FOCUS ON POMERANIA

Maritime Report 2023

Invest in Pomerania

Source: Image courtesy of Port Gdańsk/ Photo by Tomasz Dresler

The statement that the maritime industry is one of the key sectors of the global economy seems to be a truism, a statement so obvious that it is not worth mentioning. Nevertheless, what do we mean by the maritime industry?

Table of contents_

You cannot talk about Pomerania without taking into account its coastal location. The Baltic Sea is the driving force of the local economy.

The region has dynamically developing ports and an experienced shipbuilding sector. Gdańsk is already the largest container port on the Baltic Sea and our shipyards design and build specialized ships using the most modern and innovative technologies. Soon, the specialization of the regional economy will also include offshore wind energy, the development of which will contribute to the energy transformation of the country.

I am convinced that Pomeranian companies with their competences and experience will actively participate in the development of this sector.

Mieczysław Struk

Mieczysław Struk, Marshal of the Pomeranian Voivodeship

Introduction_

Foreword_

TObecnie 90% światowych ładunków transportowanych jest na falach [1]. Transport morski oferuje korzyści skali, które dzisiejsze korporacje i mniejsze przedsiębiorstwa wykorzystują na niespotykaną dotąd skalę. Ponadto oczekuje się, że do 2050 r. wielkość transportu morskiego potroi się [2].

Transport to jedno. Z drugiej strony morza i oceany od wieków były miejscem, z którego człowiek czerpał nieograniczone zasoby. Do drugiej połowy XX wieku były to głównie ryby. W latach 70. kryzys paliwowy i gwałtowny skok cen węglowodorów, zwłaszcza ropy naftowej, dały impuls do rozwoju sektora offshore oil & gas. Morza stały się przedmiotem eksploracji i niezwykle ważnym źródłem paliwa dla światowej gospodarki. Kolejnym etapem jest niewątpliwie problem globalnego ocieplenia i poszukiwania alternatywnych źródeł energii. Tutaj znów morza były w stanie zaoferować energię fal (w tej chwili na mniejszą skalę) i przede wszystkim wiatry przybrzeżne.

Tylko w 2021 roku do sieci przyłączono ponad 21 GW mocy morskiej energetyki wiatrowej, a plany na najbliższe lata są niezwykle ambitne [3]. Koncentrując się tylko na Europie: w ramach Deklaracji z Esbjerg Dania, Niemcy, Belgia i Holandia zobowiązały się do podłączenia 150 GW do 2050 r.; Polska podłączy do 2040 roku ponad 11 GW, potencjał rozwojowy Bałtyku do 2050 roku szacuje się na ponad 90 GW, Norwegia uruchamia program offshore wind [4]. Warto również wspomnieć o ogólnym postępie technologicznym światowego przemysłu oraz rosnącym zapotrzebowaniu na takie pierwiastki jak złoto, srebro, miedź, mangan, cynk czy kobalt – tutaj ponownie dno morskie oferuje szerokie możliwości poszukiwawcze.

Okoliczności kształtujące obecne trendy w branży morskiej mają różny charakter. Wspomnieliśmy już o globalnym ociepleniu, które napędza nowe sektory i technologie, w tym napęd niskoemisyjny. Obecnie tylko 5% światowej floty, napędzane jest paliwami alternatywnymi wobec ropy naftowej, choć aż 40% nowych zamówień na statki obejmuje napęd niskoemisyjny [5]. W tym kontekście kluczowa jest rola regulatora, który wymusza wdrażanie nowych rozwiązań. Wystarczy wymienić takie akty prawne, jak Dyrektywa Parlamentu Europejskiego w sprawie zawartości siarki w paliwach żeglugowych, czy Zasady Posejdona przyjęte przez IMO, aby zmusić instytucje finansowe do ścisłego monitorowania, czy portfele flot są zgodne z celem klimatycznym, jakim jest ograniczenie efektu cieplarnianego emisji gazów z sektora morskiego o 50 % do 2050 r. [6].

Inną okolicznością silnie wpływającą na sytuację sektora jest również naturalna cykliczność gospodarki i jej silny wpływ na transport morski - w szczególności zmienny poziom zamówień, który obecnie skutkuje szybkim starzeniem się floty. Na przykład

średni wiek masowców wzrósł z 8,7 lat w 2018 r. do 11,4 lat obecnie; kontenerowce – od 11,6 do 14,1 lat [7]. Innymi słowy – w najbliższych latach poziom zamówień musi wzrosnąć.

Duże znaczenie ma również geopolityka. Doskonałym przykładem jest wojna na Ukrainie, która dała państwom europejskim dodatkowy impuls do rozwoju morskiej energetyki wiatrowej w celu jak największego uniezależnienia się od rosyjskich węglowodorów. Jednocześnie zasadniczo zakończyły się dyskusje na temat ograniczenia nowych projektów offshore oil&gas, a nowe projekty związane z terminalami LNG nabrały istotnego znaczenia strategicznego.

W tym kontekście warto również wspomnieć o silnym nastawieniu na ochronę rodzimego przemysłu stoczniowego, co można zaobserwować w takich krajach jak Stany Zjednoczone czy Chiny. Jones Act czy elastyczne metody finansowania dostępne chińskim stoczniom skutecznie wzmacniają lokalną produkcję (obecnie Chiny odpowiadają za ponad 40% światowej produkcji) [8]. Otwarte pozostaje pytanie, czy Europa również pójdzie tą drogą. Jeśli chodzi o Chiny, należy wspomnieć również o drugiej stronie sprawy – dwuletni lockdown i de facto brak możliwości odwiedzania chińskich stoczni przez zagranicznych armatorów znacząco wpłynął na nastroje, a branża zaczęła głośniej mówić o powrocie produkcji do Europy. Jak wiemy, sytuacja związana z pandemią w Chinach jest dynamiczna i w tej chwili nie można powiedzieć, w jakim kierunku będzie się rozwijać.

Biorąc pod uwagę skalę problematyki branży morskiej, w naszym raporcie postanowiliśmy przyjrzeć się tylko niektórym zjawiskom, a mianowicie tym, które naszym zdaniem oraz w opinii przedstawicieli branży, którzy wzięli udział w badaniu, mają największy wpływ na funkcjonowanie sektora morskiego na Pomorzu. Dlatego w raporcie przyjrzymy się, jak obecnie rozwijają się biura projektowe w Trójmieście oraz jakie typy jednostek pływających i konstrukcji opracowują lokalni inżynierowie. Przeanalizujemy światowe trendy w budowie nowych statków i zastanowimy się, jak kształtują one pomorski przemysł stoczniowy.

Zagłębimy się w tematy związane z niskoemisyjnością statków, rozwiązaniami autonomicznymi, a także nowoczesnymi technologiami w kontekście dronów, Internetu Rzeczy i przetwarzania danych, cyberbezpieczeństwa czy wykorzystania VR. W raporcie piszemy również o sektorze jachtowym, który tradycyjnie analizowany jest oddzielnie od przemysłu morskiego, ale naszym zdaniem wpisuje się w obraz gospodarki morskiej. Oczywiście w naszej publikacji nie zabrakło również prezentacji szkolnictwa wyższego i zawodowego, a także analizy rynku pracy pod kątem potencjału lokalnego przemysłu do dalszego rozwoju i akomodacji inwestorów zewnętrznych.

Methological note_

When we decided that the subject of the next FOCUS ON report would be the maritime sector, we faced the difficult task of defining this capacious term in detail. As a result of further analyzes and discussions with our experts, we have selected several sectors of the maritime economy that are crucial for the Pomeranian economy. They include: (1) ship and offshore structure design and engineering services; (2) shipbuilding sector and (3) offshore wind energy sector. We have also added (4) yachting industry to the above mentioned, which - although nominally not part of the shipbuilding sector - is one of the significant competitive advantages of Pomerania. Of course, it is impossible to talk about the maritime economy without mentioning the port infrastructure and transport related to the service of port terminals.

We analyzed the sectors we selected through the prism of the main trends transforming the maritime sector. Sea Europe (an organization associating European shipyards, manufacturers and sub-suppliers to the maritime sector) lists here, among others: the progressive digitization of the sector (including automation and autonomous solutions), meeting the more stringent environmental requirements presented in the legislation, e.g. Fit-for-55 (decarbonisation of the sector) and preparation of future personnel of the maritime sector for the challenges related to the transformation and digitization of the sector.

As the basic research method, we adopted direct interviews with companies operating in Pomerania. Key companies and institutions representing the maritime sector in the region received direct invitations to interviews. It was also possible to apply for the project through announcements in Invest in Pomerania social media. A list of all entities is presented on page XX. Information obtained from our partners is the axis around which the report was created. In the report, our interlocutors comment on the most important trends in the sector, indicate directions for action and predict the shape and role of the local sector in the global one .

We obtained the data presented in the report from many different sources, including: press articles in specialist media, companies' own materials, research and analytical reports of institutions dealing with the maritime market and statistical data collected by various entities. One of the most important sources in the context of statistical data for us was the „Statistical Yearbook of Maritime Economy 2022" published by the Central Statistical Office in December 2022.

Acknowledgements_

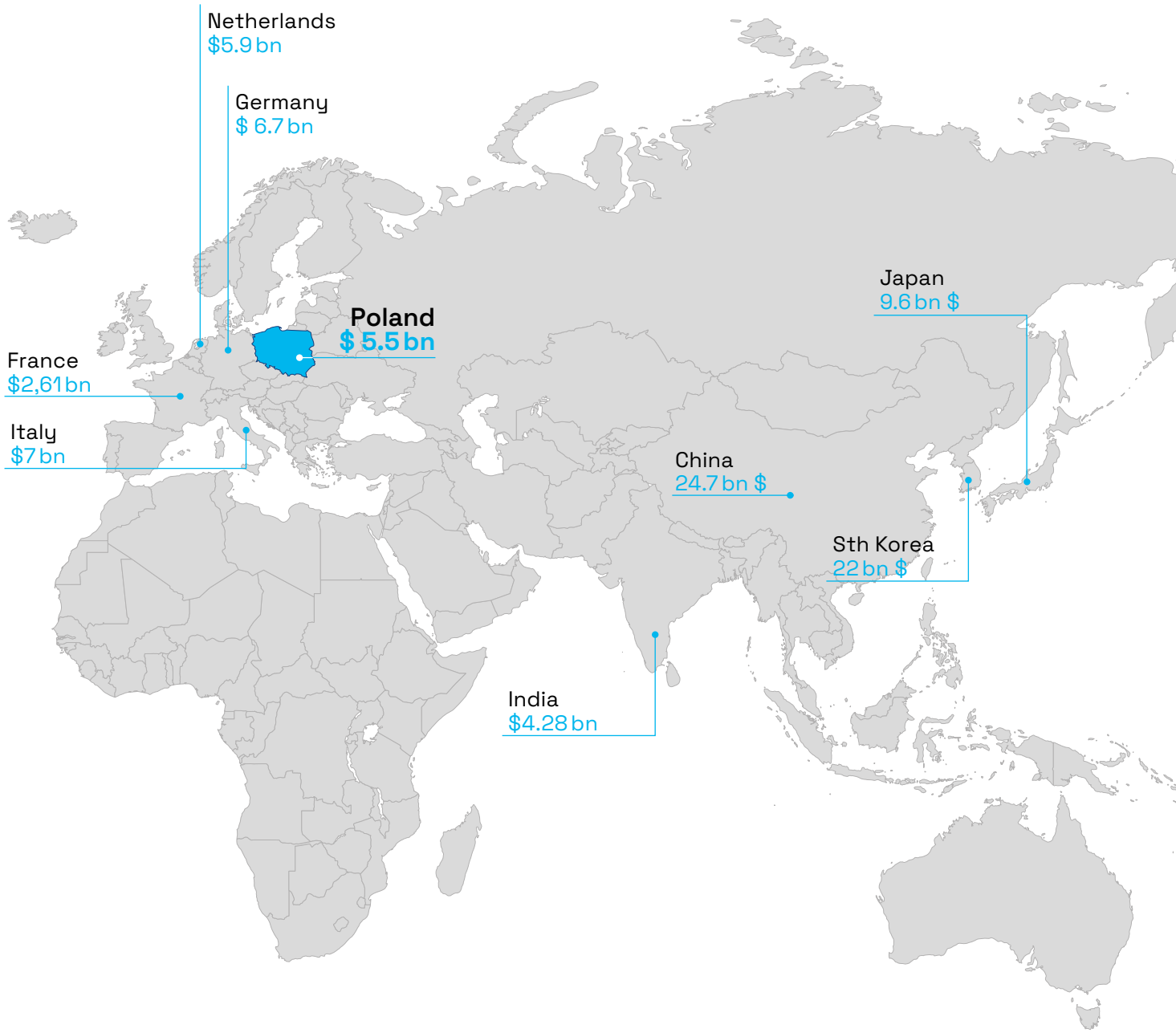
We would like to thank all Partners to the report who shared their expert knowledge on the maritime sector with us and responded to our questions during interviews. The report was created in cooperation with:

Source: Image courtesy of Port Gdańsk/ Photo Tomasz Dresler

01

Economic Outlook_

Top 10 countries in the world in terms of the value of exports of sea vessels and floating structures in 2021_



A2

FTSE Russell rating for developed economies as of 2018

1

EU region in terms of job creation by FDI investors

4.9%

GDP growth in 2022 compared to the previous year

Source: www.trademap.org

4

Poland's position in Europe
in terms of FDI inflow

7

Poland's position in the world
in terms of exports of ships. boats
and floating structures

1.1 Characteristics of Poland and Pomerania compared to the Europe and the rest of the world

Poland is the largest economy in Central and Eastern Europe. Since 2018, Poland belongs to the group of developed economies (FTSE Russell) with a stable rating of A2 (Moody's) [1]. It has also been qualified to the group of countries with the most friendly conditions for doing business and investing (Ease of doing business) [2]. In 2022, Poland's GDP was 4.9% higher than in the previous year (according to preliminary estimates of the Central Statistical Office) [3]. Poland is one of the most important markets in terms of FDI inflows in Europe. In 2021, it was ranked 4th in terms of capital invested as part of FDI and the number of projects. At the same time, it ranks first in terms of new jobs created by foreign investors (FDI report 2022) [4].

The maritime sector drives the economy of the whole country. Poland ranks 4th in Europe and 7th in the world when it comes to the value of exports of ships, boats and constructions floating. In 2021, the value of exports reached over $5.5 billion. This is an increase of approximately 86% compared to 2019 [5].

Pomerania has received multiple FDI Intelligence awards, most recently for „Mid-Sized European Region of the Future 2023 - FDI Strategy" and „Business friendliness".

The Pomeranian Voivodeship is located in the northern part of Poland the coast of the Baltic Sea. Strategic location of the region and dynamically developing seaports in Gdańsk and Gdynia, actively support the development of the maritime industry. In terms of GDP growth dynamics, Pomerania is one of the fastest growing regions in the country. A wide transport network, including the airport Lech Wałęsa in Gdańsk, an extensive railway network from the Tricity ports (3x more containers are transported by rail compared to 2012) [6], the presence of the world's leading concerns and the concentration of qualified staff enable the development of exchange international and attract foreign investors.

2,3 mln
inhabitants of the Pomeranian voivodeship [7]

1,6 mln
inhabitants of Tricity agglomeration

21 bn
GDP growth between 2020- 2021 (PLN) [8]

15,8 %
GDP growth rate

Source: own study based on available data from the Central Statistical Office

1.2 Ports in Pomerania - The Baltic transshipment hub_

The maritime sector is one of the key, priority industries for the Pomeranian Voivodeship. The region's greatest advantage are the two international seaports in Gdańsk and Gdynia, which are of fundamental importance to the national economy. They are part of the TEN-T Trans-European Transport Network, do not freeze in winter and are able to accommodate the largest floating vessels in the world.

A dense network of shipping (feeder) connections allows for regular deliveries by sea to Scandinavian countries and ports in the North Sea basin. Moreover, ships from China call at the Port of Gdańsk twice each week. 2022 was a record year for transhipments in the Tricity ports, mainly due to the transhipment of energy resources. According to the ex-CEO of the Port of Gdańsk, Łukasz Greinke, there has not been a port in Europe in the last decade that saw such an increase in transhipment as the port of Gdańsk. This is the result, among other things, of investments in upgrading the quays in the Inner Port [11].

The Port of Gdynia also recorded a year-on-year increase of 6%, making 2022 a record year for the port in terms of handled cargo. At the same time, the Port of Gdynia is a leader among the Baltic ports in terms of grain cargo [12].

The Pomeranian ports also hold a leading position in the Baltic Sea region in terms of container handling measured in TEUs. This is thanks to the Baltic Hub, Poland's largest container terminal, which has been in operation since 2007.

Pomeranian Ports in numbers_

58 765

employees in the maritime sector in the Pomeranian Voivodship [9] (37% of employment in Poland)

8 614

maritime sector entities registered in the Pomeranian Voivodeship [10] (42% of all maritime economy entities in Poland)

68.2 bn t

transshipment at the Port of Gdańsk in 2022 [13]

28.2 bn t

transshipment at the Port of Gdynia in 2022

83%

increase in transshipments at the Port of Gdansk [14] (over the past 6 years)

Source: own study based on data from the Ports of Gdansk and Gdynia Authority.
Photo courtesy of the Port of Gdansk / Photo by: Tomasz Dresler

Baltic Hub in 2022_

2.07 mln
the total amount of transshipments (TEU)

4.5 mln
planned increase in operational capacity (TEU) by 2025 [15]

100
number of the world's 100 largest container ships docked

662
number of ships served

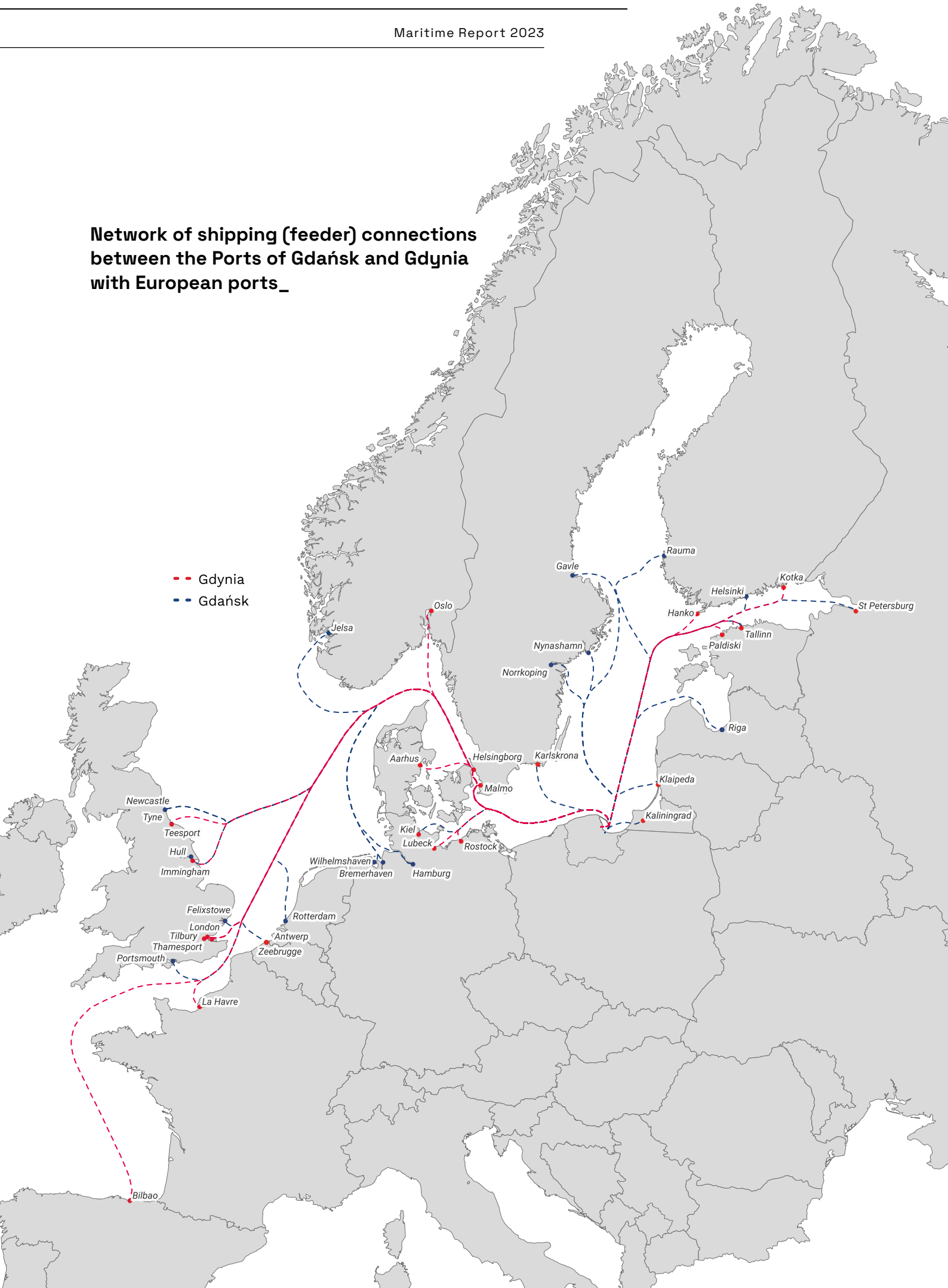
447 000
number of loaded trucks

6 860
number of loaded trains

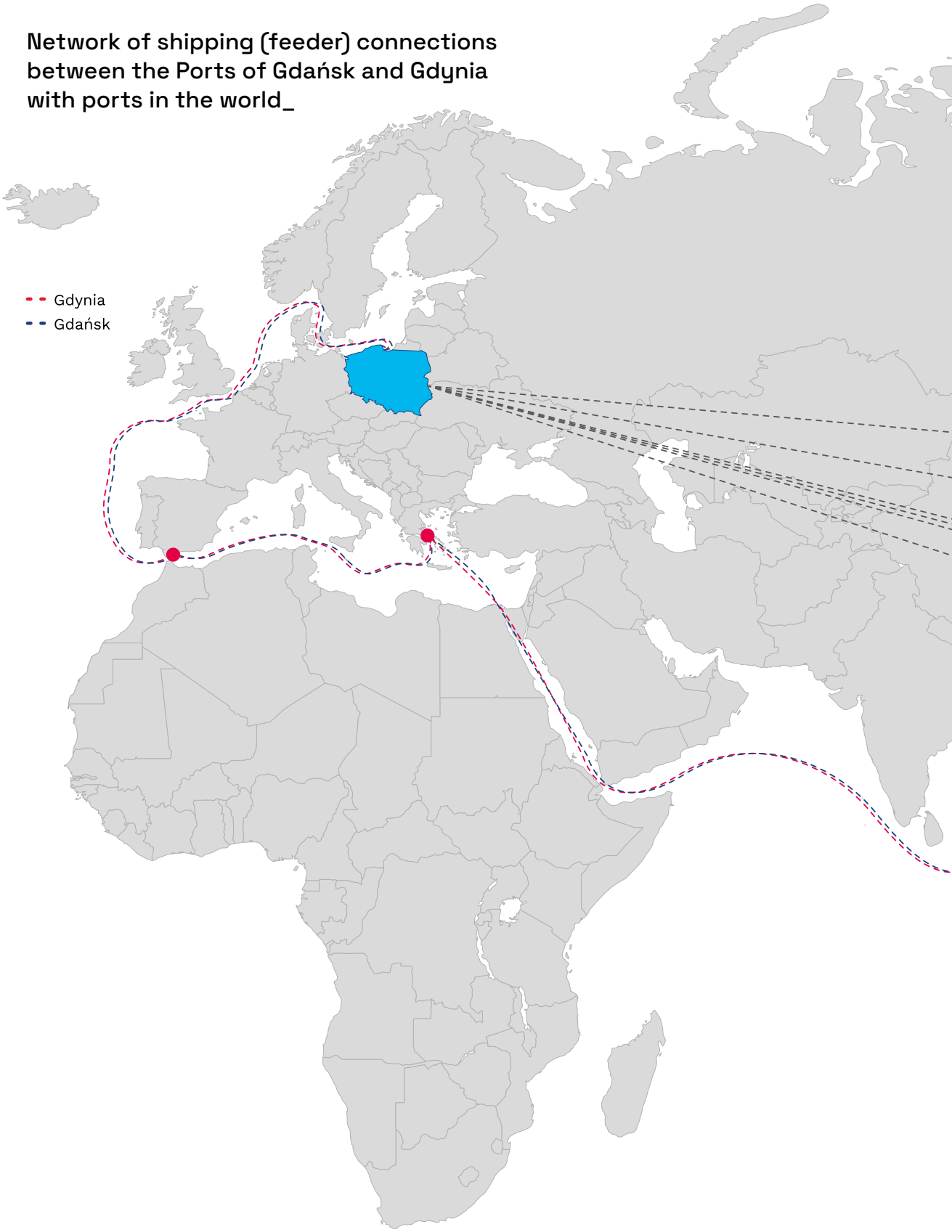
Source: www.gdansk.pl [15]

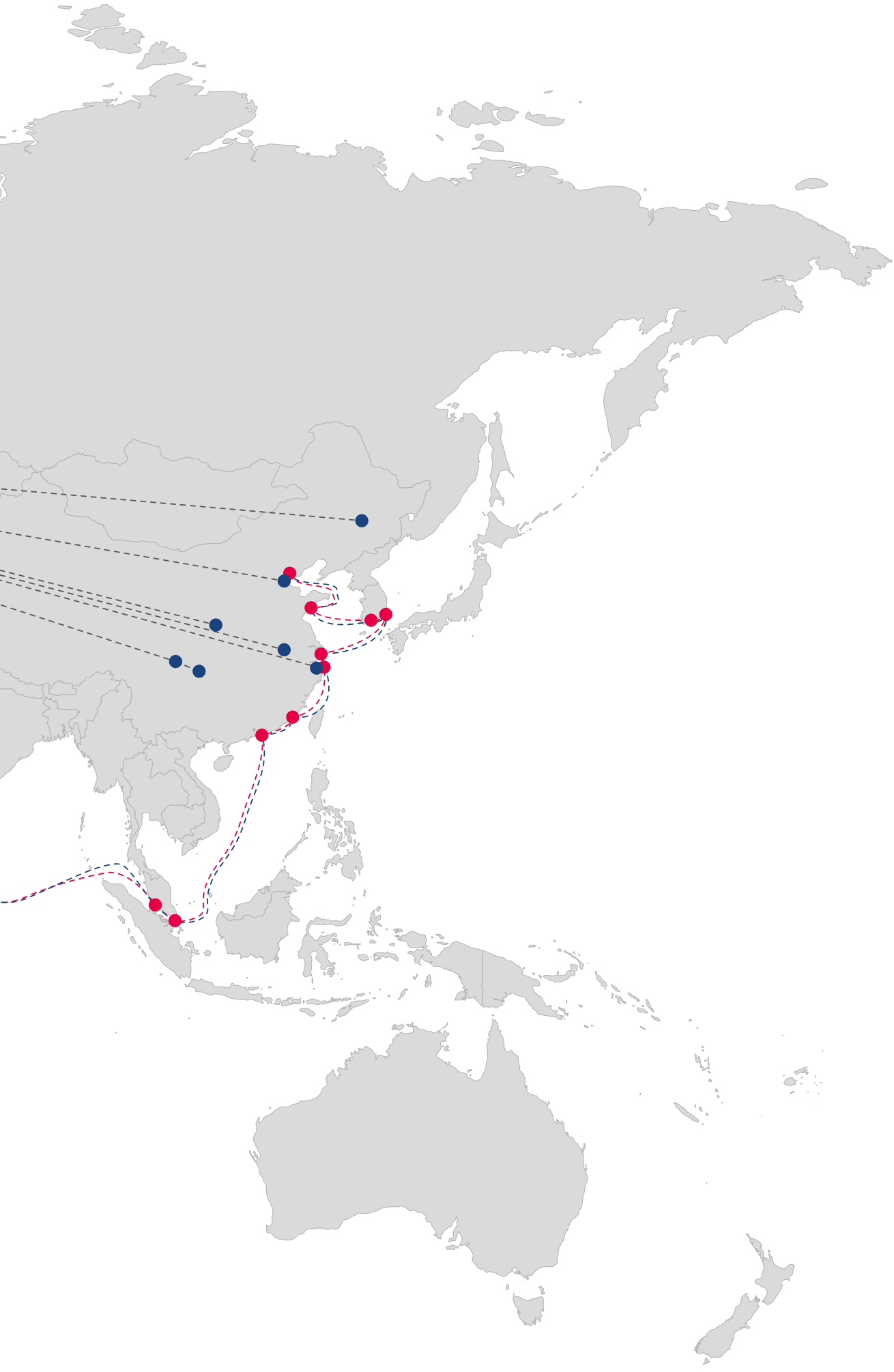
Source: Image courtesy of Baltic Hub DTC Gdańsk

Network of shipping (feeder) connections between the Ports of Gdańsk and Gdynia with European ports_



Network of shipping (feeder) connections between the Ports of Gdańsk and Gdynia with ports in the world_





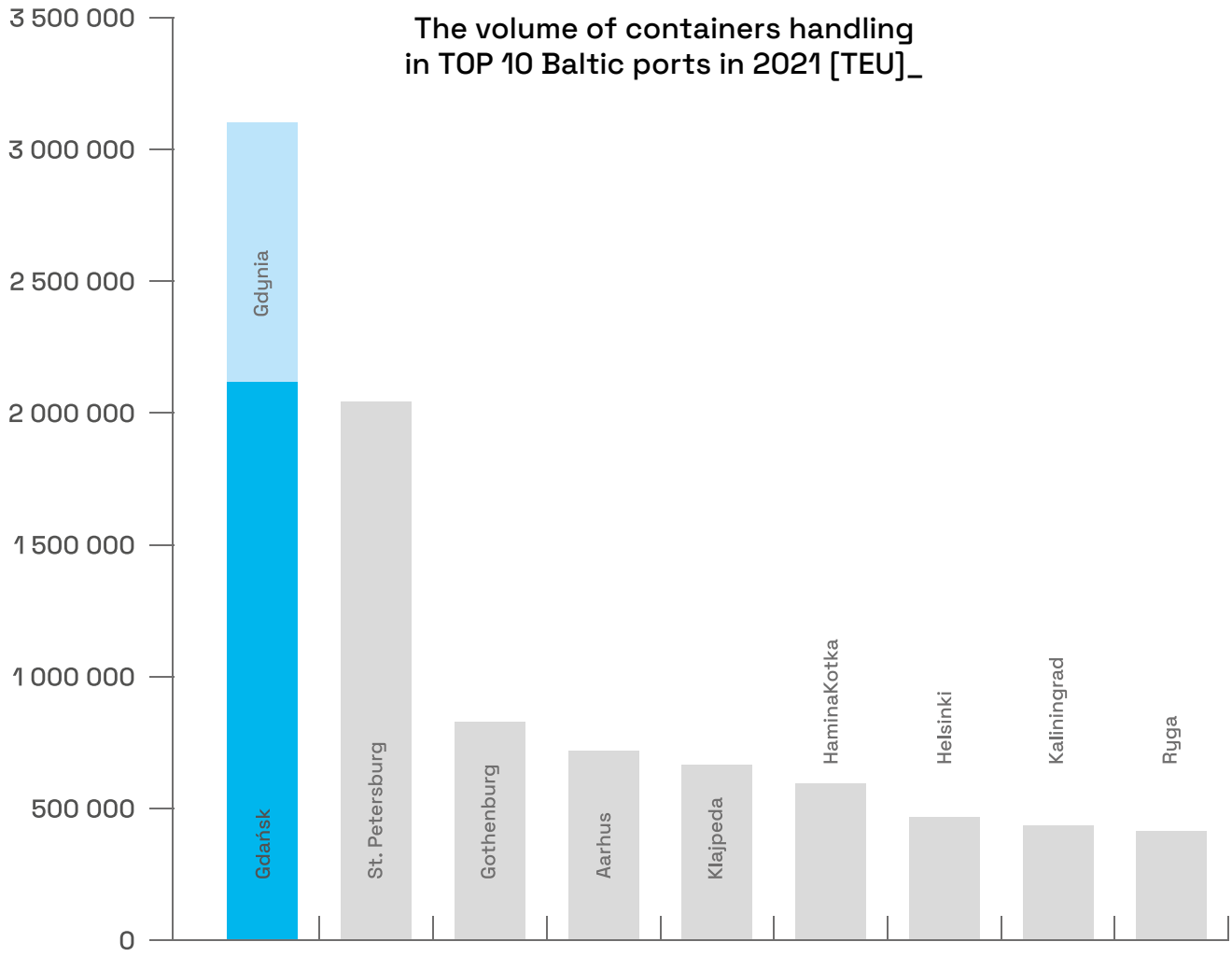
Transshipment at the Port of Gdynia and Gdańsk_

	2017	2018	2019	2020	2021	2022	
Gdynia	21.2	23.4	23.9	24.6	26.6	28.2	mln t
Gdańsk	40.6	49	52.2	48	53.2	68.2	

	2017	2018	2019	2020	2021	
Gdynia	0.7	0.8	0.89	0.9	0.9	mln TEU
Gdańsk	1.5	1.9	2	1.9	2.1	

Source: own study based on data from the Seaports Authorities in Gdańsk and Gdynia

The volume of containers handling in TOP 10 Baltic ports in 2021 [TEU]_



Source: own study based on the Actia Forum report „Cargo throughput in Top 10 Baltic ports in 2021 - rebound after tough 2020" February 2021

1.3 Key areas of the maritime sector in Pomerania

Due to its coastal location and with the development of the Port of Gdańsk and the Port of Gdynia, an ecosystem of local and international companies from the broader maritime sector has developed naturally in Pomerania.

