme and implementing the development of a new branch of industry, i.e. the offshore wind energy and the offshore industry associated with it, requires a coherent management system. Unfortunately, the scope of actions necessary to be taken is very wide and it covers the competence of numerous state and local administrative bodies and their subordinate institutions. Therefore, all actions associated with managing the Programme should be carried out at various levels of administration.

7.1. Management at the national level

We suggest to appoint an interministerial group for the implementation of the Polish offshore wind energy and maritime industry development programme, which would consist of the representative of the following Ministries and institutions:

1. Ministry of the Economy - chairman of the team, Government representative for the programme implementation issues,
2. Ministry of Transport, Construction and Maritime Economy - vice-chairman of the team,
3. Ministry of State Treasury,
4. Ministry of Regional Development,
5. Ministry of the Environment,
6. Pomeranian Voivodeship Office in Gdańsk,
7. West Pomeranian Voivodeship Office in Szczecin,
8. Pomeranian Voivodeship Marshall Office,
9. West Pomeranian Voivodeship Marshall Office,
10. Polish Agency for Enterprise Development,
11. Polish Information and Foreign Investment Agency,

12. Industrial Development Agency,
13. National Fund for Environmental Protection and Water Management,
14. transmission system operator.

The Group would be involved in the approval of the scope of major executive actions, the methods and schedule of their performance and in the coordination of those executive actions.

7.2. Management at the regional levels

At the regional levels we recommend the appointment of Voivodeship Marshal's representatives to be responsible for the management over the executive actions included in the competence of the regional self-governments. The Marshals could appoint working groups, which could consist of the representatives of the following institutions:

1. Marshal Office,
2. Voivodeship Office,
3. Maritime Offices,
4. port management,
5. commune self-government,
6. Regional Directorates for Environmental Protection,
7. offshore industry,
8. investors.

The Group would be involved in the approval of the scope of major executive actions, the methods and schedule of their performance and in the coordination of those executive actions.

7.3. Monitoring and reporting

Monitoring the implementation of the Programme should be carried out by the interministerial group that would prepare a report on the progress every half a year. The report should be presented at the Government meeting and at the meetings of appropriate parliamentary committees. The report should be prepared on the basis of information presented by representatives of particular institutions (members of the group) and by the representatives of the Voivodeship Marshals.

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Foundation for Sustainable Energy

Al. Wilanowska 208 lok. 4, 02-765 Warsaw, Poland

t. +48 (22) 412 24 92, f. +48 (22) 205 05 76

www.fnez.org

www.offshorepoland.eu

www.windenergyimpacts.com