Its most important part is the shipbuilding industry. The first vessel designed and launched at the Gdynia Shipyard was in 1931 [16]. Whereas the history of the modern shipbuilding industry in Gdańsk dates back to the early 19th century.

Until the 1990s, the Tricity shipyards produced transatlantic liners; intercontinental 10,000-tonne tankers - the first 10,000-tonne vessels; tankers; 12,000-tonne general cargo carriers; panamaxes, featuring a cinema, sauna and swimming pool, which was considered extremely modern (1970); and container ships, with a vessel built in 1992 considered the largest to have sailed from the Tricity shipyards [17].

The current changes on the shipbuilding market, including the growing importance of Asian countries in the production of large vessels, have led to changes in the area of specialisation of Pomeranian shipyards (for more on the shipbuilding sector, see Chapter 3. Shipbuilding industry).

Legislative changes to reduce CO2 emissions, continuous technological advances and implementation of innovations in the sector, worldwide development of the offshore sector and cost reductions associated with shipping are forcing shipowners to replace or upgrade their fleets to meet current environmental requirements.

These requirements are already being and will continue to be implemented in the Pomeranian shipyards (for more on the requirements for low-carbon shipping, see Chapter 4. Towards sustainable shipping).

The shipbuilding industry has also driven the ship design sector (more in Chapter 2. Pomeranian design hub). The yachting industry is also one of the region's main areas. Poland ranks 5th in Europe in terms of yacht exports. It was worth more than $943 million in 2021 (for more on the yachting industry in Pomerania, see Chapter 6. Yachting industry) [18].

The last 10 years have also seen rapid growth of the Modern Business Services sector in Pomerania. The region is becoming home to an increasing number of offices of major Fortune Global 500 companies, including key players in the shipping sector. Both Ocean Network Express and Hapag Lloyd not only operate deep-sea connections from Pomeranian ports, but have also opened business centres in the Tricity.

I think Poland has an absolutely strong position when it comes to the quality of its shipyards. Polish operators are among the best in Europe when it comes to steel processing, welding, quality and accuracy of documentation.

Moreover, Pomerania in particular is ideally placed logistically when it comes to activities related to, e.g., the development of offshore energy facilities in the Baltic Sea.

- **Malte Paul**, senior project manager,
Maintstream Renewable Power, an Aker Horizons company

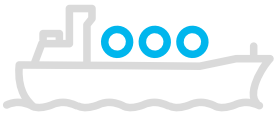
The world's leading classification societies - DNV, Lloyds Register and the American Bureau of Shipping - have also invested in the region. DNV office in Gdynia employs more than 200 engineers and its activity is not limited to certification alone. The office provides training services, supervision over new construction sites and offers access to DNV tools and databases. There is also a Drone Centre in Gdynia (see page 117).

Classification societies include the Polish Register of Shipping, which conducts independent surveying activities on the international market. There are two major research and design centres in the regioat: Maritime Advanced Research Centre (Centrum Techniki Okrętowej S.A.) (CTO) and Centre for Maritime Technology (Centrum Techniki Morskiej) (CTM). There are also two key organizations associating employers in the shipbuilding sector in Pomerania: The Association of Polish Maritime Industries FORUM OKRĘTOWE, which is a member of SEA Europe, and the Polish Forum of Marine Technologies.

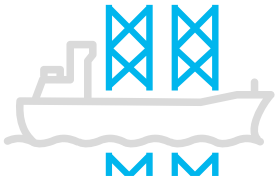
Our speciality are sophisticated projects and the demand for human creative thought will always be there. As a region, we have a huge engineering resources and the potential in the companies that want to grow

- **Jerzy Czuczman**, president of the board,
Polish Forum of Marine Technologies

Top 5 types of vessels produced in Pomerania_



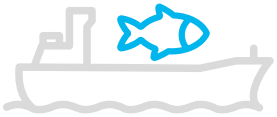
Cable-layers



Heavy lift Jack-ups

Yachts

Ro-Pax Ferries



Fishing vessels

> *The choice of the Tricity as a location is no coincidence. The hub in Gdańsk will be a key link in ONE's processes and will also take over various support tasks carried out for clients in Europe.*
>
> - **Reiner Zimbalski**, director of the Gdańsk operations centre, ONE [19]

CTO S.A. is a multidisciplinary R&D center with modern equipment and laboratories. The CTO is a partner of shipyards and design offices both at the initial stage and during the delivery and acceptance tests of the units. At the initial stage, CTO S.A. conducts computational analyzes and model tests of ships and offshore structures.

Their purpose is to provide the designed floating units with the assumed operating parameters and safe operation in changing environmental conditions at sea. At the stage of delivery and acceptance tests, CTO S.A. is responsible for conducting a number of tests of individual contractual parameters of the unit, such as speed, power, vibration and noise levels, lighting, etc.


Design
StoGda Ship Design & Engineering
HAV Design Poland
Ulstein Poland
Galliot Marine Design
Choreń Design & Consulting
Elbumed Marine
Deltamarin
Damen Engineering
Seatech Enigneering
Seacon Engineering
NAVA Ship Design Office
Nelton
Remontowa Marine Design
BOTA Technik
Biprograf Projmors
(Grupa Technologiczna ASE)
Semco Maritime
Transport and Logistics
Baltic Hub
Langowski Logistics
C.Hartwig Gdynia SA
Erontrans
Omida Sea and Air S.A.
VGL Solid Group
Cargofruit
ATC Cargo S.A.
PKS Gdańsk-Oliwa S.A.
SKAT Transport
Balticon S.A.
Adampol
Cosco Shipping Lines (Poland) Sp z o. o.
DSV Solutions Sp. z o.o.
DSV Road
DSV Air&Sea
PKP Cargo
DB Schenker
Offshore
Siemens Gamesa
Equinor
Polenergia
RWE
Orlen
Northland Power
Technology and R&D
Polskie Forum Technologii Morskich
Polskie Towarzystwo Morskiej Energetyki Wiatrowej
MEWO
Grupa Pomiarowa Echogram
Marine Technology
Pelixar
Sea Data
DAC.digital
Blue Dot Solution
F44
NNT
Centrum Techniki Okrętowej (CTO)
Societies and Institutions
DNV
Lloyds Register
American Bureau of Shipping
Polski Rejestr Statków
Forum Okrętowe
Polish Wind Energy Association

Rohlig Suus Logistics S.A.
Agencja celna
Savino Del Bene Poland
CTL Logistics
Terramar
Spedcont
Loconi Intermodal
PCC Intermodal
Uni Logistics
JAS-BFG Logistyka
Kuhne-Nagel
Hapag-Lloyd
MSC
Ocean Network Express
Unifeeder
Maersk Polska
Rhenus Port Logistics Sp. z o.o.

Mag Offshore
Orsted
Agencja Rozwoju Przemysłu
Baltic Towers
Industrial Development Agency JSC

Suppliers

Hydromega

Drew-Nauta
Famor
An-Elec
HG Solutions
Marine Teknik

Shipbuilding

Stocznia Rybacka Spawmet
Mar-Ship
PC POL SHIPPING
Stal-Rem
Nauta
Damen Shipyards
Karstensen Shipyard
Stal Complex
PGZ Naval Shipyard
Timoro
DAKAR Budowa i Remonty Statków
Baltic Engineering
Marine Projects

Remontowa Holding
CRIST S.A.
Safe
Grupa Przemysłowa Baltic
Montex Shipyard
Stocznia Wisła
Alusip Technology

Yachts

Sunreef Yachts
Conrad Shipyard
Galeon
Sportis
Damen Shipyards
Algro Yachting
Jabo
Yachtfinishing&Repairs
Alusip Technology
ALU International Shipyard
SM Europe
TES Yacht
Airmech Marine Equipment
Techno Marine
Yacht Concept

1.4 Offshore Wind

Offshore Wind Energy remains one of the areas whose development will be a key factor in determining the growth dynamics of the offshore sector.

Currently, 54.9 GW of offshore wind power capacity has been installed worldwide. Globally, the key markets remain Europe and China and, looking ahead to the next few years, the extremely dynamic US market [20].

28.4 GW
offshore wind energy generated
in Europe in 2022 r.

660 GW
offshore wind energy generated globally
forecast for 2050
by McKinsey [21]

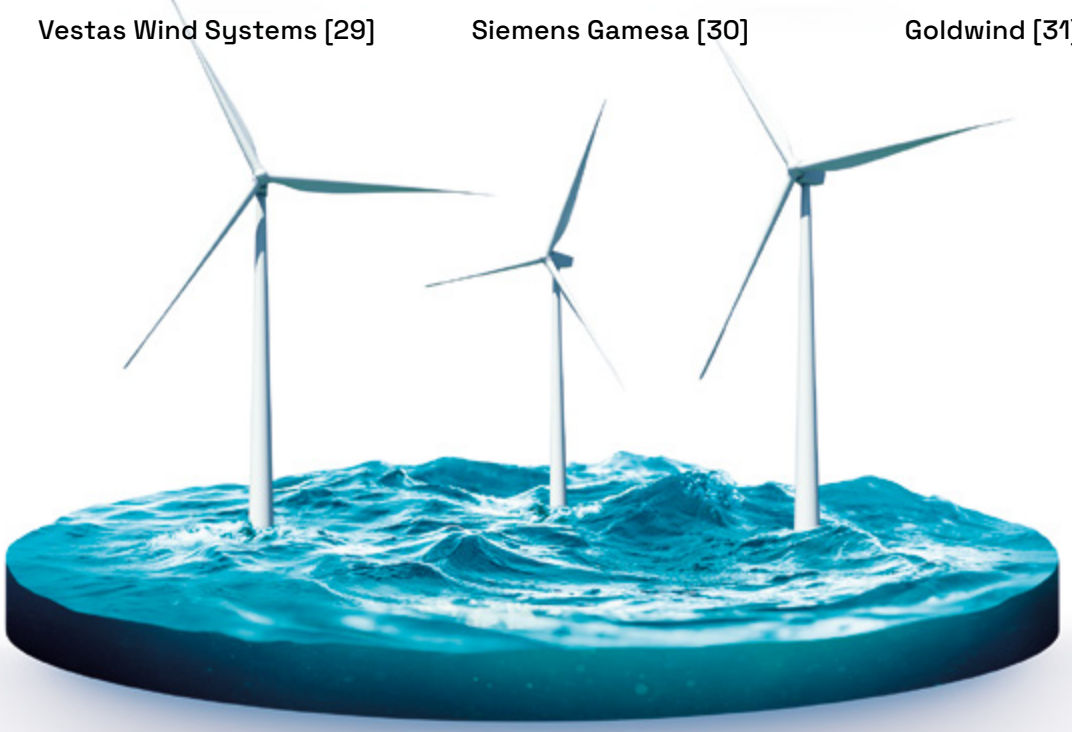
160 GW
offshore wind energy generated
forecast for 2030 **[22]**

The largest turbine manufacturers in terms of installed capacity_

+160 GW
Vestas Wind Systems [29]

122 GW
Siemens Gamesa [30]

92 GW
Goldwind [31]



Looking further ahead, the development of the sector in Europe is much more ambitious, just to mention the announcement by Germany, Belgium, the Netherlands and Denmark to connect to the grid up to 150 GW from offshore wind by 2050 [23].

Meanwhile in China, Offshore Wind Power delivers 24.9 GW (data as of mid-2022). In the first half of 2022 alone, the Chinese connected 5.1 GW to the grid [24]. The US market also looks extremely promising. Although underdeveloped for the moment (as of mid-2022, only 42MW of installed capacity), it is expected to grow to 30 GW by 2030 [25].

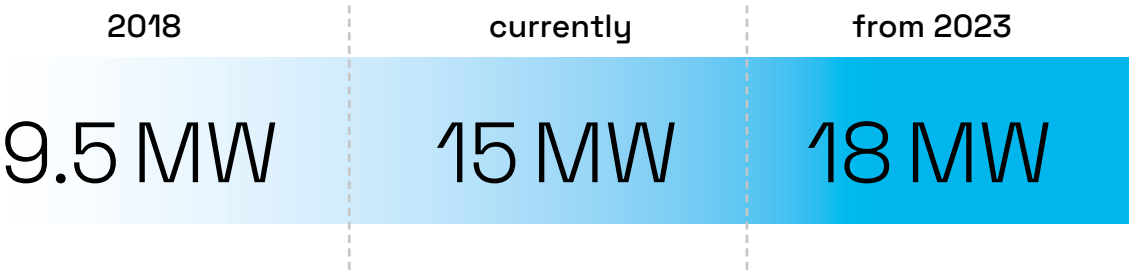
New trends and technologies

Market development is naturally coupled with technology development. On the one hand, increasingly larger turbines are being installed. In January 2023, Chinese company CSSC Haizhuang unveiled an 18 MW turbine design driven by a 260-metre rotor [26].

It should be noted that currently contracted turbines reach a capacity of 13 MW. Whereas the prototypes - 15 MW. This is the power achieved by a turbine installed this year at the Danish research centre in Osterlid. The turbine was manufactured by Vestas [27]. In 2018, the average capacity of installed turbines was 6.8 MW, with the largest reaching 9.5 MW, showing how fast the sector is evolving [28].

The production of increasingly powerful turbines is forcing technological changes in offshore wind farm construction systems, posing major challenges for jack-up vessel manufacturers in particular (See page 83).

Average capacity of installed turbines



The floating trend is also developing. It is forecast that 5.9 GW will be installed globally from floating wind farms by 2030. By 2035, generation capacity will reach 25.2 GW. Europe will be the dominant market [32]. With such rapid development of the industry, demand for offshore wind components and services can be forecast to grow just as rapidly.

The market for turbines alone is expected to grow at a rate of 8.2% (CARG) to reach US$40 billion by 2031 [33]. Meanwhile, the sector is facing additional challenges created by rising gas prices. In the second quarter of 2022 alone, Siemens Gamesa's revenues fell by 10% year-on-year. Whereas Vestas struggled to balance costs to avoid recording a loss [34].

The first wind farms will be built at the shoal area near Słupsk.

The crisis related to the global COVID-19 pandemic and the war in Ukraine is strongly affecting the supply chains around the world. Macroeconomic factors, including high prices of energy and raw materials that fuel inflation and increase the cost of implementing the projects, are also a challenge.

In the new geopolitical reality, it is clear that renewable energy sources will be one of the key issues shaping the new order in terms of energy security in Poland and the entire Europe. As a result, faster decarbonization has become a priority in many countries.

In order to enable the efficient development of renewable energy projects, many countries, such as Great Britain, simplify and accelerate the procedures for obtaining the necessary administrative decisions.

- **Michał Kołodziejczyk**, CEO, Equinor Polska

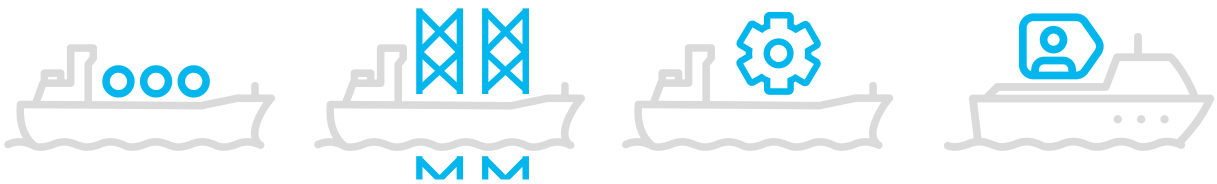
Offshore Wind in Poland

The energy transition and the increasing share of Renewable Energy Sources in energy balance will be driving forward new segments of the maritime business and boost local supply chains. Reducing greenhouse gas emissions by at least 55% by 2030 raises new business opportunities. The Fit For 55 package of legislative changes positively stimulates the potential of Polish offshore wind farms, which is estimated at 5.9 GW by 2030 and 11 GW by 2040.

The further development of the sector will depend hugely on the regulator's next steps, which the market is waiting for. As estimated by the Ministry of Development, the participation of local producers at the construction and operation stage of wind farms can reach 50% already for the first phase of projects [35].

It should be noted that Pomeranian companies are already active within the offshore wind supply chain, providing various types of products and services. This share will steadily increase due to the acquisition of new competences by local suppliers, but also due to the direct foreign investment already taking place in the region.

Current potential of local manufacturers to supply the offshore wind sector_

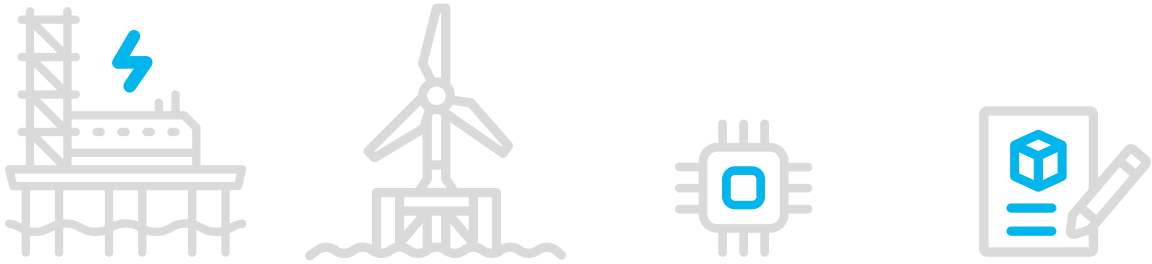


cable-laying vessels

heavy lift jack-ups

OSV

CTV



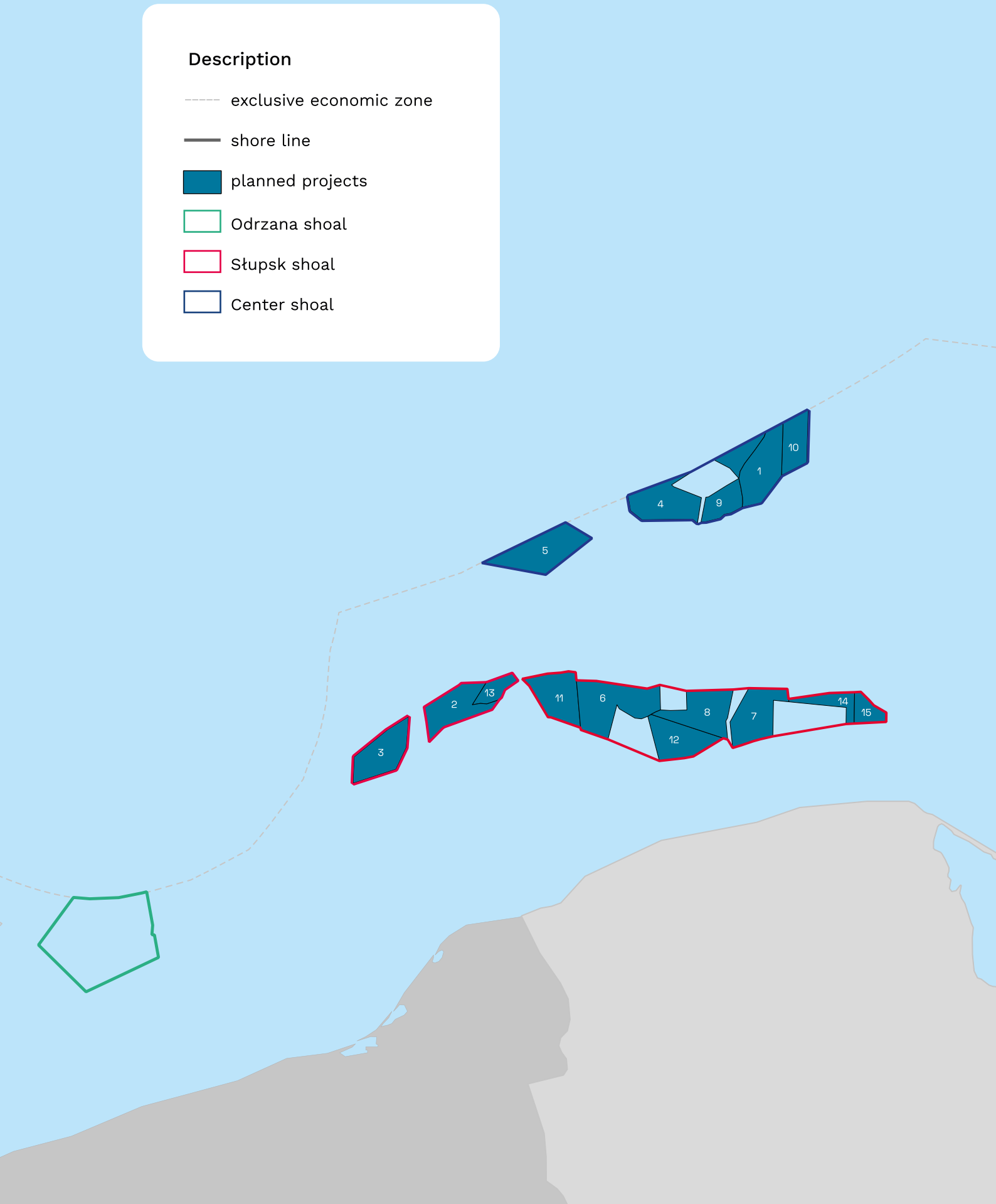
transformer stations

turbine towers

electrical systems equipment

project management and design of ships, structures and equipment

OSV - Offshore Service Vessel; CTV - Crew Transport Vessel


Description
exclusive economic zone
shore line
planned projects
Odrzana shoal
Słupsk shoal
Center shoal
10
1
4
9
5
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3

No	Developer	Project	Power [MW]	Area [km²]	Status
1	RWE	Freeboard V	1900	137	Investment at the initial stage. Planned for the next concession auction run.
2	RWE	Sharco Duo	1800	122	
3	RWE	Xlokk II	1700	118	
4	Equinor / Polenergia	MFW Bałtyk I	1560	132	The investment has a location permit and connection conditions. Currently, the project is at the stage of environmental research.
5	RWE	Freeboard I	1500	161	Investment at the initial stage. Planned for the next concession auction run.
6	PGE / Ørsted	Baltica II	1498	190	Obtained environmental decisions, PSzW permit for laying and maintenance of cables, connection agreements to the transmission network and the right to a contract for differences. Currently, the investment is preparing to obtain a building permit.
7	Orlen and Northland Power	Baltic Power	1200	131	Obtained environmental decisions, PSzW permit for laying and maintenance of cables, connection agreements to the transmission network, right to contract for difference, permit for the construction of a set of devices deriving power from the OWF. Currently, it is preparing to build a service base in Łeba.
8	PGE / Ørsted	Baltica III	1045	131	Obtained environmental decisions, PSzW permit for laying and maintenance of cables, connection agreements to the transmission network and the right to a contract for differences. Currently, the investment is preparing to obtain a building permit.
9	PGE	Baltica I	900	109	The investment has obtained PSzW, conditions and a connection agreement. Environmental tests and wind measurements are currently underway.
10	RWE	Freeboard IV	900	80	Initial stage. Planned for the next concession auction run
11	Equinor/ Polenergia	MFW Bałtyk II	720	122	Obtained environmental decisions, PSzW permit for laying and maintenance of cables, connection agreements to the transmission network and the right to a contract for differences. Currently, the investment is preparing to obtain a building permit.
12	Equinor/ Polenergia	MFW Bałtyk III	720	117	
13	RWE	FEW Baltic II	350	41	PSzW permit obtained. Currently, the project is at the stage of obtaining other arrangements.
14	Ocean Winds	C-Wind	200	49	Obtained env. decisions/ PSzW permit obtained/ Connection to the transmission network contract/ Available for contract for differences/ Preliminary contract for the lease of the service port/ Design stage of wind farm decomposition/ Application for an environmental decision for the onshore part/ marine geological research
15	Ocean Winds	B-Wind	200	42	

* PSzW - permission to build and use artificial islands, structures and equipment for offshore wind farms

Source: own study based on available press releases. Various sources.

From investors' point of view, the development of offshore wind projects on the Polish coast of the Baltic Sea depends on the predictability and stability of the regulatory environment. At the same time, the efficient implementation of these projects will increase the chances of including domestic companies in the global supply chain.

Therefore, it is necessary to ensure investment continuity, which means that the second stage of the projects' development in the Baltic Sea shall start as soon as the first wind farms are commissioned. This will require, among others, greater openness to private investors, further development of the grid, simplification of procedures, and acceleration of the process of obtaining administrative decisions, e.g. environmental decisions or building permits.

It is also crucial to set ambitious and long-term goals for the development of the offshore wind energy sector in Poland so that suppliers and sub-suppliers have a basis for investing in production capacity in our country.

- **Michał Kołodziejczyk**, CEO, Equinor Polska

Recent investments in the offshore wind sector in Pomerania

In 2021, Semco ETP Renewables opened a design centre in Gdynia at the Baltic New Technology Port, employing 40 highly-qualified engineers. The company provides specialised offshore services: technical consultancy and technical design of energy facilities (primarily transformer stations) [36].

At the end of 2022, the opening of a competence centre in Gdańsk was announced by Siemens Gamesa. The Baltic Offshore Execution Centre will employ a total of 100 offshore project management specialists and an additional 50 technical staff responsible for servicing the turbines installed offshore by Siemens Gamesa.

> *Siemens Gamesa will execute three contracts with Polenergia/ Equinor and RWE. Siemens Gamesa has been awarded contracts granting it a preferred supplier status in connection with the development of offshore wind farms in the Polish Exclusive Economic Zone in the Baltic Sea, including for the MFW Bałtyk II and MFW Bałtyk III projects.*
>
> *The Tricity was the optimal location for us, as it has all the facilities of a large agglomeration, while being close to the sea. At the same time, it has good connections to the rest of Polish cities, such as Warsaw.*
>
> - **Paweł Przybylski**, managing director, Siemens Gamesa Polska

At the beginning of 2023, the Industrial Development Agency, Baltic Towers and the Spanish company GRI Renewable Industries, S.L. signed an agreement to establish a wind tower factory for offshore wind energy in Gdańsk. Production is due to start in 2025 and is expected to generate around 450 jobs, with an investment value of more than €150 million. The new plant will produce towers for turbines above 14 MW. The annual production capacity will be 120 towers [37].

It should be noted that further projects are being implemented not only with a view to developing the Polish offshore but also global supply chains. The Baltic's potential for offshore wind is highly significant here.

> *The Tricity will play an important role in the Baltic Sea offshore sector, on the one hand as a hub for producers and on the other as a base of resources, i.e. people who will be involved in this process. Whether we are talking about components or services - the Tricity has a very large potential for new investment projects and will use it.*
>
> - **Paweł Przybylski**, managing director, Siemens Gamesa Polska

Offshore Farm maintenance will also be an important element of local content. Major developers have already decided on the location of their bases. Equinor and PKN Orlen chose Łeba, PGE Baltica and RWE chose Ustka.

We attach particular importance to cooperation with Polish partners who are familiar with the local market and share our approach to the highest safety, environmental and technological standards. Therefore, in order to effectively operate our wind farms, we are planning to build an Operations and Maintenance center in Łeba, by maximizing the potential of local companies.

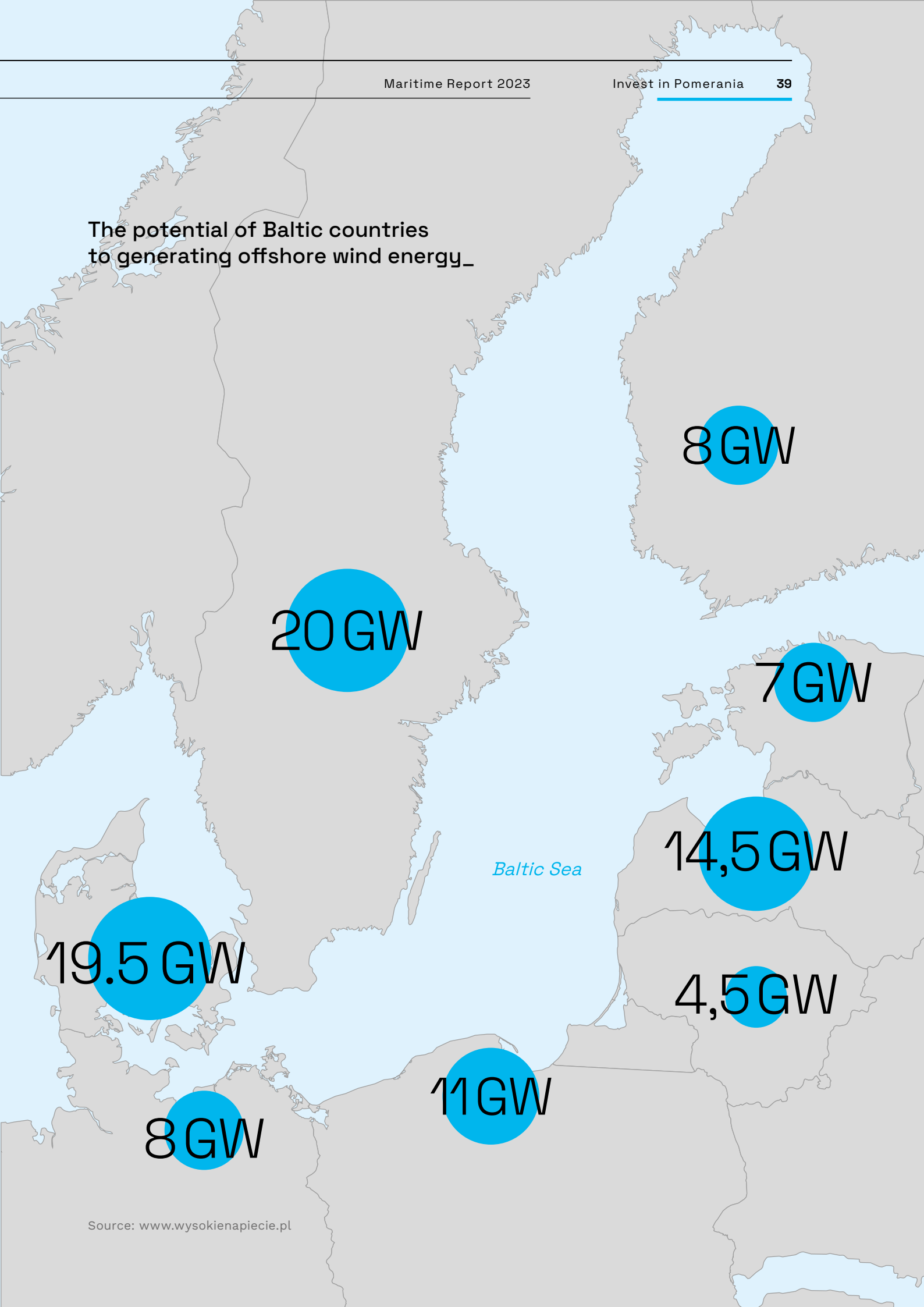
This project will not only help Pomeranian companies to integrate into the new value chain but also create opportunities for the development of the city and the region and will significantly increase the number of stable, attractive job offers in the local labor market.

Ultimately, around 100 specialists in the field of servicing offshore wind farms will find employment in our center in Łeba. In the next years, Pomerania has a chance to become a significant place for both Equinor's operations and the whole value chain of the Polish offshore wind industry.

- **Michał Kołodziejczyk**, CEO, Equinor Polska

The Pomeranian Offshore Wind Energy Platform is an initiative of the local government of the Pomeranian Voivodeship already involving 118 entities, including developers, suppliers of offshore wind farm components and services, research, academic, training and business environment institutions. The aim of the platform is to coordinate activities around offshore wind energy projects in Poland, which will result in the creation of a strong offshore wind industry hub in Pomerania.

The potential of Baltic countries to generating offshore wind energy_



Source: www.wysokienapiecie.pl

02

The Design Hub_

2.1 Challenges faced by the ship design market

Decarbonization, digitization and autonomization of shipping, development of offshore wind energy and other offshore energy generation techniques. The weight and nature of the above challenges faced by the maritime industry in the coming decades naturally direct our interest to the marine vessels design industry.

It is at the stage of creating the concept of a vessel that all key decisions related to its future characteristics and intended use must be made. On the one hand, designers and engineers, in cooperation with shipowners and shipyards, must respond to the demand for specific types of ships. On the other hand, they must creatively integrate all stakeholders' needs, including legal requirements related to the safety of navigation or environmental requirements. All these arguments allow us to claim that it is design and engineering offices that are at the forefront of the profound changes that are currently transforming the global maritime sector.

Our interlocutors from the local ship design sector confirm that the adaptation of ships to increasingly stringent environmental standards is already shaping the reality of the industry. Regulations related to climate protection force the integration of new technologies already at the design stage of the ship. The interlocutors also point out that, unlike the vessels built in East Asian shipyards, the European projects are characterized by a greater degree of complexity and specialization of the vessels themselves. We are referring to both innovative solutions (autonomy, low emissions) and specialized missions of vessels, e.g. construction or servicing of offshore wind farms. Therefore, Pomeranian design and engineering offices operate in the market niche of specialist vessels, which forces a high work culture and flexibility in project implementation.

One of the proofs that Pomeranian design offices are able to adapt new technological solutions, and that shipyards are able to implement them, is the design and construction of the „Elektra" ferry. The double-ended ferry had a pioneering at that time hybrid (diesel-electric) drive. The design of the ship was carried out by the Pomeranian design office StoGda Ship Design & Engineering, and was built at CRIST S.A. shipyard [1]. **"Elektra vessel received awards for both innovative design and innovative construction."** - says Daniel Okruciński, deputy commercial director at CRIST S.A. The CEMT award was given for outstanding contribution to the success of European maritime industries, and in the Marine Propulsion Awards competition the vessel was named „Ship of the Year" (both awards were given in 2018; more about the ship design on page 45).

At the stage of delivery and acceptance tests, the ELEKTRA ferry was comprehensively tested by the Testing Laboratory of Maritime Advanced Research Centre (CTO). CTO, as part of the Field Testing Laboratory, performs a wide range of measurements related to ship structures and mechanical devices.

Another example is the Salish Orca ferry, designed entirely by Remontowa Marine Design and built at Remontowa Shipbuilding for the Canadian shipowner BC Ferries. The ship is equipped with an innovative LNG drive and an innovative system of bunkering this fuel from the open deck - the first design solution of this type in the world used in ferry shipping. The implementation of such low-emission projects - both in the case of the construction and reconstruction of LNG-powered ferries for Canada - brought the Remontowa Holding group the SHIPPAX Retrofit Award in 2018.

The second element that will shape the global design market is the development of wind energy. This is particularly important in the Pomeranian context, where the first investments are already underway, and it is estimated that by 2040 in the Polish part of the Baltic Sea, we will connect about 11 GW of power [2]. (more about the development of Pomeranian offshore wind on page 30). Polish, but also more broadly - Baltic investments in offshore winds will be a strong economic impulse for Pomerania and an opportunity for Polish enterprises to appear in the European supply chain. This also applies to design and engineering offices.

Pomeranian design and engineering companies have been actively participating in the implementation of projects for the needs of offshore-wind for many years. An interesting example of implementation is the initial design of a CTV („crew transfer vessel") of the Gdańsk NAVA Ship Design Office named Nava WFSV 22 [3]. It is a small specialist vessel designed to support the installation and servicing of Polish wind farms. The design can be adapted in the future to other tasks and functionalities according to the needs of the investor.

Seatech Engineering has also designed a CTV type vessel named SE-219, which can be adapted to hybrid (diesel powered by hydrogen cell electric batteries) or full hydrogen (hydrogen cell electric batteries) [4]. Seatech Engineering is a Pomeranian design office that specializes in the implementation of LNG or hydrogen-powered ship designs. It also designed (from concept to technical design) a modern research vessel for the University of Gdańsk named Oceanograf.

On the other hand, one of the most spectacular activities in the field of structures for the OWE sector was the involvement of local companies in the construction of ships, the so-called heavy lift up jack-up vessel - used to install wind turbines at sea. Three ships of this type: „Thor", „Innovation" and „Vidar" were built in the previous decade at the CRIST S.A. shipyard. with the participation of the StoGda design office. The „Vidar" unit was entirely designed by the StoGda office (more about Vidar and

> *In 2012 we built the Innovation vessel and in 2013 a smaller vessel of this type. Since then, we do not carry out such orders, although discussions on the market are ongoing.*
>
> *The construction of jack-ups is not developing well, but it has a lot of potential. Investments are very expensive, but without these vessels there is no development of wind farms.*
>
> - **Daniel Okruciński**, deputy commercial director, CRIST S.A.

Innovation ships on page 47 and 48). The development of the offshore wind energy sector determines specific needs in terms of specialized vessels and offshore structures. There are many indications that they may become the specialization of Pomeranian design and engineering offices.

The mid-2022 report of the Polish Wind Energy Association (PWEA) and WindEurope points to bottlenecks in the process of balancing demand and supply of various types of vessels necessary to implement these large investments [5]. Demand for installation vessels will increase:

- WTIV (Wind Turbine Installation Vessels, e.g. jack-ups)
- FIV (Foundation Installation Vessels)
- CLV (Cable Laying Vessels)
- SOV (Service & Operation Vessel)
- CTV (Crew Transfer Vessel)

An important issue is also the adaptation of vessels to the changes taking place in wind farm construction technologies.

The authors of the report point out, for example, the need to create a new generation of WTIV vessels that will be able to transport much larger wind turbines. It is expected that in the coming years turbines with a capacity of up to 16-18 MW will be installed. For comparison, the average power of a single turbine in 2021 on the European market was approx. 8.5 MW [6].

Therefore, the technological change may increase the diameter of the turbine rotor by approx. 100-150 meters and the height by 100 meters [7]. Shipyards and design offices from around the world are trying to respond to this challenge.

> *When Innovation was put on the market, the farms built were 6MW each (the vessel allowed to erect windmills with a maximum capacity of 8 MW). Today, 15 MW wind farms are being built, so new jack-up vessels must be built that will have the same specifications but will be adapted to the new, larger installations.*
>
> *This year we expect to sign a contract for the American market. The vessel will rise 20 m above sea level, it will work in waters up to 70 meters deep. It will be possible to equip windmills with a crane. It will be a vessel that has never been built before.*
>
> - **Daniel Okruciński**, deputy commercial director, CRIST S.A.

In the light of the above information, it is not surprising that our interlocutors are optimistic about the future of their sector in the context of the development of offshore elevators in the Baltic Sea basin.

Elektra_

It is a double-ended ferry. Currently, it operates cruises on the short Parainen-Nauvo route in Finland for the Finnish ferry lines Finferries. The ferry is 98 meters long. It can accommodate up to 372 passengers and up to 90 passenger cars on board. The ferry has a hybrid drive (diesel and electric). During short journeys, it is powered only by batteries.

They are loaded automatically at stops. A full charge of the batteries takes up to 7 minutes, and their lifespan is estimated at 10 years of continuous use. This pioneer ship was built at the CRIST S.A shipyard and designed by the Sto.Gda design office in Pomerania [8]. In 2018, it received the prestigious „Ship of the Year" award and the CEMT award for its outstanding contribution to the success of European maritime industries.

The StoGda design office was responsible for providing the complete design, including the contract design, technical design, model tests (including maneuvering tests), workshop documentation and delivery documentation [9].

Source: Image courtesy of CRIST S.A. Shipyard

Salish Orca_

Double-ended passenger-car ferry (107 m long, capacity 150 vehicles and 600 passengers), the first of a series of four (the others are Salish Eagle, Salish Raven and Salish Heron) delivered in 2017 - 2021 by the Remontowa Shipbuilding shipyard. These are the first LNG-powered dual-fuel ferries in the BC Ferries fleet and one of the first LNG-powered ferries in North America.

Thanks to the innovative drive, they emit up to 25 percent. carbon dioxide, more than 85 percent. sulfur oxides, 50 percent. nitrogen oxides and 99 percent. less particules compared to propulsion based on conventional marine fuel.

Entirely designed by the Remontowa Marine Design & Consulting office, these ships can be bunkered directly from the wheeled LNG road tanker, which for this purpose enters the closed inner deck, which makes it possible to perform this operation at harbors without land infrastructure for storage and bunkering with blue fuel. They were designed and built as part of the „Clean Futures Plan" implemented by BC Ferries - the largest ferry operator in North America.

Source: Image courtesy of Remontowa Holding

Vidar_

Both vessels are self-elevating HLJVs („heavy lift-like-up vessels") used to transport and place wind turbines at sea. The vessels are distinguished by advanced technology and specialized equipment, in particular a set of powerful actuator legs.

They allow the vessel to rise above the water level, enabling the assembly of wind tower elements. Another characteristic element of the ships are cranes, which in the case of „Innovation" have a lifting capacity of up to 1,500 tons and a maximum span of 31.5 meters. Innovation has a helipad where Sikorsky S92 helicopters can land and a residential section for 100 people [10].

Both ships, along with the chronologically oldest vessel - the barge Thor with the same function, were built by CRIST S.A. shipyard. The design was carried out by the Pomeranian design office StoGda with increasing involvement in individual vessels - from elements of the documentation of the self-elevating barge „Thor" to the overall design in the case of „Vidar".

Source: Image courtesy of CRIST S.A. Shipyard

Innovation_

The Innovation vessel is a 147.5 m long ship with a width of 42 m and a side height of 11 m, intended for the construction of offshore wind farms. It is capable of performing operations in waters with a depth of 50 m, with the option of extending the legs up to 65 m. The maximum lifting capacity of the 4-leg lifting system is 30,000 tons, it has a helipad for Sikorsky S92 helicopters, the residential part is designed for 100 people with the possibility of to accommodate up to 180 people on board.

Source: Image courtesy of CRIST S.A. Shipyard

Nova WFSV 22_

Nava WFSV 22 catamaran („crew transfer vessel") is a conceptual design of the PPU Nava design office in Gdańsk. According to the design, it is to be used mainly for the transfer of service teams to wind farms. It responds to the wide demand for this type of vessels in the Baltic Sea in the near future.

The ship is to accommodate up to 16 people (including four crew people). The living area consists of among others the captain's cabin, crew cabin for two people, a room with 12 seats, a pantry, a living room, a toilet and a shower. Two MTU 12V 2000 M72 diesel engines to give the catamaran a top speed of 25 knots [11].

The catamaran's drive is conventional to meet the requirements related to transport speed and safety, but the design is open to adapting it to the investor's requirements.

Source: Image courtesy of Nava LLC

Tomasz Świątkowski, member of the management board of StoGda design office, pays particular attention to the potential related to adapting old vessels to new, more stringent environmental requirements.

> *I think that the situation on our market is stable. Looking at the direction in which Polish offshore wind energy will go, I am confident that the industry will do well.*
>
> *In time, all elements related to the construction of new and adaptation of existing ships to environmental requirements will be added. It will be a large area for cooperation for design companies. One should absolutely not be pessimistic about this.*
>
> - **Tomasz Świątkowski**, member of the board of the design office, StoGda

The ship design and engineering services sector is also undergoing a change towards the digitization of design processes. Fulfilling complex requirements while coordinating processes for all stakeholders involved in a ship design faces many challenges. This often causes errors resulting in the suspension of design work and an increase in design costs [12]. That is why it is so important to plan processes and use effective tools to implement such a complex design.

The design of floating units or ocean engineering structures requires a number of detailed analyses and simulations. The objective of these activities is to provide the designed object with assumed exploitation parameters and to ensure safe work in variable weather conditions at sea. One of the very basic method is an experimental model test of ships, yachts, off-shore facilities in towing tanks and wind tunnel. Maritime Advanced Research Centre (CTO) performs model testing for over 50 years and they still remain the most effective, both in time and cost, tool for analyzes related to the hydromechanics of the vessel - particularly in relation to more complex (dynamic) phenomena.

The model research is complemented by the use of CFD (Computational Fluid Dynamics) software. Sunreef Yachts, a world leader in the design and manufacture of luxury catamarans, uses advanced simulation software to analyze the vessel in a controlled and secure virtual environment.

> *At the design stage, we use CFD software that makes a virtual simulation of the vessel at sea. Flow simulation allows you to analyze the design of the underwater part of the hull, taking into account resistance and water flows, as well as the above-water part for air resistance and turbulence arising during the movement of the vessel.*
>
> *Taking into account the geometry of all elements contained in the model involved in the analysis. The analysis can be carried out for various vessel movement speeds and sea conditions.*
>
> - **Artur Połoczański**, PR manager, Sunreef Yachts

Design offices can implement individual phases of design implementation separately as subcontractors or as a whole (from the conceptual phase to working documentation). Our interlocutors point out that Pomeranian design and engineering offices, although they usually implement designs in the working or as-built phase, more and more often can boast of the implementation of comprehensive concepts.

Radosław Kubiszewski, president of the board of DNV Poland Sp. z o. o. indicates that Pomeranian design offices have „gained confidence" and are increasingly boldly implementing their own designs.

> *Our designers are more and more open to new challenges. They used to be more focused on the designs they had experience in.*
>
> *Currently, it seems that they take up new challenges more and more often, which makes it easier for them to attract customers from other, unobvious directions*
>
> - **Radosław Kubiszewski**, president of the board, DNV Poland Sp. z o. o.

Stages of designing a watercraft_ [13]

1

A design that starts with the first sketches and drawings is called the concept phase. The purpose of this stage is to present the potential investor (usually the shipowner) the general outline of the vessel. The design includes a technical specification, preliminary projections, but also the first hydromechanical calculations and an electrical balance. 3D visualizations of the ship are also provided.

2

After signing the contract, the concept is developed in accordance with the requirements of classification societies and the shipowner, which must finally approve the design of the vessel. Contract design provides detailed designs of the systems used on board. At this stage, the design is carried out in close cooperation with the shipowner and the shipyard, which coordinates the construction of the ship.

3

At the ship construction stage, after approval of the technical design by the classification society, a working (executive) design is created. It serves as a shipbuilding manual for shipyards, suppliers and subcontractors of installations and systems. Coordination in a 3D model is most often used for these works. The project includes, among others: isometric drawings of pipelines, valve lists, drawings showing how pipelines and electric cables are routed through bulkheads and steel elements, and blanks of smoking sheets. [14].

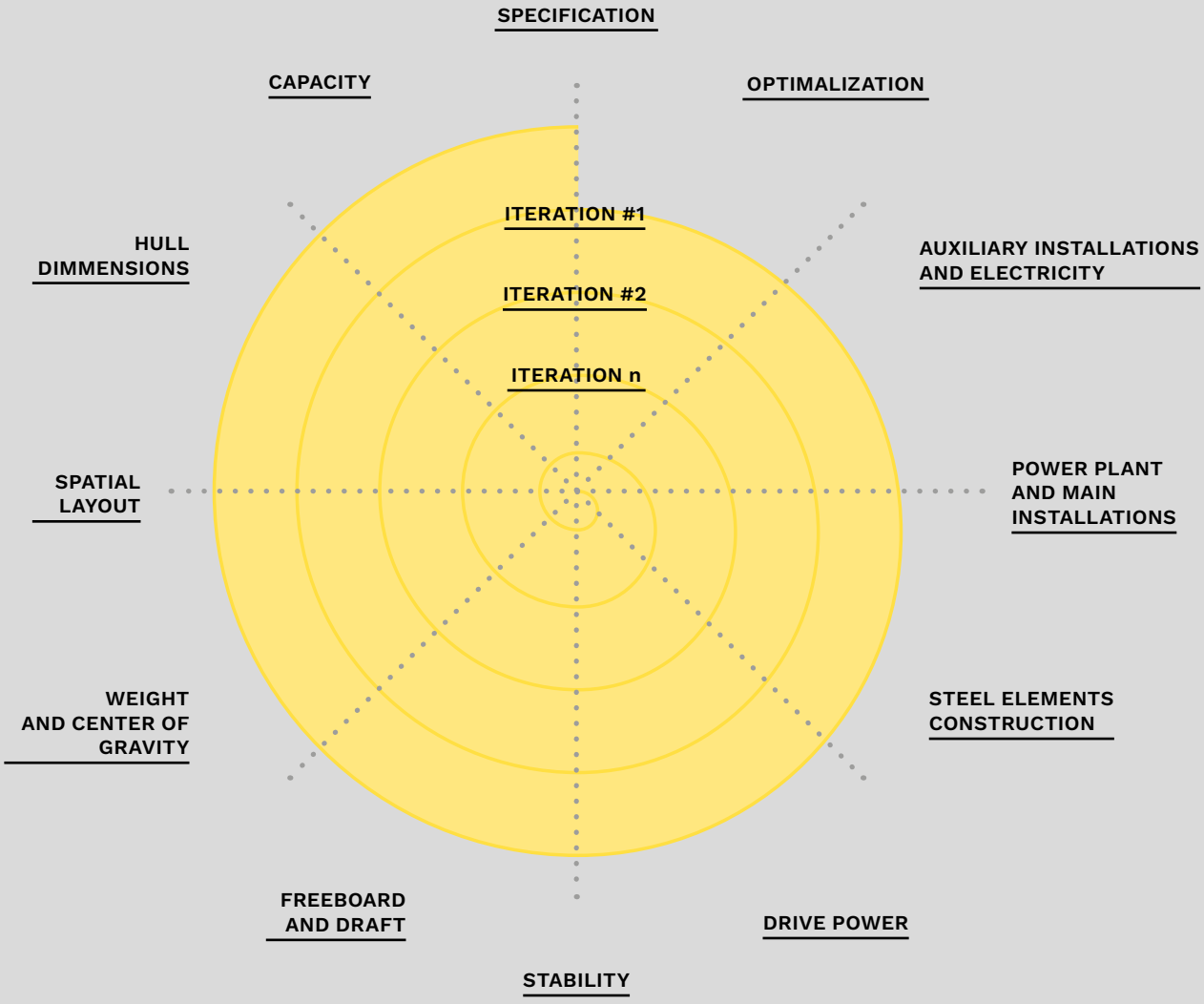
4

The final element of the project is the delivery (as-built) documentation. As the name suggests, at this stage technical documentation of the ship is prepared for its operation and future service, repair or modernization. It is worth noting that the iterative approach prevails in the ship design process, according to which each newly designed element should be checked in terms of its impact on the other already created elements of the design (iteration). The classic tool used in an iterative approach to ship design is the design spiral (see the figure on the next page).

Ship design documentation_

1. Conceptual Design (partner: investor, usually shipowner, design office)
2. Contractual Documentation (partners: shipowner, shipyard, design office, key suppliers)
3. Basic Design/Class Documentation (partner: shipowner, shipyard, design office, suppliers, classification society)
4. Working documentation (partners: shipyard, design office, subcontractors and system providers)
5. As-built Documentation

Design spiral acc. T. Lamb



Source: Kreft D., Ship design stages and documentation flow

The design spiral shows a classic design model. Recent years have shown an increased supply of ships with a comfort class (acoustic and vibration). In addition, the issue of minimizing the noise emission from the vessel to the water becomes another stage that must be taken into account at the very beginning of the design of the unit.

Thanks to the support of design offices by such entities as Maritime Advanced Research Centre (CTO) the challenges described above can be fully analyzed and adapted to the design of the unit.

- **Lech Grycner**, president of the board, Maritime Advanced Research Centre

A good example of cooperation to increase the efficiency of the ship design process is the achievement of the Gdańsk branch of Damen Engineering. Damen's hull structure design, made using specialized Napa software, received classification approval from Bureau Veritas on the basis of the 3D model only [15].

3D ship modeling is used in various stages of design development. This information carrier is used by ship designers and engineers for a variety of purposes: visualization of the hull geometry, or calculations of the strength and stability of the vessel.

However, an analog 2D drawing generated from a 3D model is still a common and widely used information carrier in the ship design and production process. In the traditional approach, the steps are as follows: 1) the designer works with a 3D model, then translates it into 2D drawings for approval of the vessel class; 2) After receiving the information in the 2D drawing, the classification societies must generate a new 3D model based on the submitted 2D drawings to carry out independent calculations and express their opinion in the 2D drawings; 3) Finally, in response to the society's comments, the designer has to translate the 2D drawings back to 3D to make the changes.

Within the new approach, 2D drawings have been eliminated from the process. This was made possible by the use of the neutral OCX format (OCX: Open Class eXchange).

As a result, the 3D model of the ship became a single working environment for all parties involved in the design.

This allowed for a significant optimization of the process - above all, time saving and elimination of inconsistencies in communication between the designer and the person responsible for approval of the structure [16].

According to Katarzyna Romanowska, Managing Director of Damen Engineering Gdańsk, the innovative way of approving a ship's design, enabling the 3D model to be reviewed and approved by all stakeholders involved in its implementation, completely changes the rules of the game [17].

2.2 Local market for design and engineering companies

The cluster of Pomeranian design and engineering companies is diverse. There are branches of large international concerns in Pomerania, such as Dutch Damen Engineering, Norwegian Ulstein or Finnish Deltamarin, as well as a number of small and medium -sized design offices with Polish capital. The numerous presence of the latter is the result of a long tradition associated with the highly developed shipbuilding sector in Pomerania. Over the decades, a whole value chain has been created that covers all stages of the construction of a vessel - from the preparation of the initial concept to the implementation of the design with the participation of specialist sub-suppliers of systems and materials in Pomeranian shipyards. Some local shipyards offer this holistic approach.

One of the largest design offices in Pomerania is Remontowa Marine Design & Consulting, operating within the Remontowa Holding group. It employs about 90 engineers. It implements designs of ferries, cargo and towing vessels as well as specialized vessels, e.g. for the needs of the offshore sector. CRIST S.A. shipyard also has its own design department, which cooperates with other entities for the purposes of implementing designs of larger vessels.

StoGda Ship Design & Engineering is an interesting example of a design office established on the basis of shipbuilding experience of its engineers. The company was founded in 1997 by former employees of Gdańsk Shipyard. StoGda has implemented a number of innovative ship designs and offshore structures in close cooperation with shipowners from all over Europe as well as European and Pomeranian shipyards. One of the specializations of the office, apart from electric vessels, are the already mentioned designs of the so-called jackup-vessels – highly specialized vessels used to build wind farms (so-called WTIV).

We are a small design office with tradition and experience dating back to the times of the Gdańsk Shipyard.
We are a pioneer when it comes to electric ship designs.

Taking advantage of the expected development of the offshore wind sector in Pomerania, we also focus on vessels used in the construction and servicing of offshore wind farms.

- **Tomasz Świątkowski**, member of the board of the design office, StoGda

The broadly understood maritime tradition of the region and the mature value chain have become a magnet for foreign investments. At the beginning of the 21st century, there was a series of significant foreign investments from the perspective of the local sector, mainly companies with Nordic capital. The reasons why foreign companies became interested in Pomerania include: Pomerania's reputation as a place for building ships, access to a relatively large pool of highly qualified employees, lower labor costs and high working standards of Polish engineers [18].

After the implementation of foreign investments, competition for the regional talent pool increased. According to our interlocutors, with the „opening" of Pomerania to the market of offshore wind farms, the competition for limited human resources will increase even more, which will be felt by design offices in the region. At the same time, there is no doubt that over the last two decades the ship design sector has grown to the rank of one of the most important competitive advantages of Pomerania in the context of maritime economy. Pomeranian design and engineering offices are the authors of interesting designs and concepts of specialized ships and offshore structures that have gained recognition on the European market.

Selected foreign direct investments in the ship design and offshore construction sector_

	2003	2008	2014
Gdańsk	Seatech Engineering (France)	Deltamarin (Finland) Wartsila Ship Design (Finland)	DAMEN Engineering (Netherlands) VARD Engineering (Norway)

	2003	2021		2006
Gdynia	Ulstein Poland (Norway)	Semco Maritime (Denmark)	Sopot	HAV Desing Poland (Norway)

According to Katarzyna Romantowska, managing director of DAMEN Engineering, there are much more arguments than just the presence of qualified staff to invest in the ship design and construction sector in Pomerania. Above all, the region has to offer a comprehensive ecosystem that includes not only companies from the ship design sector, but also the entire institutional and business environment: universities, vocational schools, research institutes, certification societies, analytical, research and design companies as well as many subcontractors and equipment manufacturers.

> *We wouldn't be able to work so effectively and grow at such a fast pace if this environment didn't exist. We make sure that the relationship with it is as good as possible, our strategy is cooperation.*
>
> - **Katarzyna Romantowska**, managing director, Damen Engineering Gdańsk.

Damen Engineering Gdańsk is a company of the Dutch shipbuilding group Damen (Netherlands). As a specialist competence centre, it currently employs 170 employees. The centre mainly employs engineers, designers and design managers. The Gdansk branch specialises in the design of prototype, specialised vessels and other floating solutions.

Projects are being implemented to operate offshore lifts (cable carriers, service carriers), double-ended ferries, other passenger and transport ferries and vessels used for special purposes, e.g. humanitarian aid or infrastructure defense. The vast majority of designs are then carried out in Damen's shipyards located around the world.

However, some designs are carried out by other shipyards in close cooperation with Damen's engineers. Other production branches of the company are also located in Tricity: Damen Shipyards Gdynia (approx. 115 employees) and Damen Marine Components Gdańsk (approx. 200 employees).

4 000 employees in the field of ship design and offshore structures and other specialized engineering services related to this industry.

Estimation by Katarzyna Romantowska

According to Katarzyna Romantowska, the ship design sector in Pomerania has not yet reached its maximum potential. According to her, there is no coherent vision of regional marketing and human resources in design companies to go out with conceptual designs of ships for the European market and effectively lobby for their comprehensive implementation in local shipyards, preferably with the participation of Polish subcontractors and components. Tomasz Świątkowski (StoGda) also points to another barrier related to the further development of the ecosystem.

There is a lack of bold political decisions to support the shipbuilding and offshore wind sector. (...)

The role of the state should be to implement important projects and thus give a positive impulse to the development of this sector of the economy - to be a kind of „umbrella" for the development of innovation

- **Tomasz Świątkowski**, member of the board of the design office, StoGda

Offshore and Oil & Gas design

Tempted by the accessibility and high level of Pomeranian universities, other companies from the broadly understood market of design and engineering services are also investing.

In 2022 Danish company from the oil&gas and renewables sector - Semco Maritime, decided to open its engineering office in Pomerania.

Semeco indicates that it was mainly the opportunities related to the dynamic development of the renewable energy sector (including offshore wind energy) that were behind the decision to establish local offices here [20].

It is also not without significance that companies are joining the market with a significant engineering resource that has specialized in offshore structures. For the needs of this market, they are also designed by engineering teams maintained by the largest companies in the region that implement this type of construction.

For example - Mostostal Pomorze - one of the largest producers of steel structures for the OWE and oil & gas market has an engineering team that provides specialized services for its business partners. Alushіp Technology can boast of a similar department, which employs about 40 people for this purpose.

Source: Image courtesy of Remontowa Holding

03

Shipbuilding Industry_

3.1 Competition on the global shipbuilding market

300 000
Specialists employed throughout Europe

22 000
Manufacturers and suppliers of marine equipment in Europe

300
Technologically advanced shipyards operating in Europe

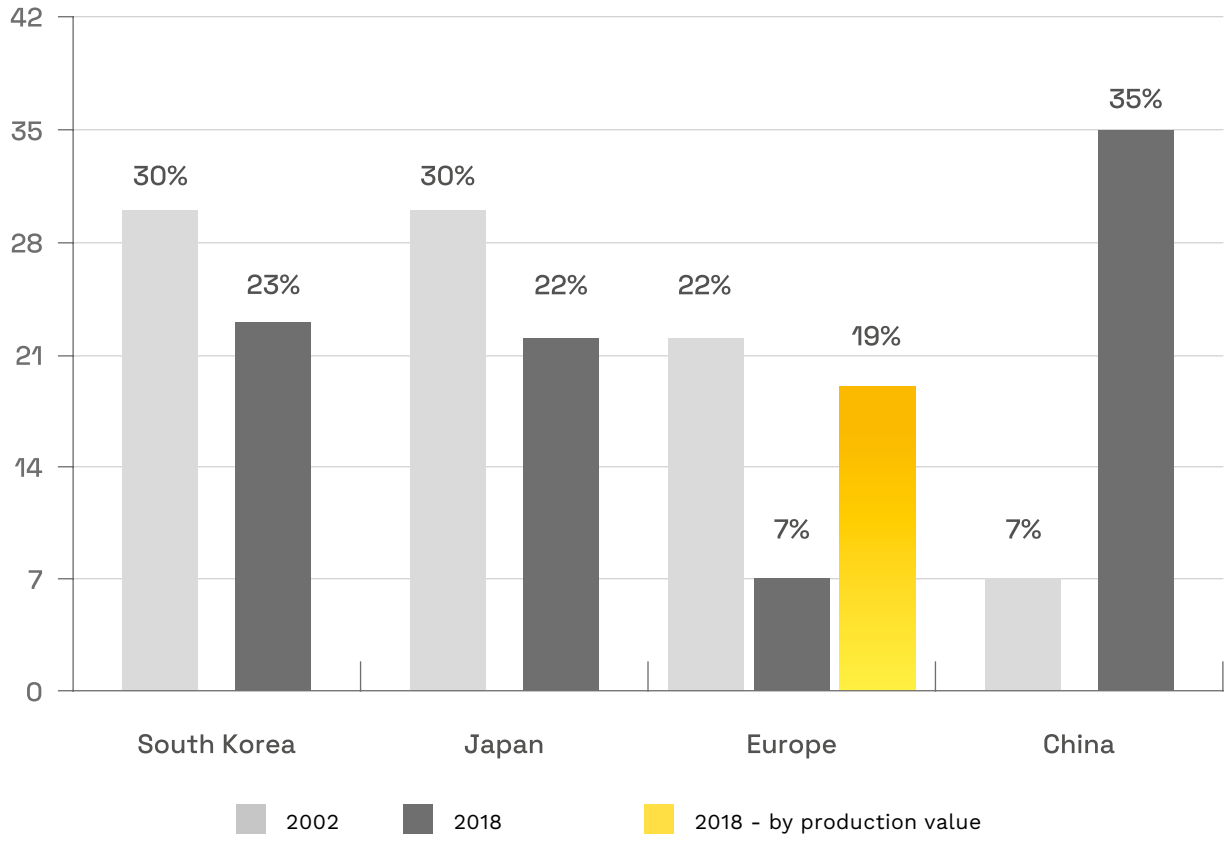
Shipbuilding is a strategic industry not only from the point of view of world trade, but also from the point of view of security and defense. In Europe, there are about 300 shipyards specializing in the construction and repair of high-tech ships. The sector employs 300,000 people across Europe [1]. According to SEA Europe, there are 22,000 manufacturers and suppliers of marine equipment in Europe, which account for 50% of the global marine equipment market. Keep in mind that equipment is a large asset to the entire ship and can account for more than 40% of its total cost [2].

Although shipbuilding industry is an important and strategic branch of industry in many EU countries, its role in shipbuilding in the world market has significantly decreased. Recent decades have led to a significant shift in global production from Europe towards Asia. In 2002, the world leaders in the shipbuilding market in terms of production volume were South Korea and Japan, followed by Europe.

China's shipbuilding industry accounted for only 7% of the world's shipbuilding industry. By 2018, the roles had reversed and China had propelled its shipyards to the sector's procurement leader. Japan and South Korea followed, while Europe's market share fell to just 6.8% [3].

However, taking a different measure of order volume than CGT, such as the value of individual vessels, Europe already accounts for 19% of orders. This means that the vessels produced in Europe are more technologically advanced.

Percentage of ship production in selected countries in 2002 and 2018, by cgt unit_



Source: own study based on data from https://www.oecd-ilibrary.org/

The report published by the Organization for Economic Co-operation and Development (OECD) clearly indicates that China's policy allows state-owned enterprises to transfer funds to other entities in the shipbuilding sector. Support is often provided under more favorable than market terms and is often provided despite the company's low profitability rate. The policy of mergers and acquisitions of state entities also raises doubts.

China is combining companies into giant enterprises with a network of connections that significantly affect market concentration and competition. It should be emphasized that nearly 59% of Chinese shipyards belong to the central or local government [4].

European shipyards are having a hard time competing with China. Chinese shipyards build at a relatively low cost, but the quality is often good enough.

At the moment, our competition with China is tough, especially when it comes to price.

- **Daniel Okruciński**, deputy commercial director, CRIST S.A.

In the case of both China and South Korea, mergers of the largest companies in the sector are a major threat to the competition of European companies. In January 2022, the European Union blocked the merger of South Korean shipbuilding giants Daewoo Shipbuilding & Marine Engineering and Hyundai Heavy Industries Holdings for fear of building a monopoly in the construction of LNG carriers. In the last decade, out of 3,000 applications submitted to the European Union for consent to mergers, 10 were blocked [5].

South Korea is another global leader in shipbuilding industry. It is home to the 5 largest shipbuilding groups in the world in terms of the number of orders. According to the Norwegian research company Rystad Energy, Korean shipyards control on average 76% of all orders for LNG tankers [6].

The Korean shipbuilding group KSOE delivers on average 20-22 LNG ships of approx. 160 000 m^3 each per year. The construction of such vessels by European shipyards at a price and time equal to Korean shipyards would not be possible.

- **Daniel Okruciński**, deputy commercial director, CRIST S.A.

On average, Korean shipyards control 76% of all orders for LNG carriers

According to the estimates of the Clarkson Research Services analytical group, orders for 108 vessels transporting liquefied gas were placed only in mid-2022. This means that nearly 20% of orders are in the hands of just one entity. As Rystad Energy said, South Korean shipyards are no longer accepting orders until 2027 due to too high occupancy. The 3 largest Korean shipyards in 2021 won orders for 64 large LNG ships [7].

As Grzegorz Landowski, communications director at Remontowa Holding, said, most FSRUs (Floating Storage Regasification Units) are also produced in South Korea. However, this does not mean that there is no place for Polish shipyards in this sector.

> *Korean shipyards have specialized in the production of FSRUs. In this area, they significantly dominate Japan and China, fulfilling orders from all over the world. It is estimated that Korean shipyards have secured orders for FSRU units for the next 7 years.*
>
> *This means that it is not possible to order a unit for the Gulf of Gdańsk at the moment, which is planned for 2025. In the case of a European shipyard such as Remontowa, it is possible to implement such a unit by converting an LNG carrier, thanks to the experience of this shipyard in the conversion of FSO and FPSO units."*
>
> - **Grzegorz Landowski**, communications director, Remontowa Holding

On the other hand, Jerzy Czuczman, president of the Polish Forum of Marine Technologies, sees a lot of room for cooperation between the Polish and Korean industries.

> *Korean shipyards have the capacity for mass production, while allocating large financial capital to the shipbuilding sector. On the other hand, Polish enterprises have a unique ability to manufacture unit products, which so far few or no one has made.*
>
> *I see this as a great opportunity to create a strong cooperation with South Korea in the shipbuilding sector. I think this trend could develop over the next five years or so.*
>
> - **Jerzy Czuczman**, president of the board, Polish Forum of Marine Technologies

Such cooperation has been carried out by a company from the area of new technologies, Enamor, for several years.

> *The Far East is an area of intense activity. We have been cooperating with Korea for 4-5 years and these relations are already mature. Poland and Korea are currently a strong area for tightening cooperation on both sides.*
>
> - **Maciej Rek**, CEO, Enamor

An example of economic protectionism is the Jones Act The United States adopted a separate strategy for the development of the shipbuilding industry in relation to European and Asian countries. Since 1920, the Jones Act has been in effect there, requiring that all cargo transported between US ports be transported in US-built, US-manned and flag-shipped vessels.

The primary purpose of the act is to protect American industry and national security. However, there is increasing discussion about the high costs incurred by the US economy. However, entering the US market is certainly difficult at the moment [8].

3.2 Changes in the market and directions of development of the European shipbuilding sector_

In the face of tough competition from the Far East, the pandemic and the geopolitical situation, the shipbuilding sector should take important steps to restore its glory. In an interview for SAFETY4SEA, Christophe Tytgat, Secretary General of SEA Europe, identifies four key challenges for the shipbuilding sector in Europe:

1. Regaining competitiveness and becoming immune to China's policies and practices through policy measures, legislation or financial support.
2. Meeting the challenges of the European Green Deal and the „Fit-for-55" legislation, including in particular the decarbonisation of maritime transport (more on this topic in Chapter 4. Towards sustainable shipping).
3. Technological steps related to digitization (more on this in Chapter 5. Advanced technologies in the maritime sector), automation and autonomy in the sector.
4. Attracting and educating young people as well as upskilling and retraining existing staff to meet the challenges of the green and digital transformation (more on this in Chapter 7. Education) [9].

In recent years, the shipbuilding sector, like others, has been affected by the outbreak of a pandemic or geopolitical events in Eastern Europe. Russia's attack on Ukraine not only affected the supplies and prices of raw materials, the availability of employees or existing contracts with Russian contractors, but also the need to review the navy. On the other hand, according to Pomeranian companies, the global pandemic has potentially reduced China's competitiveness and directed customers' eyes to a more stable and predictable European market:

The Covid-19 coronavirus pandemic has caused a lot of turbulence on Asian markets, such as the inability to hold individual business meetings. Trust must be built between the customer and the contractor, and negotiation conditions must be ensured in order to complete the contracts and their implementation.

The lack of access to these markets means that European shipyards have an increased chance of obtaining new designs, especially specialized ones, but also small ships: general cargo ships or MPV (Multi-purpose vessel), which used to be easy to order in China, now shipowners are looking at Poland

- **Radosław Kubiszewski**, president of the board, DNV Poland Sp. z o.o.

China's competitive advantages, such as production speed and price, are starting to diminish. Chinese shipyards are experiencing contract delays and production costs are rising.

- **Grzegorz Landowski**, communications director, Remontowa Holding

This opinion is also shared by Jerzy Czuczman (PFTM), at the same time predicting that this is a good time to turn our eyes to European, more predictable and stable contractors

Moreover, as Jerzy Czuchman said, in 2020 an increase in employment in the shipbuilding sector was registered. This was the highest level of employment in the sector since 2001. This showed the resilience of the Polish shipbuilding industry.

The Covid-19 pandemic contributed to the transfer of orders from Asia, among others, to Poland. The reason was the collapse of supply chains.

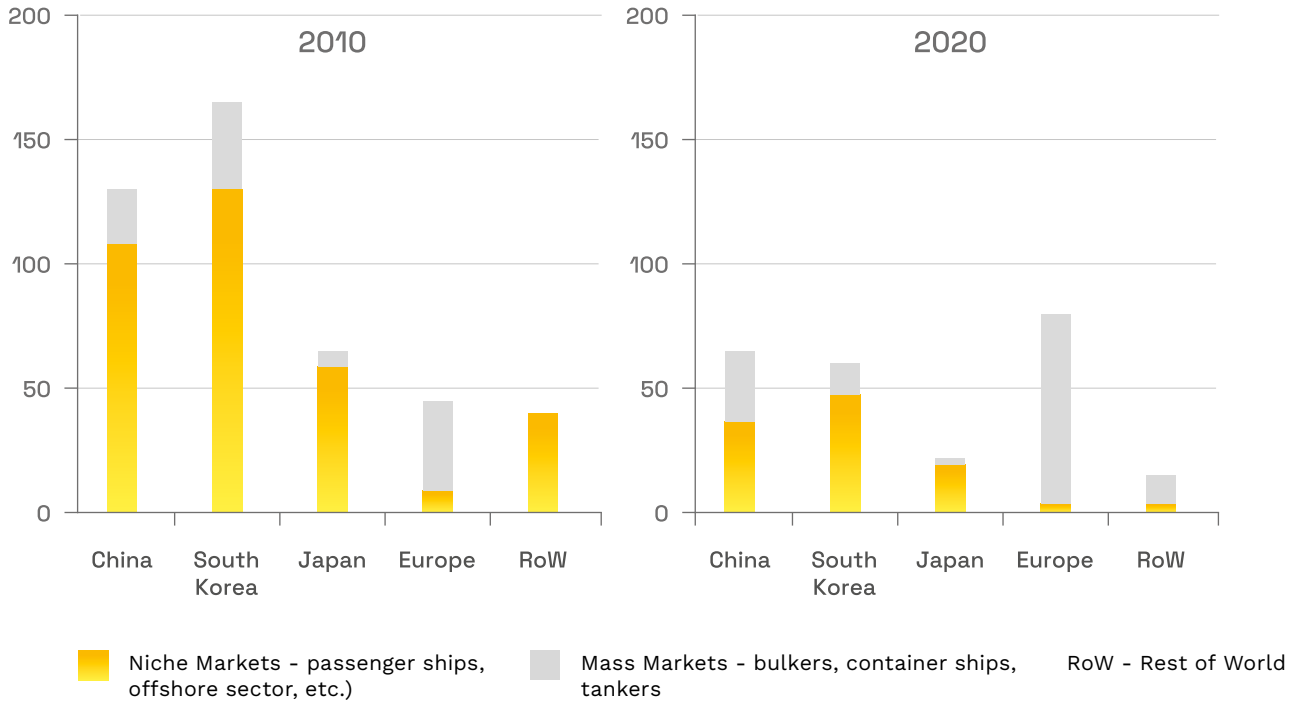
This trend will continue, it will not be a one-off year, but a constant trend. Business likes stability. The pandemic has highlighted the need to diversify procurement sources

- **Jerzy Czuczman**, president of the board, Polish Forum of Marine Technologies

According to the European Commission, due to competition from East Asian countries (especially in the area of building large commercial ships), European shipyards have shifted their activities to the production of niche, complex ships, such as passenger ships and Other Non Cargo Carring Vessles.

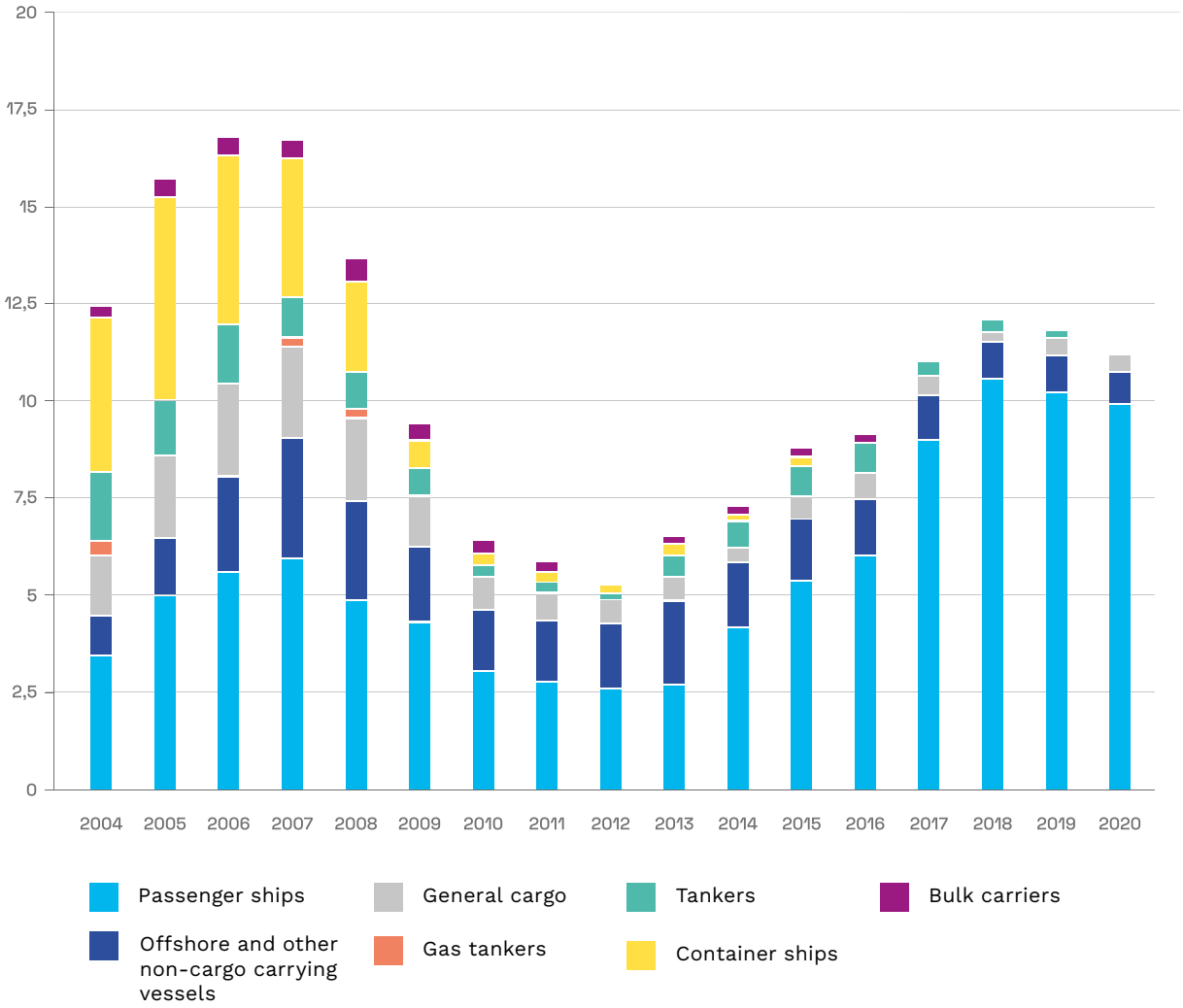
In 2019, passenger ships and ONCCVs, such as offshore vessels, tugboats, icebreakers, dredgers, fishing vessels, research vessels, rescue vessels, so-called workboats, megayachts and offshore vessels accounted for a total of 95% of all European orders [10].

Orders for ships according to the leaders of shipbuilding production in 2010 and 2020 (as per January 1st, in billions $)_



Source: www.forumokretowe.org.pl, Data Clarkson chart VSM

Ship orders in the European Union in the years 2004 - 2020_



Source: www.statista.com

In the near future, European shipyards can mainly expect orders for car-passenger ferries, vessels for the navy, ships helpful in servicing wind farms - such is the market today.

There is a great demand for container ships, but these are built in Asia because of the cost. The container ship is not a complex project, compared to complex projects that are being developed in Europe.

- **Katarzyna Romantowska**, managing director, Damen Engineering Gdańsk

3.3 Potential of the shipbuilding sector in Pomerania

The Pomeranian shipbuilding industry abounds in a number of innovative shipyards ready to compete on the international arena. In recent years, an increased number of orders for both ferries and non-freight vessels has also been observed.

According to data from the Central Statistical Office, 25 finished ships sailed from Polish shipyards in 2018-2021, of which 24 were built in Pomeranian shipyards with a total gross tonnage (GT) of 73,100 tonnes and 128,900 tonnes of CGT. Significantly more ships were also built in 2020-2021 than in 2018-2019.

> *For several years we have been observing a strong revival on the Tricity shipbuilding market.*
>
> - **Lech Grycner**, president of the board, Maritime Advanced Research Centre (CTO)

Total gross tonnage of ships built between 2018 - 2021

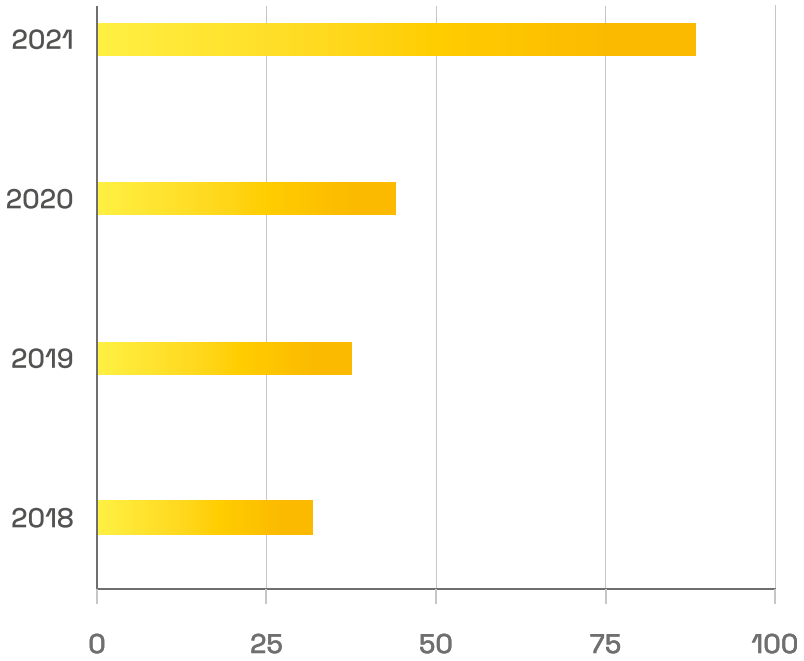
73 100 GT

128 900 CGT

Source: Central Statistical Office

In addition to the visible increase in the production of new ships in Poland, there is also an increase in the production of hulls, as well as repairs and modernization of vessels [11]. In 2021, the number of all operations related to repairs and modernization carried out in the Pomeranian region amounted to 361 ships.

Production of hulls in Poland in 2018 - 2021_



Type of ship	Built in 2018 - 2021	In the order book in 2018-2021
Container ships and semi-container ships	1	2
General cargo	1	-
Bulk carriers	-	2
Ferries	**4**	**23**
Passenger ships	1	-
Ro-Ro ferries	4	-
Fishing ships	6	5
Non-cargo ships	**8**	**36**

Source: own study based on available data from the Central Statistical Office and data from the Seaports Authorities in Gdańsk and Gdynia

Based on the data of the Central Statistical Office for the years 2018-2021, the types of ships both produced and those in the portfolio of orders in Pomeranian shipyards outline a clear trend and specialization of the Pomeranian market.

We currently distinguish two promising niches for the shipbuilding sector, one of which is the production of Ro-Pax ferries for the Baltic Sea. So far, many such units have been produced in China.

They were ordered by most European ferry operators, such as TT-Line, Stena Line or other companies, including French and Danish ones. The reason was the lack of competitive offers in Europe.

- **Grzegorz Landowski**, communications director, Remontowa Holding

Pomeranian shipyards confirm that the production of ro-pax ferries is an important direction in building a strong shipbuilding sector. Gdańska Stocznia Remontowa SA, the largest company of the Polish shipbuilding group Remontowa Holding, is currently carrying out an order for new ro-pax ships for Polskie Promy. These vessels will sail between Poland and Sweden.

The hardest part is building a prototype. Thanks to the experience of rebuilding numerous ferries, it is easier to build this type of vessel from scratch, including the production of the hull.

By implementing this project we want to change the rules of the game and be an important player in this segment in this part of Europe.

- **Grzegorz Landowski**, communications director, Remontowa Holding

The launching of the first vessel is to take place in 2023, and the last ferry will be made available to the shipowner by 2027.

The vessels produced will be not only modern but also environmentally friendly. They will use four Dual-Fuel engines with battery support, thanks to which they will reduce emissions into the atmosphere. The engines will be powered by liquefied natural gas and diesel fuel for ignition initiation. Each ferry will be equipped with two azimuth thrusters at the stern and two thrusters at the bow. Azimuthal thrusters improve the maneuverability of the vessel, thanks to which ships often do not need to use the services of tugboats [12].

Remontowa Shipbuilding, in the years 2016-2022, handed over as many as ten low-emission, fully equipped ferries for shipowners, e.g. from Canada and Norway. Among them are the four LNG-powered ferries mentioned earlier - Salish Orca, Salish Eagle, Salish Raven and Salish Heron - for BC Ferries, entirely designed by Remontowa Marine Design, and four battery-powered hybrid units for Norleda - Festøya, Solavågen, Mannheller and Fodnes. The latter represent a new generation of hybrid electric ships that meet very stringent international regulations regarding the level of harmful substances and greenhouse gas emissions, and are also among the most energy-efficient ships in their class. For the ferry Festøya Remontowa Shipbuilding received the prestigious SHIPPAX Award in 2021.

Also CRIST S.A. shipyard performs orders for the production of ferries. In January 2023, it delivered a third such vessel to the Finnish ferry operator Suomen Lauttaliikenne Oy (FinFerries). In 2017, the first fully equipped hybrid passenger-car ferry Elektra (double-ended ferry) with electric drive in the European Union left the Gdynia shipyard. The vessel is designed for a line of 90 vehicles and up to 372 people between Nauvo and Parainen (see page 45). The vessel, commissioned in January 2023, will operate on the Nagu-Korpoo route in Finland. It will be able to carry around 200 people and 52 vehicles. The ferry is designed to be operated by one person only [13].

In 2022, the Altera ferry was also commissioned. All three vessels were designed with the participation of the Polish design office StoGda Engineering (see Chapter 2. Challenges facing the vessels design market).

The Gdańsk shipyard Marine Projects Ltd. also has a share in the ferry production industry. In cooperation with Holm Construction Ltd., they implemented two steel blocks for one of the newest and most technologically advanced car-passenger ferries on the Baltic Sea. The vessel was built by the Finnish shipyard for the Estonian shipowner Tallink and since December 2022 it has been operating routes between Finland and Estonia. [14] This is not the only order from the area of ferries for this shipyard. In 2018, Marine Projects Ltd. built and delivered a four-level superstructure in an advanced stage of internal fitting, for installation on the ro-pax ferry hull.

The order was placed by the Irish Continental Group at FSG [15]. Marine Project Ltd. based in Gdańsk specializes in the comprehensive construction of ships, superstructures with full equipment and hulls with partial equipment and hull blocks. The company employs about 400-500 people. Since 2003, Marine Projects Ltd. has been the owner of Conrad SA, which specializes in the production of luxury sailing and motor yachts (see Chapter 6. Yachting industry). As Grzegorz Landowski (Remontowa Holding) said, the second breakthrough moment for the maritime sector is the development of the shipbuilding industry.

> *The war in Ukraine forced many countries to review the military equipment. In the last five years, 9 vessels for military purposes have left the Remontowa shipyard. There are few shipyards that are able to deliver so many vessels in such a short time. There are still many ships to be built.*
>
> - **Grzegorz Landowski**, communications director, Remontowa Holding

According to MarineLog data, Denmark plans to invest up to $5.4 bn in new warships, and the German chancellor has announced investments of $100 mln for defense. It is assumed that this plan will include an increase in spending on the navy.

Despite the worrying political situation in Europe, this is a chance for the shipyard to get new orders [16]. At the end of 2022, Remontowa Shipbuilding shipyard commissioned the third military vessel from the series of Kormoran II minehunters. The agreement with the Navy was signed in 2013. In 2014, a prototype was created, and then three vessels were delivered one by one - ORP Kormoran, Albatros and Mewa. 3 more ships are under construction.

Remontowa Shipbuilding will also be a subcontractor in the Delfin design. It assumes the delivery of two SIGINT radar reconnaissance ships, and the Swedish company Saab is responsible for its implementation. Another design in which Remontowa Shipbuilding shipyard will be involved is the PGZ Miecznik program, large warships (Remontowa is one of the consortium members, responsible for a part of the design). Remontowa returns to special production. Regardless of the orders carried out for the Navy, an example of other special units used to ensure the safety of sea routes and protect critical infrastructure are the two multi-purpose ships Zodiak II and Planeta I designed by Remontowa Marine Design and delivered in 2020 by Remontowa Shipbuilding.

They were built for Polish Maritime Offices as part of the project „Nostri Maris - construction of two multi-purpose vessels", co-financed by the EU from the Cohesion Fund (Operational Program „Infrastructure and Environment"). Both ships (60 m long) are intended, among others, for for transport, maintenance, replacement and control of navigation markings, hydrographic measurements, towing works, fighting oil spills and breaking ice on waters. In addition, they can serve as units supporting other services in sea rescue and firefighting.

They are equipped with modern azimuth thrusters that can rotate 360 degrees in any direction and a bow thruster, which gives full control over the ship. Precise positioning is ensured by the DP (Dynamic Positioning) system, operated by a touch screen with the latest software and controlled by a joystick, which will also enable very accurate hydrographic measurements. These vessels were named the World's Best Working Multi-Purpose Craft by Baird Maritime in 2020.

Pomeranian shipyards also have a lot to offer in other areas. Pomerania is a very important supplier of fishing vessels. Karstensen Shipyard Poland, a subsidiary of the Danish Karstensens Skibsværft A/S from Skagen, specializes in this type of vessels.

The shipyard has been operating in Pomerania since 2018. Orders are mainly carried out for Danish shipowners. In 2021, a 36-meter trawler was launched at the shipyard, which will serve the port of Hanstholm [17]. At the beginning of 2023, another fishing vessel was launched at the shipyard. This time the 77-meter pelagic trawler was made for a Scottish customer - Christina S Fishing from Fraserburgh. In 2022, two other vessels were launched for the Norwegian company Gollenes AS [18].

Źródło: www.gospodarkamorska.pl

This shows that the shipyard is not slowing down and is developing in Tricity. In 2022, a decision was made to move production from Gdynia to Gdańsk to an area three times larger than the current one.

Another important player in the region in the field of production of fishing vessels is Marine Project Ltd. In 2022, the shipyard completed an order for a partially equipped vessel for transporting live fish, Ro Senja, for the Norwegian shipowner Rostein A. This is one of many orders for this type of vessel for Norwegian companies. A similar order was also carried out by Marine Projects for a Chilean shipowner ORCA YKA [19].

In 2021, the Euro-Industry Shipyard, located in the northern part of the Pomeranian region, signed a contract for two sea inspection vessels for the General Inspectorate of Sea Fisheries, which will join its fleet this spring. The vessels will be used for control and patrol activities, supervision services, escorting fishing vessels to the nearest port, as well as conducting search and rescue operations [20].

Alushіp Technology also operates on the Pomeranian shipbuilding market. It is a leading European supplier of aluminum structures (more on Alushіp Technology's production in the area of superyachts in Chapter 6. Yachting industry).

We are a well-known brand in the EU market specializing in large and very large aluminum structures, superstructures, aluminum hulls, all kinds of smaller parts used in the offshore industry, on oil and gas platforms, as well as in the renewable energy industry and other industries. Recently, about ⅔ of our activity is the construction of ships and superyachts.

It should be emphasized that we are not only a manufacturer of structures, but we also carry out engineering works, technical designs, as well as highly advanced calculations of vessel loads. We are well embedded in Europe's leading maritime cluster.

- **Goetz Linzenmeier**, chairman/ founder, Alushіp Technology

3.4 Autonomous ships - a new era of unmanned transport_

The value of the autonomous ship market is estimated at over USD 85 bn (for 2020). Prospects speak of up to USD 165 bn in size of this market by 2030. This means an average annual growth rate of 6.8% until 2030. Autonomous ships, also known as unmanned ships, are equipped with advanced software and hardware, such as sensors, automated navigation, propulsion and auxiliary systems. Operations on autonomous ships are controlled by advanced operating systems, which enables them to make decisions and act independently based on calculations [21].

$85 bn
Value of the autonomous ship market as of 2020

$165 bn
Estimated value of the market until 2030

6.8%
Annual average growth rate until 2030

One of the leaders in the development of control systems for autonomous ships is Kongsberg. The company has the world's first contracts for the commercial delivery of autonomous ships. The company's portfolio of designs in the area of systems is extensive and includes, among others, the Yara Birkeland - the world's first fully electric and autonomous zero-emission container ship. Kongsberg is also working on a system to automate the crossing between Horten and Moss in Norway and to move ferries to and from the quay [22].

Autonomous ships are an excellent vessel for servicing wind farms, and Norway is a leader in this area.

- **Radosław Kubiszewski**, president of the board, DNV Poland Sp. z o. o.

Kongsberg Maritime is a Norwegian supplier of marine systems. The company's Centre in Gdynia specializes in repairs of Commercial Marine line devices, in particular, propulsion systems (propellers and propeller shafts, thrusters, azimuth thrusters), steering devices (rudders and steering gears), on-board devices (hydraulic motors, hydraulic pumps and valves) and Bergen engines.

The development of autonomous vessels will be associated with an increased need for instrumentation for their proper operation.

> *The trend that is already visible and what we will observe in the near future is related to the development of individual autonomy.*
>
> *With its development, the demand for instrumentation related to the ship's sensors will increase, i.e. all elements on the ship that are currently supervised by the crew will have to be measured and collected by central data collectors.*
>
> *Enamor is ready to meet these challenges.*
>
> - **Maciej Rek**, CEO, Enamor

In June 2022, the 5-week journey of an unmanned ship designed to recreate the historic voyage of the Mayflower sailing ship across the Atlantic Ocean 400 years ago ended. This autonomous vessel sailed from Plymouth, UK to Halifax, Nova Scotia, Canada. The 15m long vessel was navigated by onboard artificial intelligence based on information from six cameras and 50 sensors [23]. The aluminum hull of this vessel was built in Gdańsk at Alushipp Technology and launched in 2020 [24].

3.5 Offshore Industry in Pomerania - the driving force of the shipbuilding sector_

The offshore sector is one of the main production areas of the shipbuilding industry, as mentioned in Chapter 1. Economic Outlook. Pomeranian companies have extensive experience in building both for the oil&gas sector focused on oil and gas extraction, as well as vessels for the installation and operation of offshore wind farms. We are talking about both ships used to service platforms and wind farms, as well as specialized structures.

Energy markets were hit hard by the pandemic in mid-2020. Oil demand fell by 17 m barrels a day in the second quarter. Despite relative stabilization towards the end of the year, this slowdown had a major impact on the drilling rig market, which saw more than 100 canceled or amended contracts as of March 2021.

OECD forecasts indicate a significant increase in demand for units servicing drilling rigs due to Russia's aggression against Ukraine and growing concerns about supply.

According to the OECD, a gradual increase in the supply of offshore vessels can be expected. This is good news for the Pomorskie market and the companies operating here [25].

One of the largest Pomeranian players in the field of offshore sector services is Mostostal Pomorze. They have over 20 years of experience in the production of large-size steel structures. The company's designs include the construction of drilling platforms, steel sections for platforms and other steel structures.

Energomontaż Północ Gdynia is another leading Polish manufacturer of highly specialized, fully equipped steel structures for the offshore sector, conventional, renewable and nuclear energy, chemical and petrochemical industries, and the shipbuilding industry.

The Remontowa Holding shipyard - the largest, multidisciplinary player on the Pomeranian shipbuilding market - also has extensive experience in the field of offshore oil & gas. So far, the following vessels have left the shipyard to service drilling platforms:

- PSV (Supply ship designed to serve the offshore mining industry, built using the latest economic operational solutions)
- Specialized vessels designed for laying, lifting and maintenance of submarine cables
- AHTS type vessels for servicing drilling rig anchoring operations and acting as seagoing tugboats.

Remontowa has completed over 100 ships for the offshore sector, including those for servicing drilling platforms. One of the leading examples is the Siem Aimery vessel - a cable ship with the highest saturation with advanced technology among those built so far in Polish shipyards.

Source: Image courtesy of Remontowa Holding

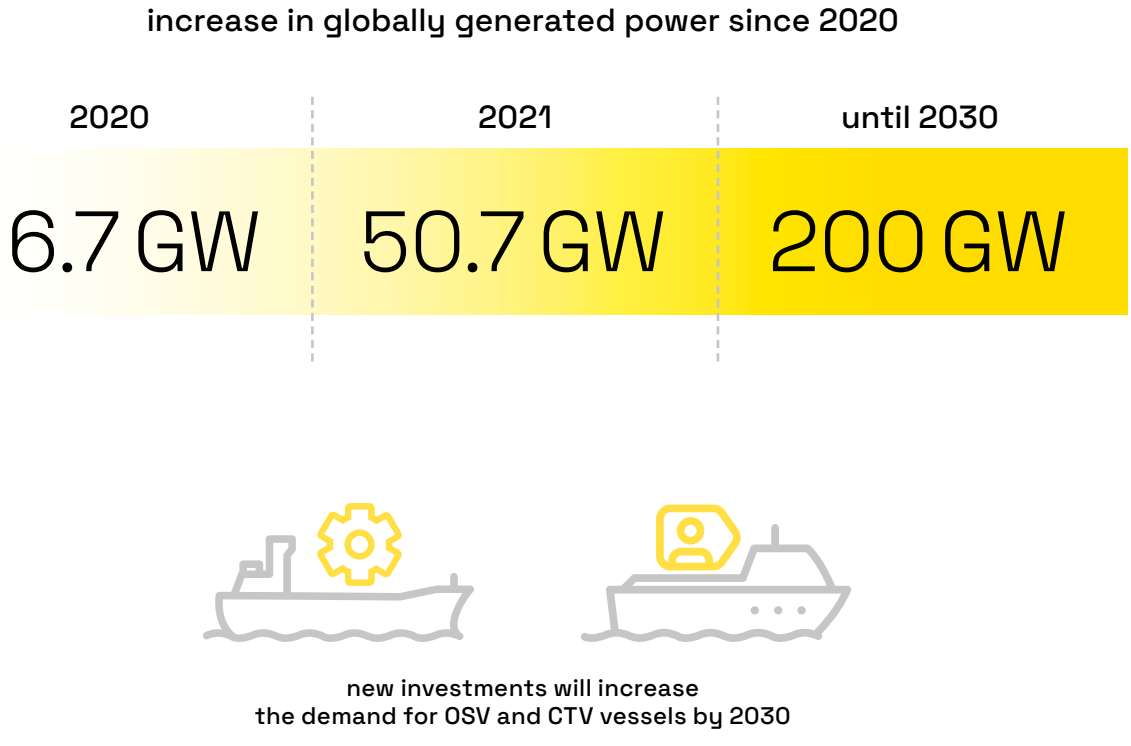
The offshore wind sector is set to play an important role in the global energy transformation. Unlike other sectors of the offshore market, offshore wind has experienced two record years in terms of investment. In 2020, investments of USD 56 bn and 6.7 GW were recorded, while in 2021, global capacity increased by 55% to 50.7 GW from 18.5 GW (Clarkson's Research, 2022).

By 2030, new investments could reach 200 GW at a CAGR of 13.5%, driving demand for SOV and CTV vessels [26]. The largest designs implemented for the offshore wind sector came from CRIST shipyard.

$56 bn
amount of investments in the offshore sector in 2020

55%
increase in globally generated power in 2021

13.5%
CARG level in 2030



new investments will increase the demand for OSV and CTV vessels by 2030

> *Heavy-lift jack up vessels are considered the most specialized vessels. That's 11 k tons of steel in the hull. Comparing the costs of individual vessels, e.g. the cost of an LNG tanker increased from $180 mln to $250 mln over the course of a year, while the heavy lift jack up costs over $500 mln.*
>
> *This illustrates what equipment is on this ship, because from the outside it looks like any other. The scale of equipment and integration is so amazing compared to other ships.*
>
> *The ship is raised on electric motors, and when leaving the vessel, the electric motors function as brakes, which generates a huge amount of energy. We plan to receive this energy and store it in batteries. Thanks to this, our vessel will be very energy efficient.*
>
> - **Daniel Okruciński**, deputy commercial director, CRIST S.A

At the same time, despite the development and wide discussion about offshore wind designs in the Baltic Sea, there are no discussions about the construction of newer generation lift jack-up ships at the moment.

In terms of orders for new ships, an optimistic outlook is presented by Jerzy Czuczman from Polish Forum of Maritime Technologies. In his opinion, the vessels for the installation will be leased for the upcoming investments in the Baltic Sea, but he sees the prospect that further designs will result in orders of this type of ships in Polish shipyards. On the other hand, Remontowa is also planning to enter the offshore wind market, using its previous experience in the oil&gas sector. The company sees its role as a supplier of service and maintenance vessels.

Over the last two years, we have converted four offshore auxiliary vessels into submarine cable laying (including power) and transmission installation vessels. We have more and more such orders.

On tankers and platforms, we have also built FPSO and FSO „floating refineries", which collect oil and gas from production fields, carry out the initial refining process and store the raw material prepared in this way.

Ships for offshore wind services will also have to be low-emission - this is a huge field for the development of new projects and technologies.

- **Grzegorz Landowski**, communications director, Remontowa Holding

Baltic Operator shipyard also operates on the offshore wind market for foreign entities. At the end of 2022, the company signed a contract with the Finnish shipyard Meyer Turku. It includes the delivery of partially equipped Offshore Patrol Vessels (OPV). Baltic Operator is part of the Baltic Industrial Group. Its specialization is shipbuilding, wind and offshore energy [27].

Source: Image courtesy of CRIST S.A Shipyard

04

Towards sustainable shipping_

4.1 Review of legal regulations

Threats related to climate change have an increasing impact on the actions of decision-makers around the world. The Paris Agreement signed by 169 international entities [1], or the commitment of the European Union to achieve climate neutrality by 2050 [2] are some of the initiatives that aim to create a legal framework to limit further environmental pollution. A sector that is not spared by such processes is also the maritime industry, whose further development will be accompanied by a number of trends directly related to the direction of global changes in the approach to environmental protection and combating climate change.

A document of particular importance for the sector is the International Convention for the Prevention of Pollution from Ships (MARPOL) of 1973, prepared under the International Maritime Organization (IMO). The result of the creation of the document is the constantly developing and evolving system of environmental regulations (since the creation of the convention, IMO forum adopts subsequent resolutions introducing annexes and amendments to the original text of the document), which results, among others, in the creation of a coherent system for assessing the energy and operational efficiency of vessels (indices EEDI, SEEMP) or even proposing the creation of sulfur and nitrogen emission control areas (ECAs) in the seas and oceans [3].

A potentially important document from the point of view of reducing further greenhouse gas emissions is also the Preliminary Strategy of the International Maritime Organization published in 2018 on reducing greenhouse gas emissions from ships. One of the proposals of the strategy is consistent action aimed at reducing the intensity of carbon dioxide emissions in international shipping. Ambitious plans assume the reduction of CO2 emissions by at least 40% on average by 2030 and the pursuit of reducing emissions by 70% by 2050, comparing the data with the baseline year - 2008. In addition, it is assumed that the total annual greenhouse gas emissions from international shipping should be reduced by at least 50% by 2050 compared to 2008 [4].

At the level of the European Union, the *Fit for 55* package is of key importance, which includes a reduction of carbon dioxide emissions in the Community by 55% by 2030 compared to 1990, which will result in the EU achieving climate neutrality by 2050 [5].

The content of the package also includes a plan to take the necessary actions in the field of the European maritime sector. At the moment, they concern vessels with a gross capacity of over 5,000 GT, whose operation in the European Union will require meeting additional requirements related to the reduction of greenhouse gas emissions by these vessels.

CO_2 emissions reduction forecast_

40%
of an average CO_2 emissions reduced by 2030

70%
of CO_2 emissions reduced by 2050

50%
of total annual CO_2 emissions by international shipping reduced by 2050

According to the assumptions, maritime transport is to be included in the emissions trading system (EU ETS). In practice, this will involve the need to change, modify or increase the efficiency of propulsion vessels operating in the EU, the ultimate effect of which is to reduce greenhouse gas emissions by 75% by 2050 [6].

Source: Image courtesy of StoGda Ship Design & Engineering

4.2 Market characteristics and further predictions

Regulations and strategies imply a number of changes that may shape market demand in the coming years. The DNV report „Maritime Forecast to 2050" published in 2022 indicates several dependencies that are already beginning to emerge in the sector.

The first is the growing trend in orders related to larger vessels in terms of the share of those adapted to use alternative fuels, such as liquefied natural gas (LNG) [7]. Approximately 5.5% of all gross tonnage currently sailing is operating or will be able to operate using alternative fuels.

For comparison, in the case of vessels currently in the ordering process, it is already 33% of their entire gross capacity. A slight percentage increase can also be seen in the ratio of the number of battery-powered or hybrid-powered vessels ordered to the number of those currently in operation.

Planned decarbonisation goals by 2050_

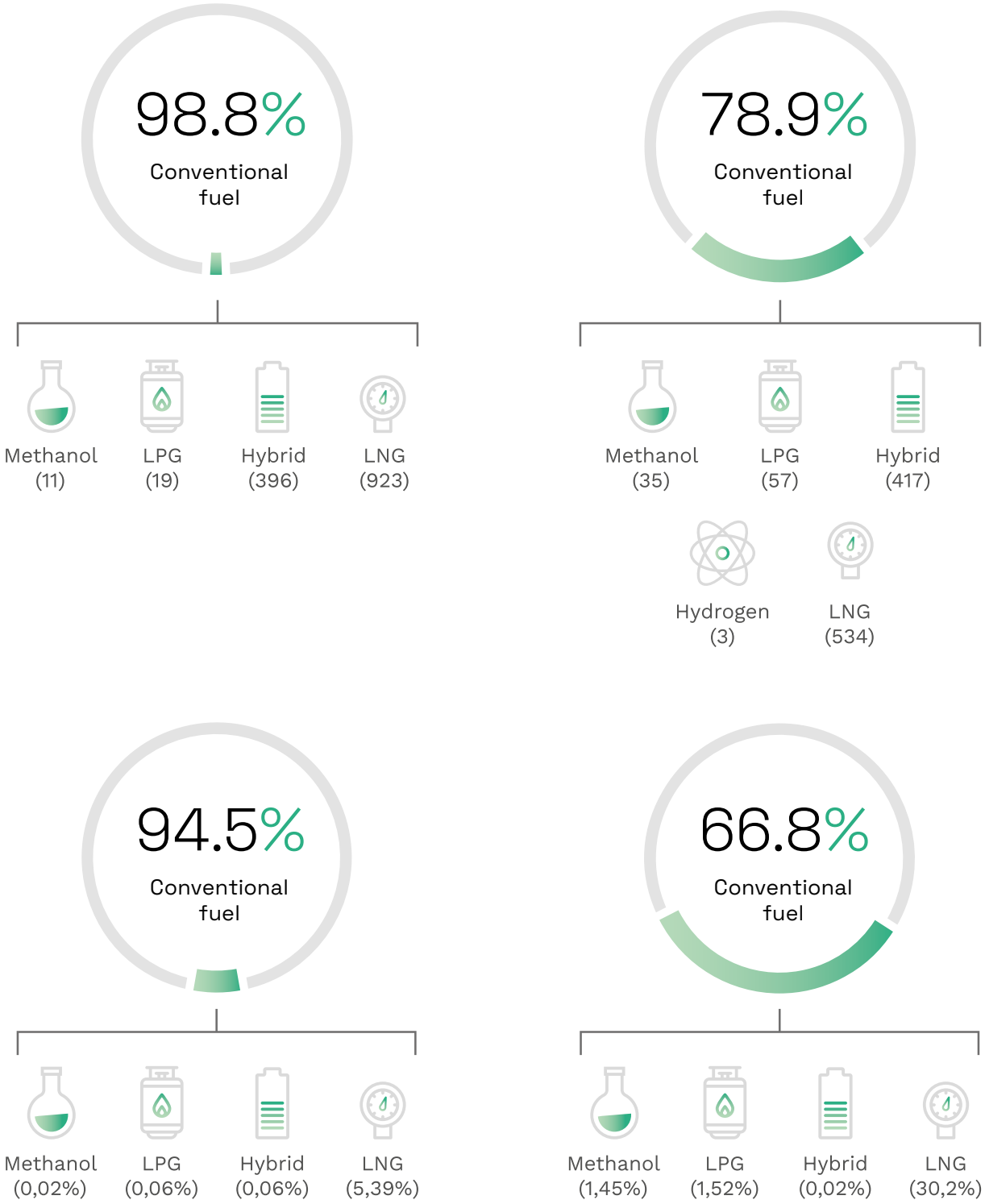
$8 bn ≤ $28 bn/ yr

an estimated amount of financial outlays necessary to achieve

Hydrogen-powered vessels are becoming more and more important. [8] According to the assumptions of the DNV report, fuels such as hydrogen or ammonia may be fully technologically adapted for commercial use within the next eight years. It is difficult to clearly determine which alternative fuels will dominate the market. We can assume that the fuel market for the marine sector will become much more diversified, and fuel prices will depend to a greater extent on the available energy sources used for their production, including renewable sources.

One of the assumptions that can be made, referring to the above elements, is the conclusion that the development of the segment of alternative fuels such as hydrogen, methanol or ammonia will force the development of accompanying safety regulations, which in the future may benefit companies offering products and services directly related to this element.

Use of alternative fuels in the world fleet by number of ships and gross tonnage_



Source: Maritime Forecast to 2050, Energy Transition Outlook 2022, DNV 2022

Different solutions - clean electricity, hydrogen, methanol, LNG still have their limitations related to, for example, the introduction of new security measures, the significant volume of these fuels, or the frequency of ship bunkering.

I think that until we technologically achieve the ability to continuously power the propulsion from a source of electric energy, it will still have to function on the vessel, in some form, the combustion process, be it diesel or LNG fuels, primarily on long routes.

- **Daniel Okruciński**, deputy commercial director, CRIST S.A.

The ship repair and conversion market is estimated to reach USD 26.5 bn in 2023, with growth projections to nearly double by 2050 to over USD 50 bn [11].

The phenomena having a positive impact on the above trend include, among others, the already mentioned tightening of emission standards, the digital transformation of maritime transport, the increasing standards of required safety, as well as the aging of the commercial fleet in many regions of the world.

value of the ship repair and conversion market_

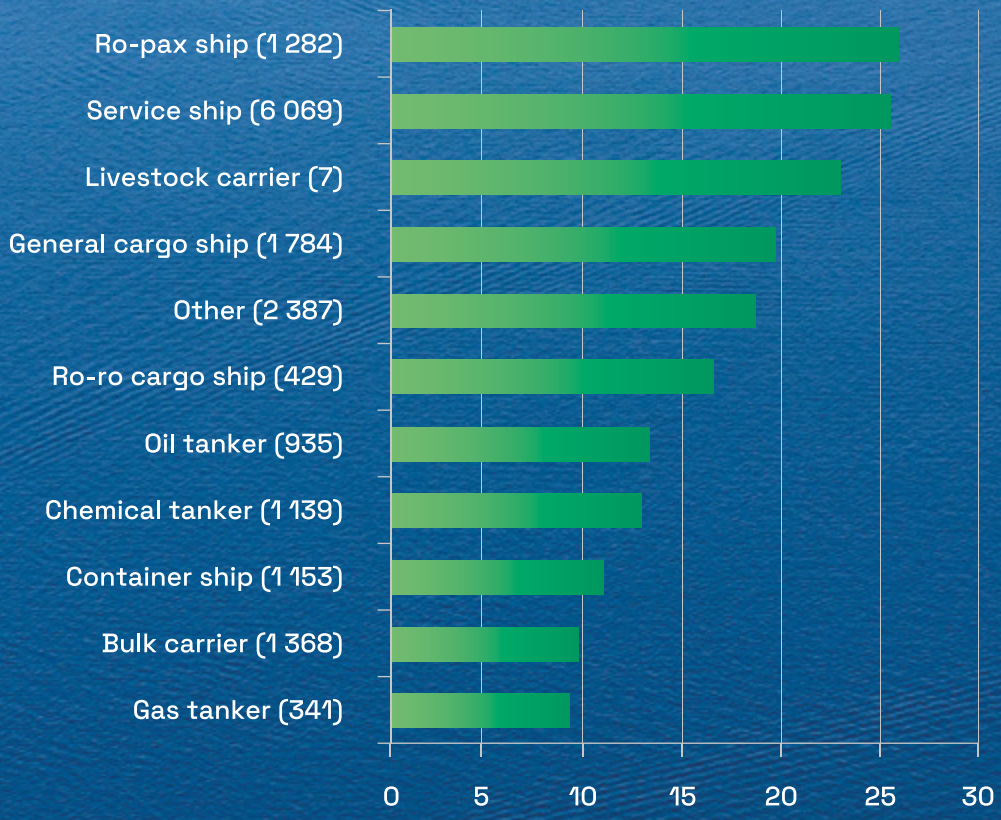
$26.5 bn

in 2023

$50 bn +

by 2050

Average age per ship type_ (ships registgered under EU Member State flag)



GHG emission reduction potential of technologies that can contribute to the decarbonisation of shipping

Logistics and digitalization	Hydrodynamics	Energy
speed reduction	hull coating	LNG / LPG biofuels
vessel utilization	hull-form optimization	electrification
vessel size	air lubrication	methanol/ amonia/ hydrogen
alternative routes	cleaning	wind power/ nuclear power
>20%	**5 - 15%**	**0 - 100%**

Machinery	After treatment
machinery efficiency improvements	Carbon capture and storage
white-heat recovery	
engine de-rating	
battery hybridization and fuel cells	
5 - 20%	**>30%**

Source: Maritime Forecast to 2050, Energy Transition Outlook 2022, DNV 2022

An example of the situation on the repair and modernization market is the area of installing ballast water treatment systems. According to estimates, in 2021 there were 35,000 vessels operating in the world that still had not been equipped with the aforementioned systems that would meet the planned standards. Assuming that due to the required restrictions, all of them would have to undergo the necessary modifications by autumn 2024, which ultimately resulted in 875 installations to be carried out per month [12].

> *If we all do not follow these guidelines, the environment will be degraded in the near future. We agree with this assumption and have been participating in various European framework programs related to environmental protection for a very long time, even before Poland's accession to the European Union.*
>
> *An example of such activities are ballast water treatment programs, where the first such projects were implemented by us in 2004, long before the annexes to the IMO Convention entered into force*
>
> - **Tomasz Świątkowski**, member of the design board, StoGda

Pomeranian enterprises actively participate in the competition for the best positions on the market. Some of the products and services offered by Pomeranian business entities are part of the sustainable development trend. In order to focus on individual elements, activities of specific entities that directly or indirectly follow the trends described above will be presented and described below.

> *Undoubtedly, low-emission technologies are a trend we want to follow. Let us remember that in addition to new constructions, in the coming years it will speed up the modernization process of the existing fleet, and in this context, especially, we will focus on new solutions in the field of fluid mechanics and structural mechanics.*
>
> - **Lech Grycner**, president of the board, Maritime Advanced Research Centre

4.3 Construction of low-emission vessels

Europe is a leader in the production of units with an electric drive system. In 2019, it was responsible for 34.9% of implementations in the world [13].

Among the European countries, Scandinavian countries are the leaders, as in the segment of electric and hybrid vessels, they focus, among others, on ferries for transporting cars and passengers. Pomeranian shipyards are an important supplier of designs that very often go to Scandinavian markets.

Entities that have many years of experience in such designs are primarily Remontowa Shipbulding S.A. and CRIST S.A. shipyards. The most important and at the same time often pioneering, from the point of view of the low-emission trend in Poland of CRIST S.A. shipyard projects from the last few years include designs such as the NB 70 Herjólfur hybrid car-passenger ferry for the Icelandic shipowner Vegagerðin, the NB913 hybrid double-ended ferry for the Vard shipyard, the Elektra ferry, the first of its kind in the European Union, and the Altera built for the Suomen shipowner Lauttaliikenne Oy operating under the FinFerries brand.

The last of the mentioned ferries is equipped with batteries with a capacity of 1,200 kWh, which can be charged from the shore as well as by three power generators installed on the vessel (14). At the end of January 2023, the shipyard launched the third vessel of this type for the Finnish shipowner - P 317. As in the case of the Altera ferry, it will take only a few minutes to load it [15]. Other designs include the construction and partial equipment of the hull of the Color Hybrid ferry for the Ulstein shipyard. At the time of handing over to the shipowner, the ferry was the largest shore-loaded vessel of this type in the world [16].

As far as the Remontowa Shipbulding company is concerned, the shipyard's designs include, among others, vessels with a more ecological, due to their efficiency in relation to the emissions, diesel electric system, Linga ferries, Princesse Isabella ferries, a series of four "Salish" – Orca, Eagle, Raven and Heron for the Canadian shipowner British Columbia Ferries, or two ferries Töll and Piret for the port of Tallinn [17].

The shipyard also has in its portfolio the construction of vessels with a hybrid drive - these are, for example, car-passenger ferries Ben Woollacott and Dame Vera Lynn plying on the Thames in London, or four hybrid ferries built in 2020/2021 for the Norwegian Norled [18].

Another type of solutions built by Remontowa are LNG-powered vessels, including the „double-ended" ferries Fannefjord, Romsdalsfjord, Korsfjord and Moldefjord for the Norwegian shipowner Fjord 1 MRF, as well as the Ryfylke and Hardanger ferries for Norled. An interesting design is also Coral Methane from 2009, which was the first vessel built in a European shipyard adapted to transport three types of cargo: LNG, LPG and ethylene. Using a diesel-electric system with partial use of LNG, it is one of the most ecological cargo ships built in Europe [19].

Alusip Technology company from Gdańsk has also built ecological solutions. Its designs include, among other, an aluminum hull for the ZeroCat vessel, currently known as Ampere - the first all-electric ferry, the construction stage of which in Poland ended in 2014 [20]. Another shipyard that builds diesel-electric vessels is also Marine Projects Ltd. sp. z o.o., which supplies, among others, customers on the Norwegian market.

Bürgenstock Swiss lake ferry. Source: www.polandatsea.com
Construction designed and built by Alusip Technology

4.4 Repairs and conversions

In addition to the construction of new vessels, the repairs and conversion of existing vessels is also an important way to reduce emissions. As in the case of the construction of new vessels, also in the field of repairs and conversion, Pomeranian shipyards make a significant contribution to the development of the European sector. In a study conducted by Clarksons Research in 2019, Polish shipyards were responsible for 3% of all ship modifications carried out globally [21].

According to the data of the Central Statistical Office from the Statistical Yearbook of Maritime Economy, the number of ship repairs carried out in the Pomeranian region in 2021 increased to 361 vessels, reaching a total value of USD 267 m. This accounts for over 79% of all vessels repaired in the country and as much as 91% of the total value of repairs carried out nationwide. In addition, the portfolio of orders for renovations for 2021 has doubled compared to 2018 [22].

Ship repairs according to the Statistical Yearbook of Maritime Economy for 2021_

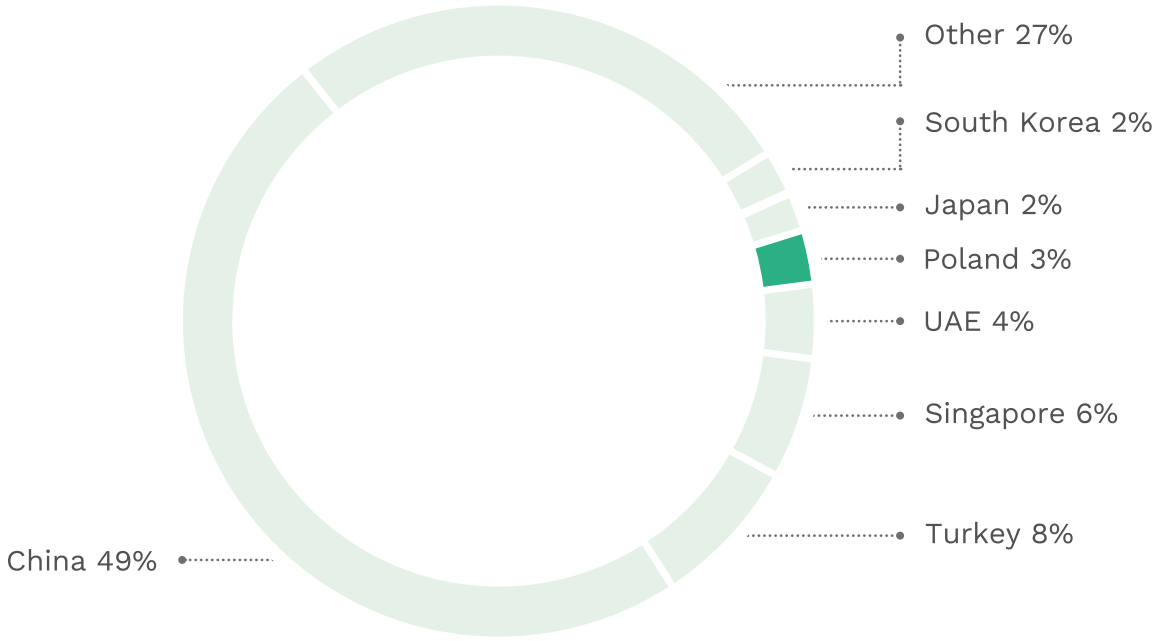
Specification	2018	2019	2020	2021
Overall				
Number of ship repairs	527	504	444	455
Value in million USD	282	292,2	310,8	293,3
Pomeranian Voivodeship				
Number of ship repairs	358	357	295	361
Value in million USD	249,747	265,4	277,8	267,9

* until 2018, the value of renovations was given in millions of euros

Source: Statistical Yearbook of Maritime Economy for 2021, data of Maritime Advanced Research Centre in Gdansk

The leader of this segment in the maritime sector is primarily the Remontowa Shiprepair shipyard, which in 2019 was ranked ninth in the world in terms of the number of class repairs carried out [23]. Each year, Remontowa repairs or modernizes, to various extents, a total of about 200 vessels, including the largest vessels that can enter the Baltic Sea.

Total number of overhauls and repairs in 2019 by country of repair yard_

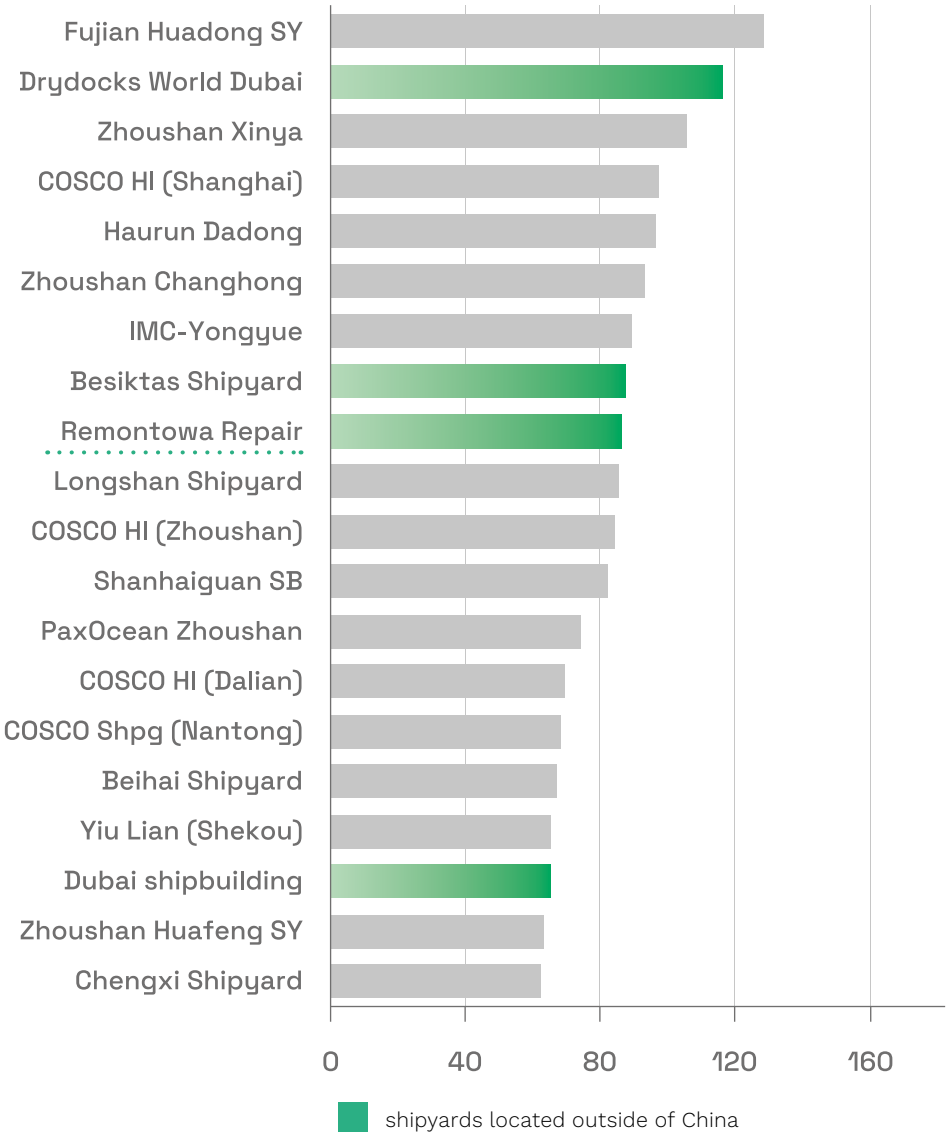


Source: Drydock Magazine June 2020/ p.15

We service all types of ships that enter the Baltic Sea through the Øresund straits. These are container ships, Ro-Ro ferries, Ro-Pax, as well as bulk carriers and tankers, or, for example, dredgers and marine engineering vessels that work on laying and backfilling subsea pipelines. There is a whole range of different units. These are ships that are up to 300 meters long.

- **Grzegorz Landowski**, communications director, Remontowa Holding

Special surveys by repair yards in 2019. Data as of May 2020_



Source: Drydock Magazine June 2020/ s.16

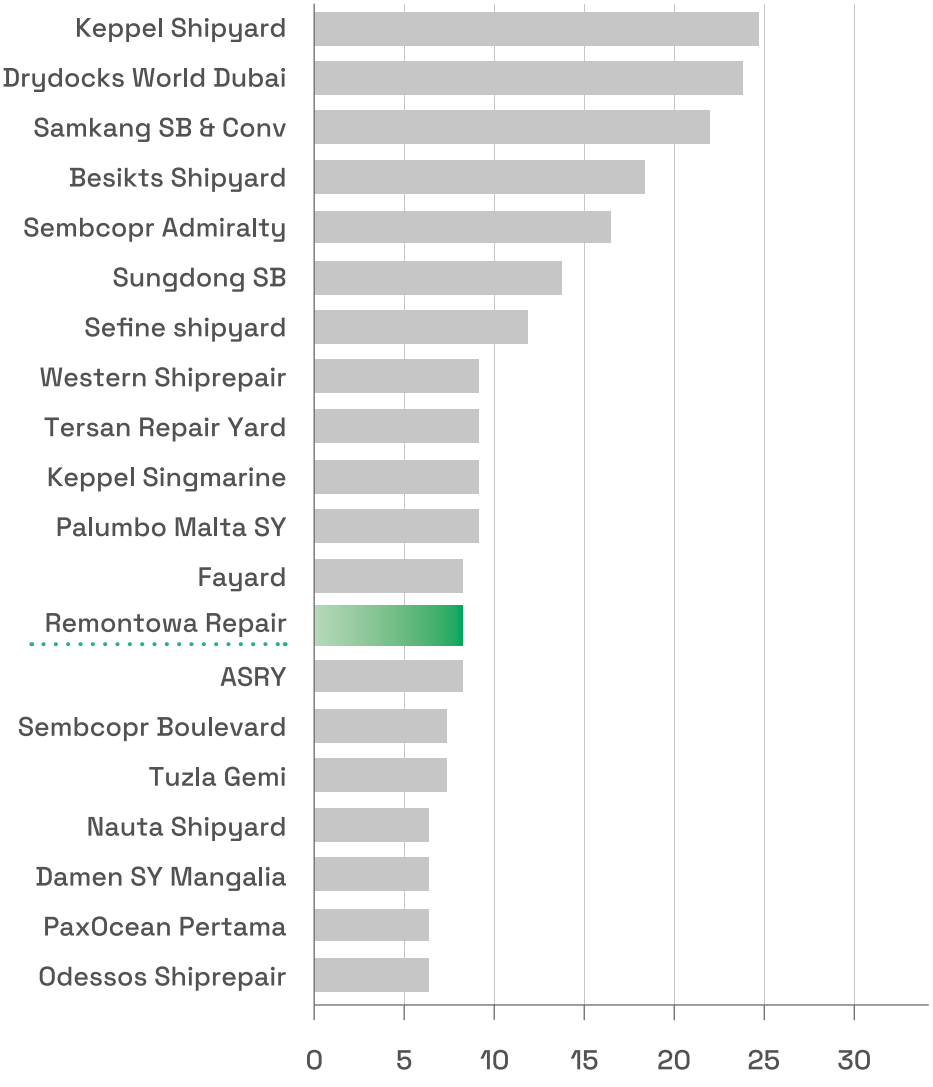
Remontowa's interesting designs include conversions of part of the Stena Line ferry fleet. The flagship design here is the Stena Germanica ferry, which in 2015 underwent a propulsion conversion in a Polish shipyard enabling the use of methanol as fuel.

Thus, the ferry became the first to commercially use this kind of fuel (24). The two newest vessels - Stena Estelle and Stena Ebba, although built in China, also underwent a number of adaptations in the shipyard related to preparation for work in the Baltic Sea basin.

In 2017-2018, the shipyard also rebuilt two large Canadian ferries, Spirit of British Columbia and Spirit of Vancouver Island, adapting them to LNG combustion. As a result, they reduced CO_2 emissions by 25,000. tonnes per year, which corresponds to the removal of approximately 5,000 vehicles.

Other conversions include, for example, the installation of catalytic reduction systems on the Nordnorge vessel in 2022, which reduced carbon dioxide emissions by 25% and nitrogen oxide emissions by 80% [25], or the modernization in 2019 involving the preparation of a steel mounting for a rotating sail on the Copenhagen ferry (26). Moreover, in the rankings of the installed flue gas scrubber systems, Remontowa occupies high positions in terms of the number of works carried out in this area.

Total number of scrubber upgrades in 2020. Data as of June 2021_



Source: Drydock Magazine June 2020/ s.16

The installation of exhaust scrubbers in the Pomeranian region is also carried out by, among others, Nauta shipyards, Alusip Technologies and Trident Maritime Systems. The latter has so far equipped 99 vessels with flue gas cleaning systems, installing a total of 232 scrubbers. It is expected that the mud installation segment in the world, as well as the entire ship conversion and repair market, will develop intensively in the coming years. It is assumed to increase from the level valued at USD 3.5 bn in 2021 to over USD 16 bn in 2030 [27].

$3,5 bn

value of the scrubber installation segment in 2021

$16 bn

estimated value of the scrubber installation segment in 2030

Other procedures related to increasing the efficiency of ships include the use of special coatings for covering the hulls, which can increase the efficiency of the vessel by reducing its fuel consumption. Such activities are carried out in Pomerania, as exemplified by the renovation of two Canadian tankers carried out as part of the Remontowa Holding group, during which the hulls were covered with a special paint coating, which ensures better anti-corrosion properties and contributed to reducing the operating costs of these vessels [28].

Other activities carried out in Pomeranian shipyards, which are not directly related to reducing the emission of vessels, include class inspections and repairs, shortening and lengthening of hulls, construction of ship superstructures, repairs after fires and collisions, or installation of ballast water cleaning systems. Due to the long delivery times of new ships, it is becoming more and more common to modify existing vessels for use in the offshore sector.

In the context of reducing emissions and the impact of the maritime sector on the environment, the issue of port infrastructure, which is very important for the shipping service system, cannot be overlooked.

4.5 Green Port infrastructure

In 2018, the Port of Gdansk became a member of the pan-European EcoPorts initiative, which consists in exchanging experiences and cooperation between its participants in the context of green solutions. The environmental protection activities of the port of Gdańsk include, among others, the possibility of bunkering LNG-powered ships. In addition, the ports of Gdańsk and Gdynia conduct research on the level of pollution in port basins, noise levels and air quality. In 2019, the reconstruction of the sewage and water supply network began at the port of Gdańsk in order to create five new wastewater collection points from ships.

More points are planned to be built. Among the concepts taken into account in the context of further development of the trend of sustainable activities in the port is the application of discounts to port fees depending on the operating parameters of incoming ships and the preparation of infrastructure for powering vessels from shore [29].

The Port of Gdynia can already boast of having a shore power supply system, which was built as part of the new ferry terminal. [30] Thanks to this, the ferry moored at the wharf does not emit gases generated by the operation of internal combustion engines, and it also reduces the level of vibrations generated by the vessel [31].

An important, although not yet fully defined, element of infrastructure that may affect the maritime sector in the future is hydrogen. This fuel could bring new opportunities to the industry over time, especially considering the context of blue fuel production via offshore wind installations.

An environment of institutions and organizations is already being created in Pomerania, whose activities include activities that take into account the development of this type of fuel in the region. These include, among others, the Pomeranian Offshore Platform, the Baltic Maritime and Space Cluster, or the Pomeranian Hydrogen Cluster. As part of the latter, the NeptHyne design is being developed to use wind farms to produce hydrogen and transport it to land.

„Currently, there is a lot of interest in Europe in the concept of combining renewable energy technologies and use of hydrogen.

In the long run, this may be a kind of facilitation and support in the matter of overloads for power grid operators, such as PSE.

A large part of offshore wind energy can be converted into hydrogen, and hydrogen production in Poland alone could create a whole new sector in the industry."

- **Malte Paul**, senior project manager, Maintstream Renewable Power, *Aker Horizons*

05

Advanced technologies in the maritime sector_

5.1 Digital transformation of the maritime industry

Digitization is one of the global trends, in the transformation process it is of key importance to invest in modern technologies that allow you to move away from the traditional image of the maritime sector and benefit from innovative solutions.

The direction of changes is also evidenced by the growing use of data, according to International Maritime Satellite (Inmarsat) statistics on commercial shipping, the average daily data consumption per vessel increased by almost 35% from 3.4 GB in 2020 to 9.8 GB in 2021 [1].

> *In the coming years, the analysis of data with a significant degree of uncertainty, such as weather conditions, nautical data, the analysis of which will contribute to reducing emissions, fuel savings and improving safety, will be of key importance. The development of data infrastructure, which will enable ongoing monitoring and analysis by ports, will also be of significant importance.*
>
> - **Maciej Rek**, CEO, Enamor

The Covid-19 pandemic has disrupted supply chain flows. It should be emphasized that the pandemic was a catalyst for changes in the field of digitization, increasing the level of their use and acceptance among the entities involved [2]. According to Inmarsat estimates, carried out during the pandemic period, the global market for digital solutions for the maritime sector in 2021 was worth USD 159 bn, and the expected market value by 2030 will increase to USD 345 bn [3].

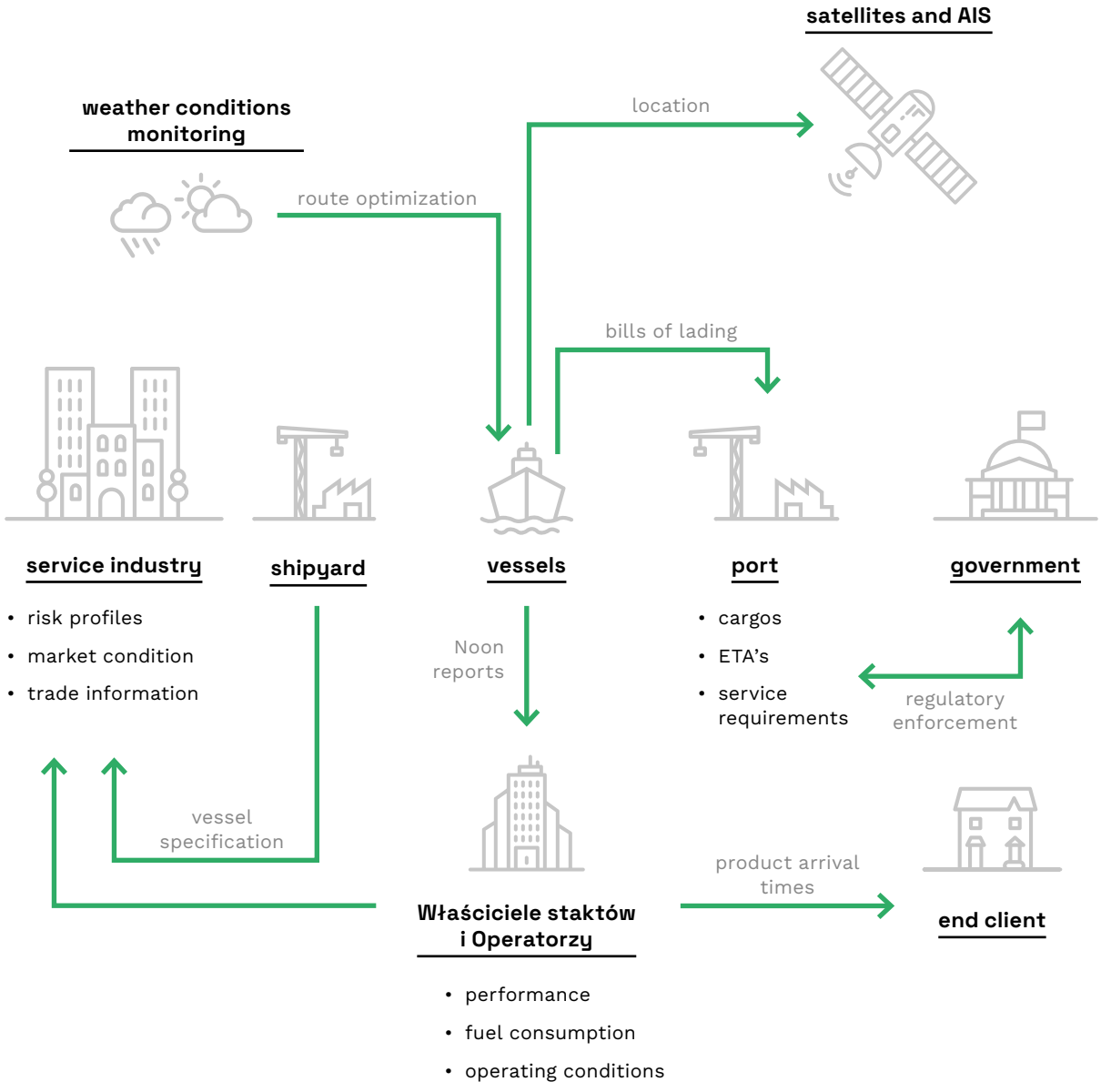
> *The Covid pandemic caused problems with performing tests in real conditions and affected the availability of components, in particular on orders for electronics from China*
>
> - PhD, **Krzysztof Kanawka**, CEO, Blue Dot Solutions

Value of the digital solutions market for the maritime sector_

$159 bn
market value in 2021

$345 bn
market value by 2030

Data flow in the maritime sector_



Source: geospock.com

Even before the pandemic, our company was focused on developing the concept of remote certification, thanks to which, at the outbreak of the pandemic, we were prepared to some extent for the introduction of this tool.

We were one of few classification societies that had such solutions. During the pandemic, over 60% of inspections and certification of marine components were carried out remotely. I believe the trends associated with this process will continue.

- **Radosław Kubiszewski**, president of the board, DNV Poland Sp. z o.o.

Sensors that are able to measure and assess the technical condition of components and vessels are widely used in the maritime sector. Generating operational data is a valuable source of information for those involved in the design and construction of ships, in terms of extending life and designing future equipment. In addition, the development of the possibility of using sensors is driven by legislative changes in the context of the environment.

An example is the Shaft Power Limitation „ShaPoLi" resolution introduced in 2021 by the International Maritime Organization in order to reduce the level of pollutants emitted by sea shipping [6]. In order to meet the standard, Enamor, a Pomeranian company, in cooperation with Samsung Heavy Industries, created the „Samsung Smart Power Limitation" system for monitoring the level of emissions of vessels. The design was announced in December 2022 [7].

As a result of the collaboration, Samsung developed the measurement system, while Enamor designed and supplied the load sensing sensor for the main engine.

- **Maciej Rek**, CEO, Enamor

Long life and ecology also applies to the designed sensors, this policy results from care for the natural environment, which also directly translates into the economic aspect. Sensors are more and more often designed taking into account the miniaturization of components in order to reduce the amount of materials used, attention is also paid to the quality of materials that must be easy to dispose of and based on lower energy consumption. The aspect of auto-calibration, resistance to possible errors and high-quality data transmission are also crucial for the smoothness of the sensors [9].

IoT (Internet of Things) has a positive effect on the efficiency of the processes performed, ensures transparency between the entities involved in the operation, increases the level of security, reduces the impact of unforeseen factors [4]. The development of 5G network infrastructure is a key aspect in the context of IoT is, which enables the mass implementation of IoT technology [11].

Digitization in seaports translates into the creation of smart seaports, which are the fourth generation of their development [10]. Over the years, the approach to the scope of the port's activity has changed, which is treated more as a service, it is also an opportunity for additional profit resulting from the commercialization of this data [12]. Based on calculations made in 2017 by Maersk and IBM, it was shown that 20% of the costs related to transport is the process of administering and processing documentation [13].

Enamor is a company based in Gdynia, with branches in Warsaw and Szczecin, and representative offices in Hamburg, South Korea, Turkey and Singapore. The company specializes in maritime navigation, as well as the supply of systems and devices for monitoring and optimizing the operation of ships.

The scope of their activities also includes solutions for the defense industry. The company cooperates with the Navy, Land Forces and the Border Guard. Enamor has obtained the First Degree Industrial Security Certificate, confirming the full ability to protect confidential information (Secret, Nato secret) [8].

The use of blockchain technology in port transport simplifies and improves the processes taking place in terminals through, among others, optimization of cargo storage processes, precise location of the container in the transport process, thanks to which it is possible to reduce operating costs incurred by entities [14].

In 2021, two Pomeranian companies, Sea Data and Rexs.io, were awarded grants of EUR 60 k in a competition for small and medium-sized enterprises as part of the European GALATEA design. 18 Polish small and medium-sized enterprises participated in the competition for funding, with Sea Data and Rexs.io being the highest scoring among them [15].

Sea Data, located in Gdynia, specializes in Data Science and Big Data, offers smart services for ports in the field of monitoring the movement of vessels, as well as their reloading. In addition, it runs a database on the condition and occupancy of port quays, as well as observes weather conditions for water and air.

As part of its activities, it offers products such as MobileMonitoring [16], which is an inspection and measurement platform based on data from drones and measuring stations. In the accelerator, Galatea, together with partners from Spain and France, was involved in the CORAL design, the aim of which was to create solutions for small and medium-sized ports in the field of managing and optimizing data generated by the port, as well as monitoring water and air pollution. The result of the design was also the development of an application enabling the management of docks and ships in order to improve the exchange of communication between the vessel entering the port and directly the port itself [17].

> *Our spin-off company Rexs.io uses blockchain technology to notarize data. Our customers use it as a module in the software they produce, allowing for the authentication of data sent within the application. It's a relatively new technology, but it's already getting a lot of attention.*
>
> - **Przemysław Szleter**, CEO, DAC.digital in a statement for the Pomeranian Economic Review magazine, September 29, 2020

DAC.digital, a company from Gdańsk, offers IT solutions, including blockchain and AI. In 2022, it was awarded the SoDA award at the SoDA Conference in the revenue and export category among medium-sized companies. DAC.digital cooperates with customers from 20 countries, including Canada, Norway, USA and Israel [18].

As part of the Galatea accelerator, in 2020, it established a separate entity Rexs.io [19], and together with a Romanian partner, it implemented the ABAMS design, consisting in creating a tool to streamline the flow and digitization of documentation. The technology can be used for document circulation in the maritime sector [20].

A technological solution that has been developing in Pomerania in recent years is the use of digital twin technology, whose philosophy is to reproduce a perfect replica of a physical object, system or process. The replica is a three-dimensional visualization that is able to monitor and process data on the condition of the facility on an ongoing basis [22].

Thanks to digital twins, it is possible to assess performance, simulate operations before actually performing them, making it easier to anticipate potential consequences and respond to them [23].

In 2022, the Port of Gdynia signed an agreement with the Krakow consortium HydroBIM related to the construction of a digital replica of the port. This solution will allow to monitor the condition and performance of port infrastructure, collect data on its history, and integrate it with existing documentation [24].

> *The Digital Twin of the Port of Gdynia will enable efficient planning, analysis, data centralization, and the mobile application will provide remote access to data, which will facilitate and accelerate the implementation of tasks at the Port.*
>
> - **Jacek Sadaj**, CEO the Port of Gdynia Authority, 05.08.2022 [25]

Similar solutions in the catalog of its services have been developed for 2 years by a start-up from Gdynia, F44, which has collaborated with Google, Here, TomTom. F44 is developing a design whose aim is to integrate the architecture of different formats of digital twins, thanks to which it will be possible to exchange information between them.

In order to establish relations and further development, the company joined the process of applying for membership in the international consortium Digital Twin Consortium. Which is a platform integrating the business environment, enterprises and the educational sector, acting to accelerate the implementation and development of digital twin technology and supporting technologies in the world.

The consortium includes global brands such as Dell Technologies, Microsoft, Lockheed Martin, Mitsubishi Electric, Intel, AkerBP [26].

> *The big problem for companies producing digital twins is the lack of consistency in terms of their format, they are not able to exchange data. Twins are usually created in relation to very specific problems, responding to specific needs.*
>
> *The integration of twin systems will enable their development and range extension. Contextual data about the environment in which a particular process or digitized object is located will contribute to the prediction and detection of human errors.*
>
> *The use of a digital twin in the future will change the approach to work and operations, computers will become smarter and processes safer.*
>
> - **Dariusz Burciu,** co-founder and board member, F44

5.2 Data infrastructure powers the development of the economy

Space technologies are of key importance for the development of the maritime sector and for maintaining the safety of waters. Satellite data and systems are used in a wide range, above all, they are an important element of navigation and positioning of ships, beyond the reach of ground systems.

The development of satellite systems has enabled the development of autonomous vessels technology [27]. The increase in maritime traffic, the designation of marine protected areas and the development of wind farms result in the narrowing of sea routes, which is why precise navigation plays a key role in maritime transport [28].

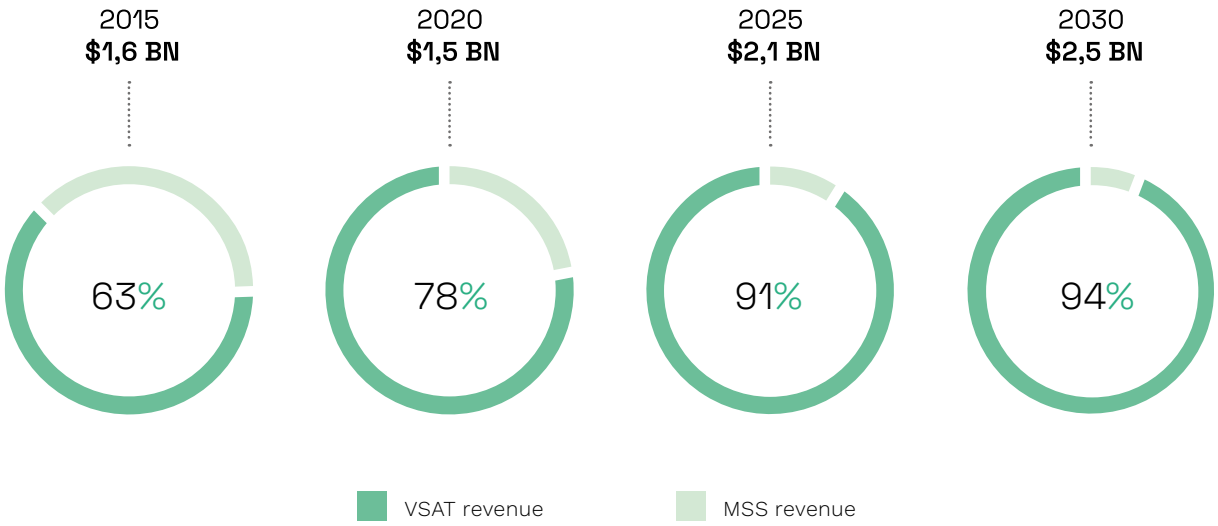
The estimated value of the global satellite communications market for the maritime sector in 2020 was USD 2.3 bn, and in the perspective of 2030, its value will increase to USD 3.2 bn [29].

Global Satellite communications market value_

$2,3 bn
estimated value of the market in 2021

$3,2 bn
estimated value of the market by 2030

Revenues from maritime market services_



Source: Euroconsult. Prospects for Maritime Satellite Communication 2021

Based on satellite data, it is also possible to detect marine poaching, smuggling, monitor the coastline, detect pollution in the context of illegal discharge of oil into the water and respond to crisis situations. The integration of satellite data with modern technological solutions allows shipowners to better adapt to natural conditions and reduce emissions [30].

An example of the use of satellite data in its activities is the Blue Dot Solution company from Gdańsk, which uses satellite data in the context of positioning and observing the Earth. In the catalog of its products, it offers, among others, Ground Eye, a project that is a platform for the location of ground infrastructure.

Since 2015, the company has been involved in running the Space3ac accelerator, which develops startups and connects them with the business environment [31], so far, the accelerator has provided support to 150 startups, which have received a total of over PLN 40 mln in non-refundable grants for the development of the first prototype of the offered solution.

> *The space industry in Poland is developing, at the beginning there were several entities, currently nearly 100 operate in this field.*
>
> *Pomeranian companies should protect and invest more in the development of their intellectual property, this is the reason why there are so few companies of this type on the market, another problem is the difficulties in communicating needs by companies from the maritime sector.*
>
> - PhD, **Krzysztof Kanawka**, CEO, Blue Dot Solutions

The coming years will also bring challenges in terms of expanding the terrestrial data infrastructure to meet current and future requirements. According to CORDIS [32], more than 1,000 research vessels are operated by governmental and non-governmental organizations in the marine waters of the European Union to collect marine data.

The development of offshore wind farms on the Polish coast means that there is a lot of interest on the market in the context of pre-investment research. The largest company of this type in Poland and in the Baltic region conducts its operations in Pomerania, Mewo. The company has two branches, the main one in Straszyn near Gdańsk and a small one in the Netherlands. Its offer includes geophysical, geotechnical and environmental tests, as well as UXO related to the identification of unexploded ordnance from the period of World War II. Mewo has been operating in the Baltic, Mediterranean and North Seas since 2012.

MEWO is involved in all major Polish energy projects in the context of offshore research, nuclear power plant and Baltic Pipe.

Conducting marine research is a demanding, long-term process. It is of key importance for our company's operations to strive to develop the highest standard of the quality of the collected data.

- **Paweł Gajewski**, CEO, MEWO Subsea Solutions

In 2022, the company established the Amber Offshore shipping team, which includes private investors, through which the 60-meter long OSV (offshore supply vessel) *Amber Cecylia* research vessel was purchased.

This is the first vessel of this type registered under the Polish flag after 1989, according to the statistics of the Maritime Chamber, where research activities are carried out by Polish agencies, offices and certification bodies. The ship has great capabilities in the context of tidal research and heavy geotechnical research.

We made this purchase in order to secure our interests and the reputation of the services offered, but also for Poland, in order to secure the commissioned designs.

- **Paweł Gajewski**, CEO, MEWO Subsea Solutions

5.3 Augumented Reality, Cybersecurity and Robotics

Augmented reality has great potential in maritime sector

Interesting in the context of the activities of entities in the maritime economy are, among others, the prospects for the development of the MR (mixed reality) market, which combines the solutions offered by VR and AR (augmented reality), MR allows the virtual world to interact with the outside world. In Norway, research is being conducted on the use of MR capabilities in maintenance work on the vessel [33].

> *Service and maintenance is a big problem at sea, when something breaks, it forces the vessel to wait for a long time for the installer to make repairs.*
>
> *The use of VR and MR technologies together with the appropriate system will enable remote analysis of the vessel and management of the repair process.*
>
> *The development of tools of this type is a worldwide trend. However, the problem is the lack of satisfactory technological solutions in this direction at the moment.*
>
> - **Dariusz Burciu,** co-founder and board member, F44

VR (virtual reality) is based on solutions in the field of virtual reality, has a special potential in the context of educational activities, enabling training to be conducted in a cheaper and safer way. An example of using the possibilities of VR is the Center for New Competences from Gdynia, which conducts training and professional courses, among others, for crane operators, cranes, stevedores.

All senses are deceived in the simulator. The platform has 3 degrees of freedom, which makes it possible to generate movements and vibrations that occur during real work on cranes or overhead cranes.

The training is carried out in safe conditions, with less effort and resources, which is crucial due to how expensive the equipment is to conduct the course in traditional conditions. There are currently three simulators of this type in Poland, all of them in the Tricity area.

The training cycle on the simulator entitles the participant to take the exam conducted by the Transport Technical Inspection and the Office of Technical Supervision, which are responsible for granting licenses in this area in Poland. Our newest child is the Crew Transfer Vessel simulator for training crews in operating offshore wind farms. It's an absolute game changer.

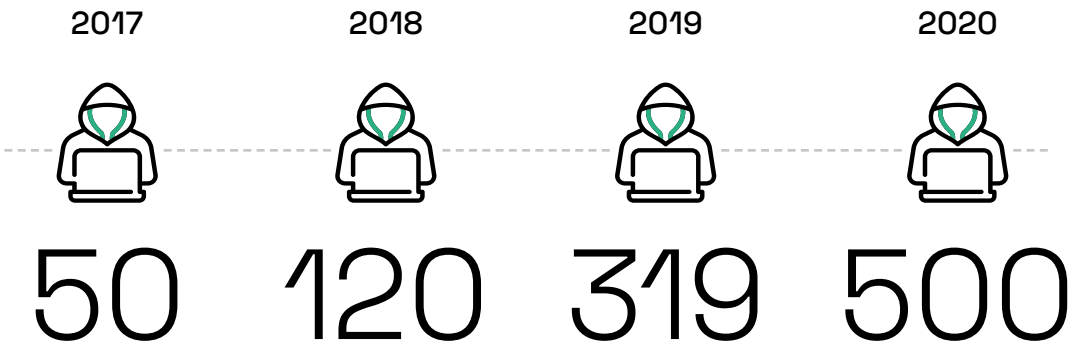
- **Tomasz Lisiecki**, president of the board,
Centre for New Competences

Cybersecurity is becoming more important than ever

In the perspective of recent and subsequent years, the issue of cybersecurity is becoming increasingly important, this element requires more and more resources - in recent years, the number of attempts at cyberattacks on security systems in the maritime sector has drastically increased.

Vessels may be exposed to intentional interference with the satellite signal. Incorrect information about the position, speed and direction in which the ship is moving poses a threat to the safety of the crew, citizens, critical and civil infrastructure, in particular when the vessel is transporting dangerous cargo, signal authentication systems are of key importance [34].

Number of attacks on OT systems_



Source: Sokołowski W., 2021

An example of how drastic a cyber attack can be is the 2017 “Petya” virus attack that affected Maersk, among others. The attack exposed the company to the loss of data from over 40 000 computers, 4 000 servers and losses of over USD 300 m, moreover, it affected the work of ports and paralyzed sea and truck transport.

As a result of the attack, not only Maersk, but also other entities involved in the global supply chain, suffered [35]. After the incident, Maersk prioritized the development of cybersecurity systems, and also shares its history and experience with other entities [36].

Robots and drone technologies improve quality and safety standards

The drone market has great development prospects, according to the forecast, its value in 2026 will amount to PLN 3.26 bn. The development of the market depends on the emerging legal regulations, especially in the case of the development of automatic, autonomous solutions [37]. The drone technology market in the world has great potential in the perspective of the coming years in the context of delivering components for offshore constructions and delivery of shipments. Cargo drones can reduce the need to use ships, which are a bigger polluter than drones, to transport spare parts. In Denmark, energy group Ørsted tested the use of drones to transport small components to offshore wind farms [38].

In Singapore, drones are being tested that are able to load cargo onto an anchored cargo ship weighing from 2 to 5 kg at a distance of up to 5 km and in less than 15 minutes. It is planned to introduce a model with a load capacity of up to 100 kg, taking into account that according to estimates, nearly 20% of global cargo in ports are shipmentsweighing up to 100 kg, further development of drone transport will increase competition for other means of transport [39].

Robots in the maritime sector are used for cleaning the bottom of the hull of a vessel, cleaning water in the event of a leak, characterized by high risk and danger to people, with chemicals, fumes and fire hazards. Replacing people makes operations safer and more efficient [40].

The DNV classification society runs a Drone Centre in Gdynia, which consists of specialists with appropriate qualifications and certificates issued by the Civil Aviation Authority. Drones are used to inspect vessels (bulk carriers, tankers), offshore vessels and drilling platforms.

> *Drones are used in inspection works when the process of scaffolding, raft installation or tank flooding is difficult or cost-ineffective.*
>
> *The drone works well for visual inspections, it allows to detect progressing corrosion or cracks. This technology saves time and is safer.*
>
> - **Radosław Kubiszewski**, president of the board, DNV Poland Sp. z o. o.

Drones are also used in port works in Pomeranian ports. Gdynia cooperated with Gdynia's Marine Technology to develop a surface drone - HydroDron. Measurements performed at sea include bathymetric, LIDAR and sonar measurements. In order to avoid the likelihood of a collision, the device is equipped with probes and a set of sensors that monitor the situation around the drone and weather conditions [41].

The organization has 5 research laboratories, it also deals with 3D visualization, expert opinions, spatial analyzes and the preparation of digital terrain models, Marine Technology is working on the development of the autonomous navigation system HydroDrona [42], moreover, it is the only representative of the Hypack company in Poland, which specializes in the development of hydrographic and underwater software [43].

In 2020, the Port of Gdynia also established cooperation with Pelixar from Gdynia, which is to result in the development of a drone that will be used for port works in difficult weather conditions and high salinity [44]. Pelixar achievements also include development of rescue and search drones, which, in the event of an emergency, are able to provide a person in need with the necessary rescue equipment and then tow them to the nearest safe place [45].

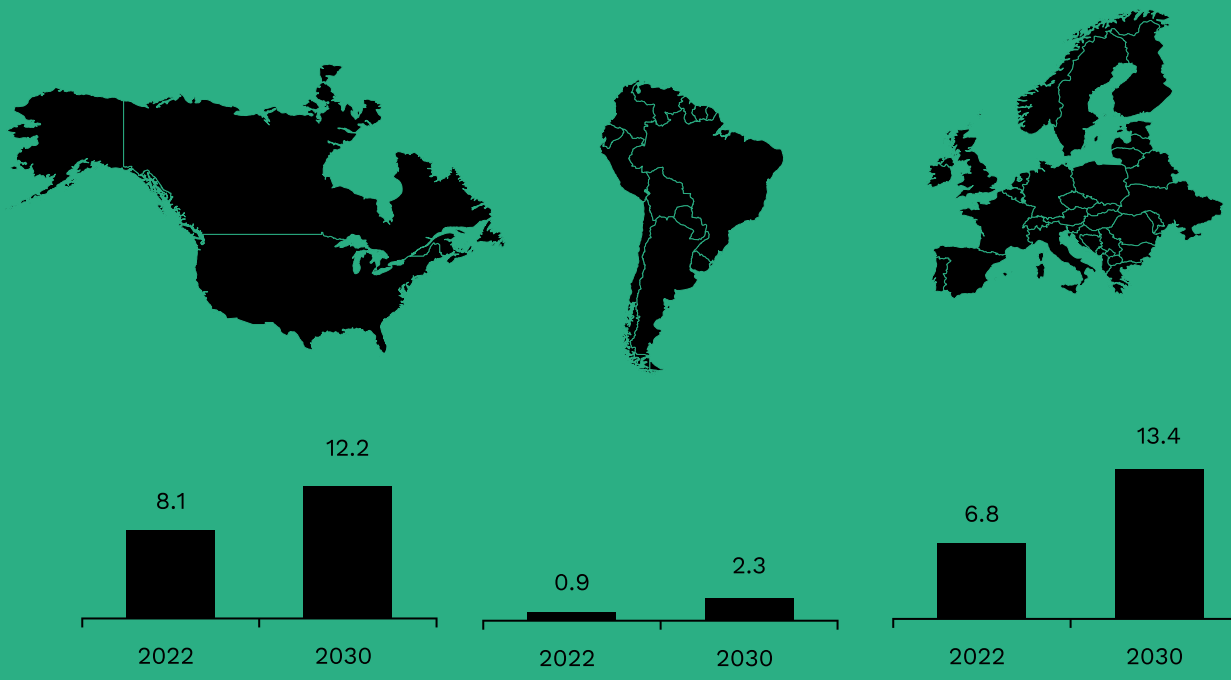
In order to protect the safety of Polish quays and critical infrastructure, as well as to prevent criminal activity, anti-drone systems are used, the purpose of which is to neutralize dangerous drones. In Pomerania, APS from Gdynia is a dynamically developing company in this field.

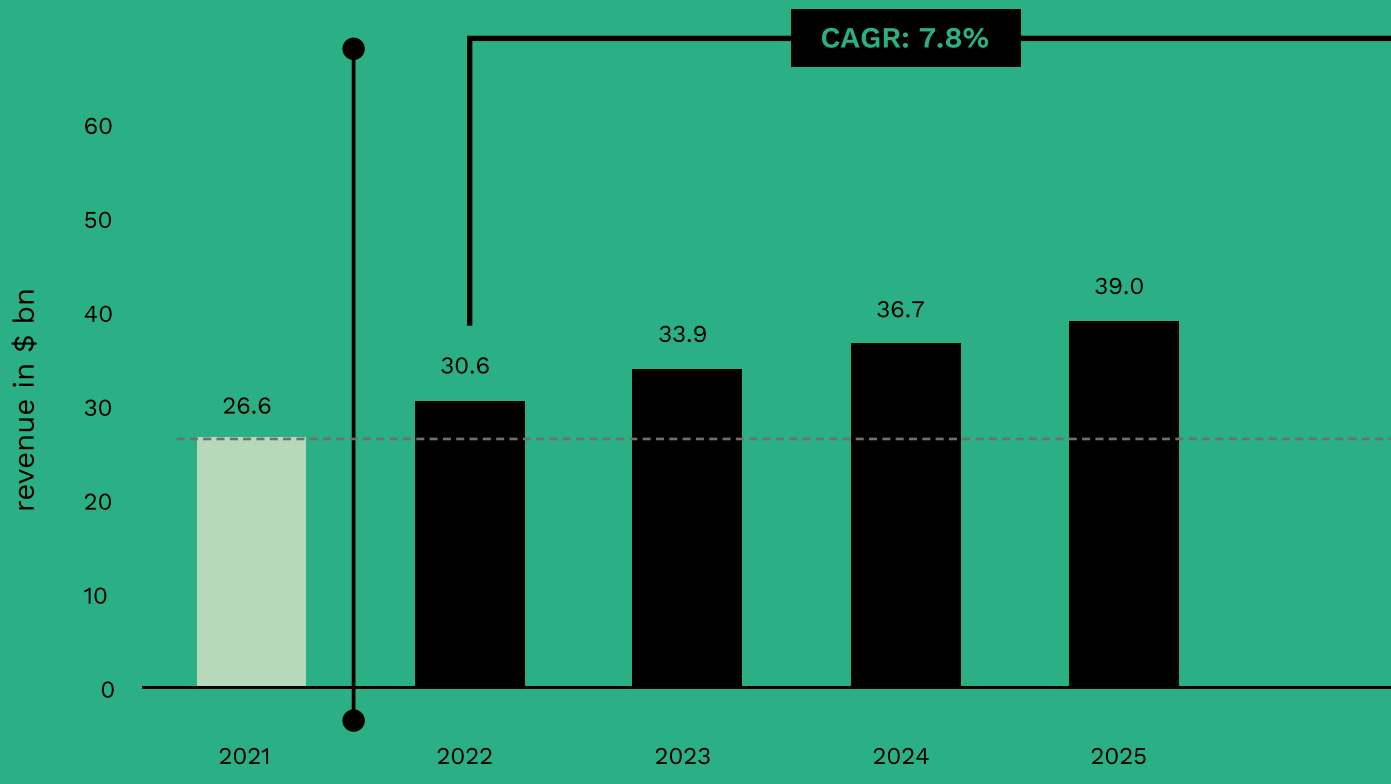
The company creates anti-drone systems that allow the detection of drones and jamming their signal. One of the company's most recognizable products in the world is the SKYctrl system. The range of the system is from 7 to 50 km, enables precise detection and tracking as well as immediate classification of the threat. The system is used by, among others: Saudi Telecom Company, Avinor Stavanger Airport, Port of Gdynia, Lotos Gdynia Aerobaltic AirShow and prison in Tallinn [46].

It is also worth mentioning the research team of prof. Łukasz Kulas. The group was established in 2020 by the Gdańsk Tech University, Interizon and the Marshal's Office of the Pomeranian Voivodeship. The team is working on new technologies related to autonomous mobility.

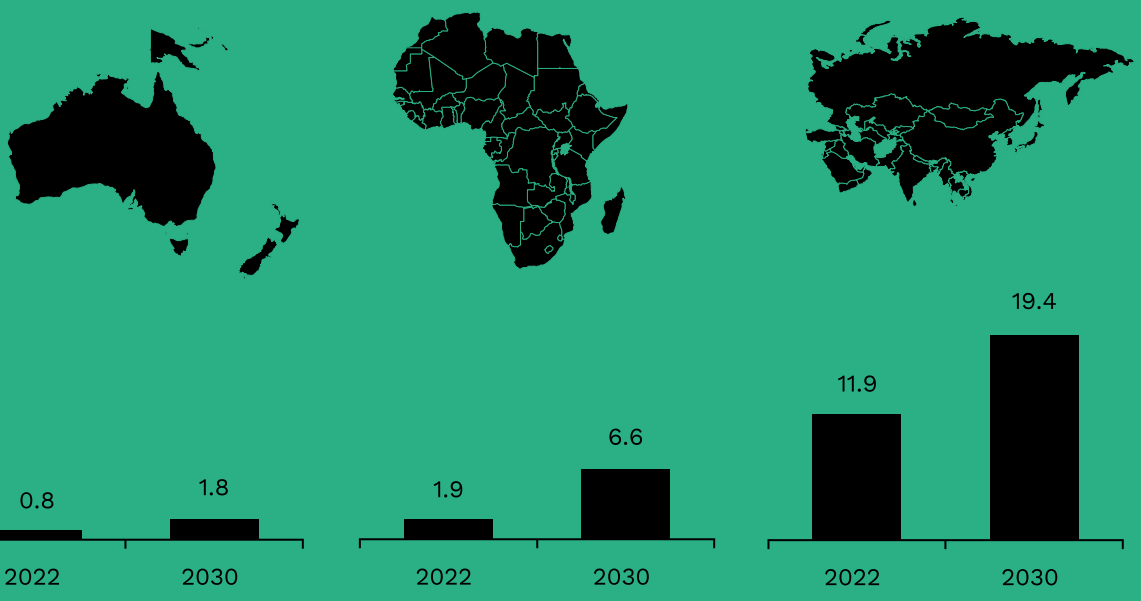
Currently, an unmanned boat used for wind farms and port channels inspections is being developed. The „Hornet" unit has already undergone the first tests on water. The technologies implemented are based on edge and cloud computing.

Drone market between 2022 - 2030_





Source: droneii.com 2023


0.8
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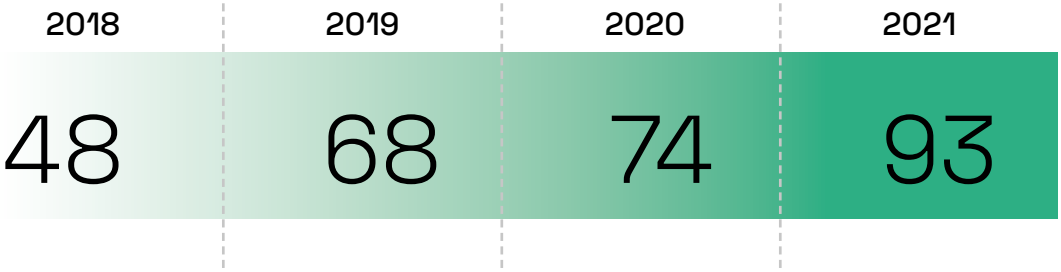
5.3 Expenditures on Research and Development

Research and development vessels are the pillar of the development of new technologies in the maritime sector in Poland. According to the data published by the Central Statistical Office, the number of scientific research vessels has been growing dynamically in recent years, in the years 2018-2021, the number of R&D vessels in Poland increased by almost 94%.

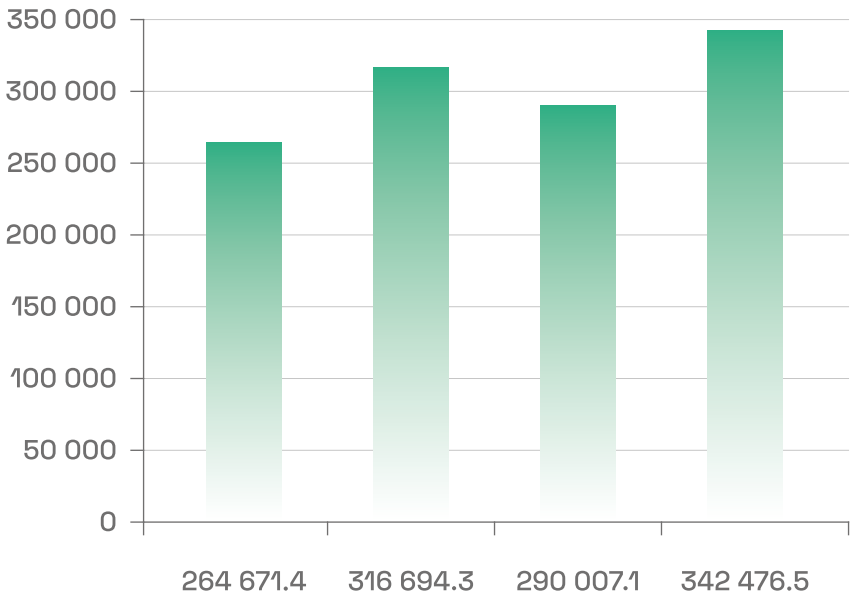
Scientific and research units in Poland in 2018-2021_



Source: own study based on data from the Central Statistical Office, 2022

In addition, expenditures incurred to forward the progress of research and development activities in the maritime sector are also growing. Internal expenditure incurred for conducting and investing in research by the vessel's research facilities in 2021 compared to 2018 increased by almost 30%.

Internal expenditures in Poland in 2018-2021 (PLN k)_



Source: own study based on data from the Central Statistical Office, 2022

Due to its seaside location, the Pomeranian region has many research and development units working for the benefit of the maritime economy, with some of the most important in Poland being units of the Polish Academy of Sciences, the Ship Technology Centre, the Maritime Technology Centre and the Sea Fisheries Institute.

Research and Development units in the Tricity area_

Source: own study based on dispersed materials

„CTO S.A. conducts numerical calculations in the field of hydro- and aerodynamics as well as experimental model research of ships, warships, and offshore structures. The conducted research allows for the optimization of resistance and propulsion of ships and forecasting the power demand of the propulsion system, as well as the assessment of sea and maneuvering properties.

The scope of conducted analyzes is complemented by the study of screw propeller cavitation, taking into account pressure pulses and acoustic emission, as well as performance forecasts of dynamic positioning systems. For wind turbines mounted on the sea bed, measurements of the reaction of the foundations for given wave and wind conditions are carried out, and for floating turbines, measurements of reactions in the anchor cables and registration of movements and maximum displacements." - says Lech Grycner (CTO).

The Polish Academy of Sciences has the Institute of Fluid-Flow Machinery, the Institute of Maritime Engineering and the Institute of Oceanology in the region. Institute of Fluid-Flow Machinery them. Robert Szewalski is located in Gdańsk and consists of five research centers:

- hydrodynamics
- flows and combustion
- plasma and laser technology
- machine mechanics
- thermal energetics

The activity of the Institute is based on conducting research on engineering and technical sciences [47]. In 2015, the Institute was awarded the prestigious Energy Globe National Award in the field of environmental protection [48]. The Maritime Construction Institute conducts its activities in Gdańsk within three departments:

- mechanics and coastal engineering
- wave mechanics
- building dynamics

The Institute also has a modern hydraulic laboratory. The Institute specializes in engineeringoceanography, water construction and coastal protection. The unit was involved in carrying out works for such projects as e.g.: nuclear power plant, Baltic Pipe, LNG terminal in Świnoujście and Żelazny Most [49].

The Institute of Oceanology is located in Sopot. The activity of the Institute is based on the study of the sea area, it conducts its research in the Baltic Sea and in the area of the European Arctic. The Institute has modern laboratories and a research vessel *Oceania* [50].

Gdańsk located Maritime Advanced Research Centre (CTO) is a unique company in terms of profile and capabilities. CTO S.A. specializes in the design of research stations and devices, measuring equipment, model tests of floating structures, structural mechanics, vibroacoustics, fire resistance, materials science and corrosion, and in medical engineering. Its offer also includes certification of marine products and equipment. CTO has implemented over 100 domestic and 40 international designs, offering innovative solutions. [51]. The centre specializes iat:

- designing research stands and devices
- measuring apparatus
- testing of model floating structures
- construction mechanics
- vibroacoustics
- fire resistance
- materials science and corrosion
- medical engineering

The Maritime Technology Centre, specializing in military and civil technology, operates in Gdynia. The center is of key importance for the development of the state's maritime security systems. The Centre has competences in the field of design execution, creation and maintenance of command systems, data analysis, communication of ship and submarine vessels [52].

In the field of fisheries, the Sea Fisheries Institute conducts its activities in Gdynia, which deals with environmental assessments and research, it is also involved in issuing opinions for administrative entities, the European Commission and various international organizations in the field of fisheries. The Institute has the Baltica research vessel, motor boats, acoustic cameras and sonars [53].

Our center is probably the oldest of its kind in Poland. CTO S.A. conducts numerical calculations in the field of hydro- and aerodynamics as well as experimental model research of ships, warships, and offshore structures.

The conducted research allows for the optimization of resistance and propulsion of ships and forecasting the power demand of the propulsion system, as well as the assessment of sea and maneuvering properties.

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- **Lech Grycner**, president of the board,
Maritime Advanced Research Centre (CTO)

Source: Image courtesy of Maritime Advanced Research Centre

06

Yachting industry_

Globally, the yachting industry is worth more than USD 19 billion. Luxury yacht segment - USD 12 billion. This segment alone is estimated to grow at 4.1% CAGR and is supposed to reach USD 19 billion in 2031 [1].

According to Boat International, the global order book for the superyacht category alone in 2022 was 1,024 projects compared to 825 in 2021, a growth rate of 24%. The leading shipyards are fully booked until 2026 [2] [3].

> *The coronavirus pandemic led to increased sales and interest in yachts. Customer behaviour changed.*
>
> *Customers who had hesitated and postponed their purchase began ordering their vessels during the pandemic. This effect was felt not only by us, but by the entire yachting industry.*
>
> - **Artur Połoczański**, PR manager, Sunreef Yachts

Europe remains the key market for luxury yachts. It is estimated that in the last five years, 40% of vessels in the 40m segment have been bought by European customers [4].

In contrast, vessels up to 30m in length remain the dominant segment of the luxury market, accounting for just under 54% of global sales in 2021 [5]. The largest yacht manufacturers (in general, not just luxury yachts) in the world remain the Netherlands and Italy [6].

6.1 Yacht manufacturing in Poland

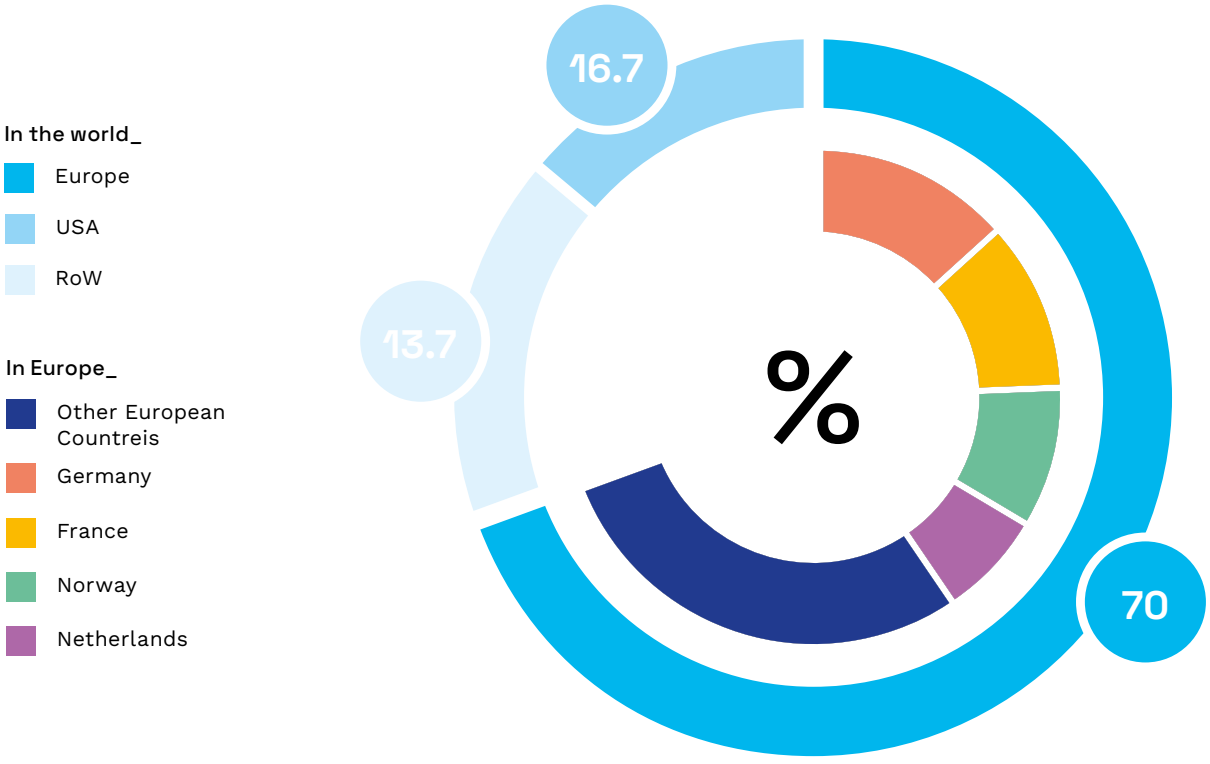
From 2010, yacht production in Poland grew by 10-15% year-on-year to stabilise at 24,000 units built annually in 2018 [7]. Currently, Poland is the 6th largest exporter of yachts in Europe and 7th in the world. In the segment of motor boats up to 9 metres, Poland is second only to the United States [8]. The main consumers of the Polish yachting industry are European countries. This is the destination for around 70% of Polish exports, with a significant share of Germany, France and Norway. The US, in turn, consumes more than 16% of Polish export production [9].

It is worth noting that emerging markets, where the number of millionaires (who are, of course, the target consumers of luxury products) is growing, are playing an increasingly important role as consumers of luxury boats. China and the Middle East in particular are such markets [10].

> *Our clients are mainly Europeans, but we are nevertheless noticing that it is worth reaching out to clients in Turkey, Australia or the Middle East, where interest in our yachts is growing. Hence our presence in Dubai.*
>
> - **Artur Połoczański**, PR manager, Sunreef Yachts

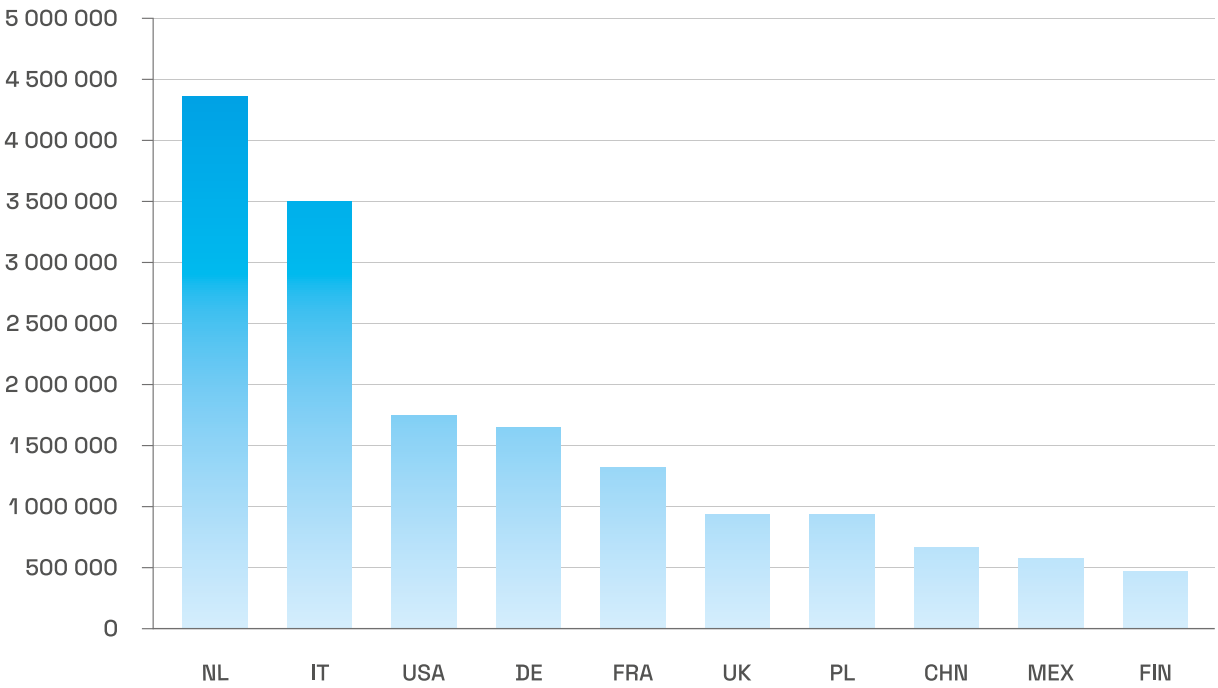
Source: Image courtesy of Sunreef Yachts

Polish yacht export destinations, 2020



Yacht production, export value, 2021

export value in USD K



6.2 Green technologies and customisation

The main trend observed in the yachting industry is broadly in line with what we see in the wider marine industry and naturally relates to the implementation of low-carbon boat fuels. Especially as motor boats account for 82% of the market [12]. The use of hybrid and electric motors with solar power is becoming the new standard.

> *Sunreef Yachts is currently working on its own patent for solar panels. The idea is to integrate the solar panel into the composite from which the yacht is made. A catamaran powered 100% by solar energy with mounted solar panels e.g. on the side of the hull, on the mast - this can be described as reinventing the catamaran.*
>
> - **Artur Połoczański**, PR manager, Sunreef Yachts

Another solution is to also use other alternative energy sources. In this respect, German shipyard Lurssen Yachts is carrying out pioneering projects. Currently, together with Rolls-Royce, propulsion technologies are being developed using green hydrogen derived from biomethanol [13, 14].

Next trend, especially in the luxury yacht segment, is customisation. Yachts cease to be mass-produced and all details are agreed directly with the new owner. Sunreef Yachts fits perfectly into this characteristic.

> *We specialise in luxury catamarans. We are in a leading position when it comes to custom-made luxury electric yachts.*
>
> *I highlight this element of luxury because it is an aspect that demonstrates the company's competitiveness. There are a lot of these types of vessels on the market and where we show our advantage is in the element of exclusivity and bespoke finishing, i.e. custom made vessels.*
>
> - **Artur Połoczański**, PR manager, Sunreef Yachts

The use of alternative materials in boat design is also an interesting development. In this context, an interesting project was carried out by the Alusip Technology shipyard in Gdańsk, which supplied the aluminium hull superstructure for what was at the time the largest sailing yacht, the “Black Pearl”. Alusip also supplied the aluminium structural components for Amazon founder Jeff Bezos’ superyacht [15].

Most interesting projects

100 Sunreef Power S – is the largest motor yacht in the portfolio of the Gdańsk-based luxury catamaran manufacturer Sunreef Yachts. The shipyard, founded by Franciss Lapp in 2002, is one of the world’s flagship catamaran manufacturers. There are currently two production facilities in Gdańsk, while another is being built in the United Arab Emirates in Ras Al-Khaimah. Among the lucky owners of Sunreef’s boats are Rafael Nadal, Fernando Alonso and Nico Rosberg. The 100 Sunreef Power S is a 29-metre vessel offering transatlantic range and the ultimate sailing comfort. It was launched in 2021 [16].

ACE of C144S line – it is the largest yacht built to date. It was built in Gdańsk at the Conrad shipyard specialising in the construction of motor and sail-powered superyachts. The ACE was two years in the making, with the hull and superstructure constructed from steel and aluminium. The boat is just under 45 metres long. Its range is 4,000 nautical miles [17].

Top yacht manufacturers in Pomerania_

- Sunreef Yachts – 1500 employees, products: catamarans
- Conrad Shipyard – 500 employees, products: monohull sailing and motor yachts
- Galeon – 1400 employees, products: motor boats

07

Education_

7.1 Talent Pool - Higher education

Tricity is the largest educational hub in the northern part of Poland_

The Institute of Ocean Engineering and Shipbuilding at the Faculty of Mechanical Engineering and Shipbuilding of the Gdańsk University of Technology is of key importance for higher education in the maritime sector in Pomerania. The education of shipbuilding engineers has been treated as an important specific feature of the Gdańsk University of Technology since its inception [2]. At the Faculty of Mechanical Engineering and Shipbuilding we will find such fields of study as:

- **Ocean Engineering** (first-cycle studies in the specialties: Shipbuilding and Power Plants and Ocean-Technical Equipment, and second-cycle studies in the specialties: Design of ships and ocean-technical equipment, Design and construction of marine energy systems and Marine Engineering)
- **Yacht design and construction** (first degree studies). The field of study was created in cooperation with Polboat - Polish Chamber of Yacht Industry and Water Sports and well-known yacht companies that have their production plants in Gdańsk (Alushіp, Complex Jacht, SunReef) or its vicinity. The company that also joined this project is the Polish Register of Shipping classification society [3,4].

Currently, fields of study related to the offshore industry are becoming more and more popular (see page 30). Apart from the Gdańsk University of Technology, the courses desired by the maritime industry are taught at: University of Gdańsk, Gdynia Maritime University, Heroes of Westerplatte Naval Academy in Gdynia, Pomeranian Academy in Słupsk, Pomeranian University in Starogard Gdański, Eugeniusz Kwiatkowski University of Administration and Business in Gdynia, WSB University in Gdańsk and University of Security in Gdańsk.

Interestingly, also at the Academy of Fine Arts in Gdańsk we will find a major related to the maritime industry - at the Faculty of Design there is a thriving Naval Design Studio [5].

Faculties directly related to the maritime industry in the academic year 2021/2022_ [6]

Faculty	No. students	No. graduates
navigation	979	216
ocean engineering	452	150
water management and protection of water resources	47	15
aquaculture - business and technology	38	6
marine hydrography	26	no data*
yacht design and construction	26	no data*
marine and Shore Engineering	15	12
state maritime security	no data**	13
oceanography	-	80

* the faculty is available at the University of Gdańsk since the academic year of 2021/2022

** the faculty was available during the academic year of 2021/2022

Faculties indirectly related to the maritime industry in the academic year 2021/2022_ [6]

Faculty	No. students	No. graduates
information technology	4684	621
logistics	2631	459
mechanical engineering	1199	403
electronics and telecommunication	979	231
electrotechnics	943	275
transport	939	231
computer science and econometrics	668	203
environmental engineering	576	134
management engineering	465	12
engineering management	449	92
power engineering	431	103
mechatronics	306	105
automation, robotics and control systems	306	47
automation, cybernetics and robotics	287	27
commodity science	280	181
automation and Robotics	241	149
technical Physics	239	54
nanotechnology	222	53

Faculty	No. students	No. graduates
data engineering	215	43
mathematical modeling and data analysis	214	39
transport and logistics	159	5
design	134	34
bioinformatics	90	12
environmental Protection	88	33
protection of natural resources	79	14
green technologies and monitoring	77	12
business and green technology	53	16
safety in transport, forwarding and logistics	45	no data*
space and satellite technologies	30	17
cyberspace engineering	21	no data*
engineering and technologies of energy carriers	20	6
corrosion	17	22

* the faculty is at the University of Gdańsk since the academic year of 2021/2022.

18 943
total number of students in 2022

4 186
total number of graduates in 2022

Pomerania has a developed education sector. We have good universities. We have a large academic background and graduates with very good theoretical knowledge.

Gdynia Maritime University educates great engineers, navigators and mechanics.

- **Paweł Gajewski,** CEO, MEWO Subsea Solutions

Strengthening education for the maritime sector

Tricity with its educational hub and the tradition of education in the maritime sector has a huge potential that is constantly being adapted to the needs of the market. An example of a company that was created by separating from a scientific unit is Enamor. The company was established as a spin-off of the Gdynia Maritime University, where Enamor's warehouse and production are still located today [7].

The stereotypical perception of the maritime industry related only to hard physical work in unfavorable conditions does not translate into modern realities. Today, the maritime industry is inextricably linked with new technologies and the search for ecological solutions. This should be emphasized in order to encourage young people to work in this industry.

Source: Image courtesy of Maritime University in Gdynia

Our company is closely related to the Maritime University and we have plenty of opportunities to update each other on needs and opportunities.

We can observe the response of education to the changing needs of the market - for example, some time ago a Computer Science course was opened at the Maritime University, which is profiled on issues related to the maritime sector.

The maritime context must be combined with new fields. In our industry, such specialties are needed, e.g. among shipowners, in shipyards. I think that it is relatively easy to open a profile educating programmers and IT specialists more broadly, while profiling them in a faculty related to a given industry is a bit of a challenge.

- **Maciej Rek**, **CEO**, Enamor

It is important not to pigeonhole students and then employees into one industry. In my opinion, the transition of people between one and another industry during and after studies is the best added value. We need cross-industry and cross-departmental cooperation.

- PhD, **Krzysztof Kanawka**, CEO, Blue Dot Solutions

We have to take care of education, the attractiveness of the educational environment of the maritime industry. It is important to start educating young people much earlier than the final years of technical or high school, where young people are already really focused on what they want to do. We should start much earlier - in elementary schools.

Be there and say that the maritime market is in Tricity as the main factor of what Pomerania is. And this is not some outdated crane, but something completely different. Let's talk about autonomous ships, about IT. Let's emphasize the „greenness" of all this. It's important for young people that we talk about the environment.

- **Radosław Kubiszewski**, president of the board, DNV Poland Sp. z o. o.

Pomeranian companies actively participate in activities promoting work in the maritime sector, including Sunreef.

We participate, among others, in the European Blue Generation design. As part of it, we visit our shipyard with young people and students, whom we try to encourage to take up professional activity in the maritime industry.

We try to inspire young people. We also organized visits for high schools and vocational schools. In our opinion, the education sector in Pomerania meets our needs, and we have access to well-educated people. We only reinforce this with our activities.

- **Artur Połoczański**, PR manager, Sunreef Yachts

The BlueGeneration design aims to attract and engage young people aged 15-29 to develop their careers in the blue economy of Greece, Spain, Portugal, Bulgaria and Poland. The innitative is funded by Iceland, Liechtenstein and Norway. According to the authors of the design, the blue economy provides around 5.4 m jobs in Europe, and by 2030 this number is expected to even double. Within the project information days, free mentoring programs and study visits are organized [8]. Another example is MEWO comapny, which actively cooperates with the University of Gdańsk:

As part of the consortium and the signed letter of intent, we cooperate in the implementation of research and organization of student internships at research units, thanks to which students gain practical skills and get to know the culture of our work.

The University of Gdańsk has the entire Faculty of Oceanography, which educates measurement specialists and scientists. We support the University of Gdańsk in creating a new master's degree course „Physical and Applied Oceanography".

We are part of the program council of the faculty. From our point of view, the practical aspect of studies is crucial, which is why during the two-year teaching cycle, half a year will be practical exercises, together we will create a program of these internships.

- **Paweł Gajewski,** CEO, MEWO Subsea Solutions

Faculties related to the Offshore industry

The growing popularity of majors faculties related to the offshore industry is observed, in regards to the strong development of the renewable energy sector in Poland. We currently have the following faculties available in Pomerania [9]:

- **Second-cycle studies** in the specialization of Logistics in the offshore sector (major: Transport) and Offshore Technologies (major: Navigation) at the Gdynia Maritime University [10,11]
- **Second-cycle studies** in Economics: Maritime offshore sectors at the University of Gdańsk implemented under the patronage of: Marshal of the Pomeranian Voivodeship, RWE Offshore Wind Poland, Grupa Energa S.A., BOTA Technik [12]
- **Post-graduate studies** in Offshore Wind Energy at the Faculty of Mechanical Engineering and Shipbuilding of the Gdańsk University of Technology under the patronage of the Polish Offshore Wind Energy Association [13]
- **Post-graduate studies** Education for sustainable development: offshore wind energy at the University of Gdańsk [14]
- **Post-graduate studies** Risk management in the offshore mining industry and wind energy at the Maritime University of Gdynia under the patronage of PGE Baltica [15]
- **Executive Offshore Wind MBA**: The program is implemented by the Center for Offshore Wind Energy of the Gdynia Maritime University, in cooperation with the University of Applied Sciences Bremerhaven and Business Academy SouthWest; The honorary patronage over the studies was taken by: British Embassy Warsaw, Royal Danish Embassy Warsaw, Embassy of Norway, Global Wind Energy Council. The content partner is the Polish Offshore Wind Energy Association [16]

Currently, the construction of the Offshore Center of the Maritime University of Gdynia is underway. The Center will include comprehensive tests and measurements at sea needed in the fuel market, shipbuilding, offshore wind energy and maritime transport. The design is being implemented by a consortium consisting of the Maritime Institute of the UMG and MEWO S.A., an offshore market company [17].

On March 14-15, 2023, the 1st EDU OFFSHORE WIND Educational Career Fair took place in Gdańsk, the first event on such a scale dedicated to offshore wind energy in Poland, intended for secondary school students and students planning their career in the offshore sector. The fair was the culmination of an educational program conducted in Pomeranian schools by the Pomeranian Maritime Renewable Energy Competence Center in Rumia, aimed at educating about work in the offshore

sector. The initiators and organizers of the event were the Pomeranian Platform for the Development of Offshore Wind Energy in the Baltic Sea under the leadership of Karolina Lipińska, Rumia Invest Park sp. z o.o. together with the Pomeranian Center for Maritime Renewable Energy Competence, Co-Made Sp. z o.o., Gdańsk International Fair S.A. and the Foundation for the Innovative Maritime Energy Industry. The fair was held under the patronage of the Pomeranian Voiveodeship Local Government and the Municipality of Gdańsk [18].

The popularity of initiatives related to education in the offshore industry is pleasing, but it is worth not forgetting about other key maritime destinations. Among the conversations with our partners, the thread of concern about the liquidation of the shipbuilding specialty at the Faculty of Mechanical Engineering and Shipbuilding of the Gdańsk University of Technology was repeated.

7.2 Talent Pool - Vocational Education

About **83 k students** are currently educated within vocational education in the region. In order to assess the potential of the workforce for the needs of the maritime industry, the number of students studying in professions useful for the industry was verified. Occupations aggregated within the groups selected for analysis (based on the classification of the Education Development Center (ORE).

Maritime industry_

- Yacht and boat fitter
- Boat hull fitter
- Vessels construction technician
- Port and terminal operation technician
- Ship mechanic technician
- Marine navigator technician
- Welding technician
- Inland navigation technician

Supporting industry_

- Electrician
- Electromechanic
- Building Structures Builder
- Machines and Devices Mechanic -Assembler
- Electrical Technician
- IT Specialist
- Environmental Engineering and Melioration Technician
- Logistics Technician
- Mechatronics Technician
- Environment Protection Technician
- Technician Programmer
- Robotics Technician
- Forwarder Technician
- Broadband Electronic Communication Technician
- ICT Technician

From September 1, 2022, it is possible to educate in 6 new professions, which were introduced by the Regulation of the Minister of Education and Science of January 26, 2022 amending the regulation on the general objectives and tasks of education in trade education professions and the classification of trade education professions (Journal of Laws item 204), including two new professions in the water transport industry [19]:

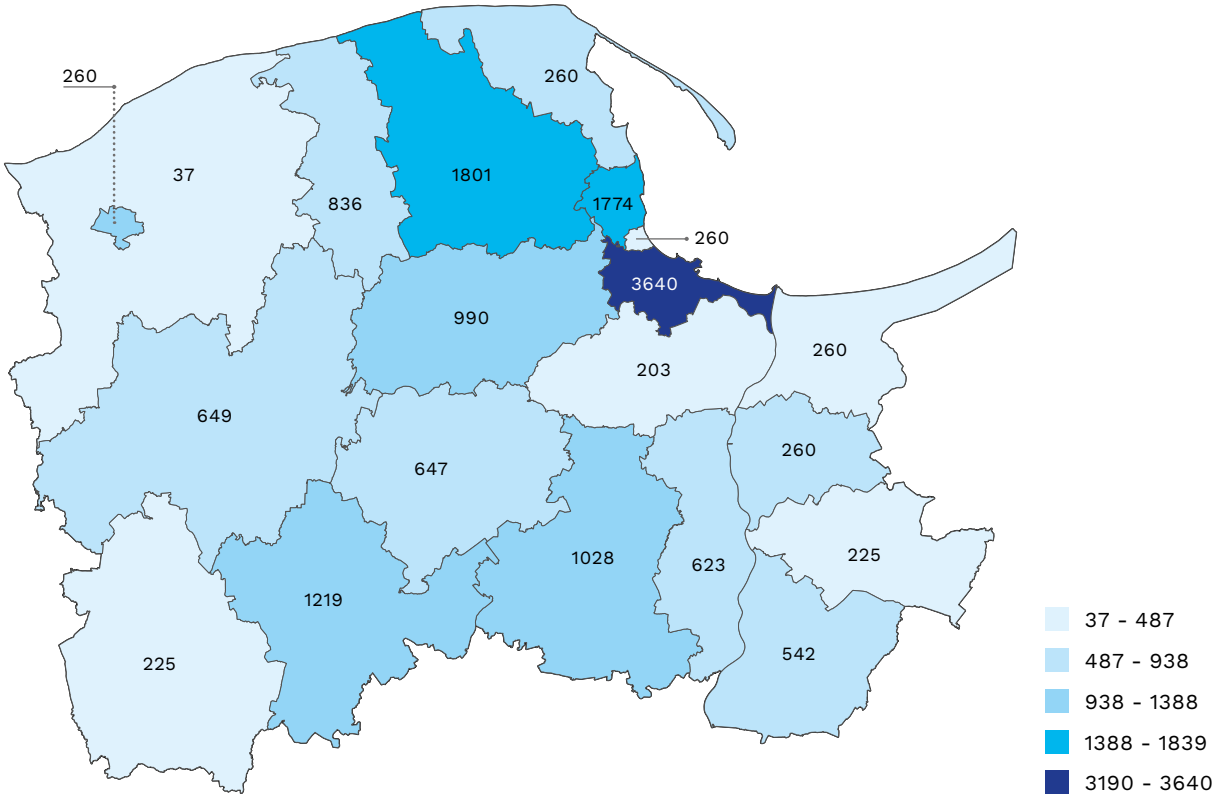
- marine electroautomatic technician
- yacht industry technician

82 839
vocational students in the voivodeship

17 440
students in key professions for the maritime sector

Number of students of vocational schools and technicians educating in the maritime industry in individual districts of the Pomeranian regioat:

- **Tricity (5,674 students in total in 2022)**
- Wejherowo (1,801)
- Słupsk (1,446)
- Chojnice (1,219)
- Starogard (1,028)
- Kartuzy (990)
- Lębork (836)
- Malbork (654)
- Bytów (649)
- Kościerzyna (647)
- Tczew (623)
- Kwidzyn (542)
- Puck (535)
- Sztum (228)
- Człuchów (225)
- Nowy Dwór (102)



Source: own study based on Central Statistical Office

> *Educated workers who graduated from vocational schools, such as welders, pipeline fitters, electricians, carpenters, etc., are in demand by companies. The shipyard also trains people itself.*
>
> **Grzegorz Landowski**, communications director, Remontowa Holding

There are examples of successful cooperation between companies and vocational schools. One of them is the District School Complex in Kłanino (Puck district). Already in 2016, this facility concluded a cooperation agreement in the field of terms and conditions of vocational training with Stocznia Remontowa Nauta in Gdynia and educates the profession of mechanic - assembler of machines and devices and assembler of hulls of vessels. The shipyard guarantees employment to all graduates [20, 21].

Another example are the professions which are taught at the CONRADINUM Shipbuilding and Technical School in Gdańsk, include specializations of vessels construction technician in cooperation with CRIST shipyard and Stal-REM S.A. and electrician technician - industrial installations and on vessels - in cooperation with the Remontowa group. A CONRADINUM student has the opportunity to undergo paid internships in sponsored companies [22, 23].

An example of successful cooperation between science and business is the Maritime School Complex in Gdańsk. In cooperation with the Gdynia Maritime University, they carry out the education process in the profession of a ship mechanic technician. Selected fields of study have their patronage. In the field of inland navigation techniques, it is „Żegluga Gdańska" Sp. z o. o., port and terminal operation technician - DCT Gdańsk, and the direction of marine navigator technician is under the patronage of „WUŻ" Port and Maritime Services Ltd. Other interesting examples are:

- County School Complex No. 2 in Rumia - cooperation with the Naval Shipyard in Gdynia
- Vocational and Continuing Education Center No. 1 in Gdynia (Shipbuilding Technical School) - cooperation with CRIST S.A.

This chapter was created in cooperation with

randstad

08

Labor Market_

8.1 Challenges of the local labor market

Due to the long-standing traditions of the region related to the maritime economy sector, the Pomeranian region has been providing specialists for the industry for years. The data for 2021 indicated that 58.8 k employees were employed in positions directly related to the maritime economy. Over 49 k employees from the Pomeranian region are employed in the private sector. Companies from the maritime economy sector are a significant percentage of employers in Pomerania.

In 2021, jobs in the maritime sector accounted for 6.7% of all people employed in the region, and the average gross salary was PLN 6,988.16 and was 24% higher than the average salary in the entire province. The types of activity with the largest share of employees in Pomerania include production and repair of ships and boats (17,219 people), activities classified as other [1] (9,661 people), processing and preservation of fish and fishery products (9,008 people) and transshipment, storage and storage of goods in seaports (6,791 people).

Due to the expected development of the offshore wind energy sector, the demand for specialists, engineers and service technicians will increase significantly. In the investment phase of offshore wind farms, the needs are estimated at 34k full-time jobs, while ultimately, in the operational phase, i.e. the operation of already completed wind farms, it will be additional about 29,000 jobs. This is a perspective for the years after 2033, when the capacity of offshore wind farms may reach even 10 GW [2]. There are also higher estimates, which say up to 77 k jobs, depending on the development scenario being analyzed [3].

There is no doubt about two things: the development of this sector will generate huge employment, especially in the Pomeranian region, and the demand for specific competences related to the installation, planning and operation of wind farms will increase sharply. This means that the creation of this resource related to the emergence of a de facto new sector of the economy will be a significant challenge for the region.

Comment by Kamila Staroszczyk
Randstad Professionals - Engineering Consultant

In recent years, we have seen intensified activity of local authorities and institutions oriented at the development of the offshore and wind energy sector. This activity is aimed at supporting investors who are increasingly willing to consider Poland as a strategic location for their business by providing them with reliable information to help make their decision.

Access to the Baltic Sea and modernised ports make Pomerania an attractive location for foreign capital. The growing number of these companies on the local market is a positive sign. The economy benefits, and these changes have a social dimension, as they mean, first and foremost, new and interesting jobs, but also tax revenue, which can be used for local government investments.

Our recruitment efforts are also attracting workers previously seeking employment in Norway, Malaysia or Singapore. Very often we reach out to Poles who previously had no opportunity to develop in their area of specialisation in Poland. This shows that the labour market in the region is changing and attracting experts with high qualifications more effectively. The talent pool is also growing with new investors building their competence centres in the region. They are becoming an opportunity for new generations in the labour market to develop their skills under the guidance of top-class managers.

New generations of employees are paying increasing attention to professional development and like to take on new challenges. At a time of dynamic changes in the professional sphere, accompanied by the development of IT technology, such challenges are quite numerous. This also applies to the maritime sector, where new technologies are also widely used. New generations are also entering the labour market with a greater awareness of the importance of sustainability.

They want to identify with organisations that reduce their impact on the environment or even act for its benefit. This is one of the reasons why young engineers are keen to work in the offshore wind sector, which is conducive to the decarbonisation of the Polish economy. In addition, our country has the potential to become one of the key players in this sector.

In recent years, Poland has been making efforts to develop its energy independence. This process is also based on the development of the maritime sector, and working on such projects promotes the professional satisfaction of involved experts. A sense of the broader, social dimension of the duties performed is one of the factors that is gaining traction with employees.

However, the offshore wind industry also faces some challenges. There are still too few professionals graduating with technical degrees, and there is a lack of training to support competence development. Nevertheless, many joint initiatives bringing together businesses, academia and local authorities are aimed at bridging these skills gaps in the labour market.

8.2 Competences of the Future

Professional competences in the maritime sector

Invest in Pomerania ACADEMY

Along with the increased pace of development of the offshore sector and the port industry, a strong demand for qualified staff with permissions in specific areas of work appeared on the market. Therefore, the Invest in Pomerania initiative has created an initiative that responds to the needs of the sector in the area of demand for vocational educatioat:

In February, the Invest in Pomerania Academy training program was launched by the Center for New Competences. The training will be conducted at the positions of a tower crane operator, an RTG crane operator, a terminal tractor operator, a reach stacker operator and a forklift operator. The program provides training for a total of 300 people. Each of them receives funding in the amount of 50% of the training costs. The program is also adapted to the participation of foreigners. In the future, it will be possible to train staff for the needs of the offshore wind energy sector in a similar formula.

> *The Center of New Competences deals with training. The training is dedicated to people who want to start working in the broadly understood logistics and port reloading. As the only company in Poland and few in the world, we deal with this using simulators.*
>
> *These simulators stand as a safe, economical, ecological and cheaper way to prepare future operators of heavy equipment that is present in ports, but not only. Here we train such operators as operators of overhead cranes, cranes, reachstakers, wharf cranes, which are a frequent element of the port landscape. (...) They are huge, difficult to access, very expensive, so any wrong maneuver can cause incalculable costs, so everything is in the simulator.*
>
> - **Tomasz Lisiecki**, president of the board, Center for New Competences

More about the use of VR in educating marine personnel on page 115 (Subchapter: Augmented reality has great potential). Other initiatives related to increasing interest in the maritime sector (including offshore-wind) are described in the section dedicated to vocational education in the Chapter 7. Education

IT and engineering competences in the maritime sector

The increased demand for professionals in ship design and offshore construction engineering and design management will require the development of a whole new set of competencies. According to Katarzyna Romantowska, paradoxically, very important competences useful in this job are the so-called soft skills.

> *Technically, our students are very well prepared. However, in addition to strictly technical knowledge, soft skills are very important, i.e. understanding the project management standard, the ability to co-create a team, „the ability to play on a team" in the daily work of every specialist - this is the key to the success of a given project.*
>
> *We are a nation of individualists, cooperation does not come to us intuitively, we have to learn it*
>
> - **Katarzyna Romantowska**, managing director, Damen Engineering Gdańsk.

The development of technology in the maritime industry will be inextricably linked to the work of programmers and IT specialists. All trends related to the digitization of the maritime sector force the implementation of advanced works in this area. As Jerzy Czuczman, president of the Polish Maritime Technology Forum, said, the quality of cooperation between engineers, experts in the maritime sector and programmers will play a very important role in this process. Therefore, it is necessary to work with business analysts who will mediate in this process and improve the quality of manufactured products or processes.

> *At the moment, knowledge of computer languages and programming and trends around are by far the most important thing. Knowledge of foreign languages is always important. The problem starts when a programmer is not able to explain in English how anything works. (...)*
>
> *It also seems to me that if someone knows a foreign language well, they can write documentation, express themselves well and is also a cool programmer, they will be a very valuable employee.*
>
> - PhD, **Krzysztof Kanawka**, CEO, Blue Dot Solutions

An extremely important and sought-after skill will be data processing as well as process optimization and automation. Digitization of processes as well as new capabilities of units in the field of data collection and processing as well as the autonomy of many operations will force the need to control the stream of various data.

> *We will need a ship data engineer. Someone who will be able to control the chaos of automated data that flows from the ships. Such a person will be able to show the shipowner methods of streamlining and automating processes. Everything related to data processing is the future.*
>
> - **Radosław Kubiszewski**, president of the board, DNV Poland Sp. z o. o.

In the field of data analysis, the maritime market will need specialization focused specifically on this market. According to it, Pomerania has the resources and possibilities to offer education in such a niche.

We know that in Pomerania the component related to data analysis, big data, is very well represented in some faculties and has a high level of general knowledge.

However, there is a lack of specialization and context. For many engineers who are well prepared for this profession, these are still numbers like any other. However, there is a difference whether it is data that describes the operation of a car or the operations of a ship or port.

This industry knowledge is needed and here I see an opportunity when it comes to our region. Because we have excellent experience in shipbuilding and design, some engineers are still active.

We have young people who are well educated in data analysis in the abstract. If these can be combined, a niche is created here, where you can find yourself on the market.

And based on such a knowledge base, we offer services to various customers.

- **Maciej Rek**, CEO, Enamor

Data processing and broadly understood digitization will be at the center of the competence areas that the maritime industry will need in the coming years.

- **Lech Grycner**, president of the board, Maritime Advanced Research Centre

8.3 Women in the Maritime Industry

KOBIETY TEŻ BUDUJĄ STATKI

There is a clear disproportion between the number of women and men studying maritime sciences. This later translates into the labor market and additionally confirmed the harmful stereotype that the maritime industry is the exclusive domain of men. Not only in the field of IT and ship engineering we have a chance to improve these statistics, but also in the area of vocational education - even more associated with the work of men.

> *The port and logistics industry is very specific. In physical positions, we most often see men. This is such a natural first association. Considering the current feminized wave of refugees from Ukraine, we encouraged women to try their hand at the industry. Because it's not true that women can't operate a gantry or a crane. The women are doing great.*
>
> *They used to be dominant in these competitions. Now they are rare, but it's not like they don't exist. We want to enlarge this group, give them a chance. This experience was double and successful. We have trained foreign-language candidates who have obtained qualifications and gained a chance for a good, permanent job.*
>
> - **Tomasz Lisiecki**, president of the board, Center for New Competences

An interesting initiative aimed at supporting women related to the maritime industry is the design of the Gdańsk Entrepreneurship Incubator STARTER „Women also build ships" [4], implemented since 2019. Workshops improving the managerial competences of female leaders from the maritime and logistics industries, workshops for school counselors and career counselors, a mentoring program (2 editions) and a special discussion group in social media are offered within it. You can read more about the project on the website: Report on the study of women's careers in the maritime industry" edited by Monika Popow Ph.D., presenting women's experiences.

You can read more about the project on the website: https://kobiety.inkubatorstarter.pl/pl/

8.4 Simulation of employment at a wind turbine production plant with an R&D engineering center

Below we present a simulation of employment as part of a new production investment in the field of wind turbine production with the accompanying engineering center carrying out R&D works. For the purposes of our report, an employment simulation with the following assumptions was prepared by Randstad.

Basic assumptions_

- engineering/R&D center - 60 people
- production plant - up to 500 people*
- 450 people in basic positions
- 50 specialist and managerial positions

* Sourcing area for basic positions for a plant of 500 employees

Tricity, Elbląg, Lębork, Tczew, Kościerzyna, Wejherowo, Pruszcz Gdański, Chwaszczyno, Rumia. Locations located 80 km away require support in organizing transport for employees.

Recruitment schedule_

	Q1	Q1	Q3	Total
Production Plant				
unskilled and skilled workers (450 persons) 20 persons per week	240	210	-	**450**
specialists and managers	30	20	-	**50**
Engineering centre				
specialists and managers	20	20	20	**60**

Candidate availability_

basic roles	up to 50	50-100	100-150
Turbine assembly worker (no experience)	●	●	●
Turbine assembly worker (with technical competencies)	●	●	●
Welder	●	●	●
Grinder	●	●	●
Start-up technician	●	●	●
Painter	●	●	●
Mechanical technician	●	●	●
Service technician	●	●	●
Electrical mechanic	●	●	●
Automation technician	●	●	●
Electrical technician	●	●	●
specialised roles	**up to 5**	**5-10**	**10-15**
Project manager	●	●	●
Technical manager	●	●	●
Project engineer	●	●	●
Electrical designer	●	●	●
Marine construction designer	●	●	●
Maintenance planning specialist	●	●	●
Calculation engineer	●	●	●
Coatings engineer	●	●	●
Mechanical engineer	●	●	●
Electrical engineer	●	●	●
Automation engineer	●	●	●

● high availability ● medium availability ● low availability

8.5 Salary levels in the maritime industry

Below is a list of salaries for selected positions by sector:

1. Ship design and construction
2. Engineering centre
3. Offshore wind energy sector
4. Port sector
5. Yachting industry

The table shows the type of position, job title and gross salary range on a monthly and annual basis. For the purposes of our report, the salary grid was prepared by Randstad recruitment company.

1. Ship design and construction_

Pomeranian voivodeship			
Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Managerial	Managing Director	23 000 - 35 000	276 000 - 420 000
	Production Manager	14 000 - 20 000	168 000 - 240 000
	Quality Manager	13 000 - 20 000	156 000 - 240 000
	Warehouse Manager	13 000 - 18 000	156 000 - 216 000
	Construction Manager	18 000 - 25 000	216 000 - 300 000
	Project Manager	15 000 - 25 000	180 000 - 300 000
	Technical Manager	18 000 - 25 000	216 000 - 300 000
Specialist with 2-3 years of experience			
Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Engineering	Constructor	6 000 – 10 000	72 000 – 120 000

Specialist with 2-3 years of experience			
Category	**Job position**	**monthly (PLN | min. - max.)**	**annualy (PLN | min. - max.)**
Engineering	Process Engineer	7 000 - 10 000	84 000 – 120 000
	Maintenance Specialist	7 000 – 10 000	84 000 – 120 000
	Planner	5 000 – 9 000	60 000 – 108 000
	Electrical Engineer	9 000 – 12 000	108 000 – 144 000
	Automation Engineer	8 000 – 12 000	96 000 – 144 000
	HVAC Engineer	9 000 – 12 000	108 000 – 144 000
	Construction Engineer	11 000 – 15 000	132 000 – 180 000
	Electrical and Automation Designer	9 000 – 12 000	108 000 – 144 000
	Mechanical Designer	9 000 – 12 000	108 000 – 144 000
	Calculation Engineer	7 000 – 10 000	84 000 – 120 000
	Marine Construction Engineer	10 000 – 13 000	120 000 – 156 000
	Pipeline Engineer	9 000 – 12 000	108 000 – 144 000
Specialist with 2-3 years of experience			
Category	**Job position**	**monthly (PLN | min. - max.)**	**annualy (PLN | min. - max.)**
Quality	Quality Control Inspector	10 000 – 13 000	120 000 – 156 000
Specialist with 2-3 years of experience			
Category	**Job position**	**monthly (PLN | min. - max.)**	**annualy (PLN | min. - max.)**
Production	Assembler	5 000 - 6 000	60 000 - 72 000
	Welder	6 000 - 8 000	72 000 - 96 000
	Grinder	5 000 - 6 000	60 000 - 72 000
	Start-up Technician	7 000 - 10 000	84 000 - 120 000

Specialist with 2-3 years of experience			
Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Production	Service Technician	8 000 - 11 000	96 000 - 132 000
	Electrical Technician	6 000 - 8 000	72 000 - 96 000
	Mechanical Technician	6 000 - 8 000	72 000 - 96 000
	Automation Technician	6 000 - 9 000	72 000 - 108 000
	Electrical Mechanic	7 000 - 10 000	84 000 - 120 000
	Production Tester	6 000 - 8 000	72 000 - 96 000
	Painter	5 000 - 7 000	60 000 - 84 000

2. Engineering centre_

Specialist with 2-3 years of experience			
Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Engineering centre	Project Manager	23 000 - 35 000	276 000 - 420 000
	Technical Manager	25 000 - 35 000	300 000 - 420 000
	Project Engineer	13 000 - 20 000	156 000 - 240 000
	Electrical Designer	13 000 - 18 000	156 000 - 216 000
	Marine Construction Designer	18 000 - 25 000	216 000 - 300 000
	Maintenance Planning Specialist	15 000 - 25 000	180 000 - 300 000
	Calculation Engineer	14 000 - 18 000	168 000 - 216 000
	Coatings Engineer	10 000 - 13 000	120 000 - 156 000
	Mechanical Engineer	9 000 - 13 000	108 000 - 156 000
	Electrical Engineer	10 000 - 13 000	120 000 - 156 000
	Automation Engineer	13 000 - 18 000	156 000 - 216 000

Specialist with 2-3 years of experience			
Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Operations	Purchaser	5 000 - 8 000	60 000 - 96 000
	OHS Specialist	7 000 - 9 000	84 000 - 108 000
	Logistics Specialist	6 000 - 8 000	72 000 - 96 000
	Design Documentation Specialist	5 000 - 7 000	60 000 - 84 000
	Lean Specialist	10 000 - 13 000	120 000 - 156 000

3. Offshore wind energy sector_

Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Managerial	Managing Director	23 000 - 35 000	276 000 - 420 000
	Production Manager	14 000 - 20 000	168 000 - 240 000
	Quality Manager	13 000 - 20 000	156 000 - 240 000
	Warehouse Manager	13 000 - 18 000	156 000 - 216 000
	Construction Manager	18 000 - 25 000	216 000 - 300 000
	Project Manager	15 000 - 25 000	180 000 - 300 000
	Technical Manager	18 000 - 25 000	216 000 - 300 000
Specialist with 2-3 years of experience			
Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Engineering	Constructor	6 000 - 9 000	72 000 - 108 000
	Process Engineer	7 000 - 10 000	84 000 - 120 000
	Maintenance Specialist	7 000 - 10 000	84 000 - 120 000
	Planner	5 000 - 8 000	60 000 - 96 000
	HV Electrical Engineer	9 000 - 12 000	108 000 - 144 000

Specialist with 2-3 years of experience			
Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Engineering	LV Electrical Engineer	9 000 - 12 000	108 000 - 144 000
	Automation Engineer	8 000 -12 000	96 000 - 144 000
	HVAC Engineer	9 000 - 12 000	108 000 - 144 000
	Construction Engineer	11 000 - 15 000	132 000 - 180 000
	Electrical and Automation Designer	9 000 - 12 000	108 000 - 144 000
	Mechanical Engineer	9 000 - 12 000	108 000 - 144 000
	Marine Construction Engineer	10 000 – 13 000	120 000 – 156 000
	Calculation Engineer	7 000 - 10 000	84 000 - 120 000
Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Quality	Quality Control Inspector	10 000 – 13 000	120 000 – 156 000
Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Production	Turbine Fitter	5 000 - 6 000	60 000 - 72 000
	Welder	6 000 - 8 000	72 000 - 96 000
	Grinder	5 000 - 6 000	60 000 - 72 000
	Start-up Technician	7 000 - 10 000	84 000 - 120 000
	Service Technician	8 000 - 11 000	96 000 - 132 000
Specialist with 2-3 years of experience			
Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Production	Electrical Technician	6 000 - 8 000	72 000 - 96 000
	Mechanical Technician	6 000 - 8 000	72 000 - 96 000
	Automation Technician	6 000 - 9 000	72 000 - 108 000
	Electrical Mechanic	7 000 - 10 000	84 000 - 120 000

Specialist with 2-3 years of experience			
Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Production	Production Tester	6 000 - 8 000	72 000 - 96 000
	Painter	5 000 - 7 000	60 000 - 84 000

4. Port industry_

Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Managerial	Port Agency Manager	13 000 - 16 000	156 000 - 192 000
	Crew Manager	8 000 - 10 000	96 000 - 120 000
	Development Strategy Director	16 000 - 24 000	192 000 - 288 000
	Business Development Manager	10 000 - 14 000	120 000 - 168 000
	Technical Director	15 000 - 18 000	180 000 - 228 000
	Technical Manager	11 000 - 14 000	132 000 - 168 000
	Warehouse Manager	10 000 - 12 000	120 000 - 144 000
	Planning Manager	10 000 - 12 000	120 000 - 144 000
	Sustainability Manager	10 000 - 13 000	120 000 - 156 000
Specialist with 2-3 years of experience			
Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Technical	Electrical Technician	6 000 - 8 000	72 000 - 96 000
	Mechanical Technician	6 000 - 8 000	72 000 - 96 000
	Automation Technician	6 000 - 9 000	72 000 - 108 000

Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Administrative	Port Agent	6 500 – 14 000	78 000 – 168 000
	Port Operations Specialist	6 200 – 9 000	74 400 – 108 000
	Port Officer	5 000 – 6 000	60 000 – 72 000
	Purchasing Specialist	6 500 – 9 000	7 800 – 108 000
	Customs Agent	6 500 – 9 000	7 800 – 108 000
	Crew Agent	5 500 – 7 000	66 000 – 84 000
	Sustainability Specialist	6 500 – 8 500	7 800 – 102 000
	Commodities Trading Specialist	6 000 – 8 000	72 000 – 96 000
	Supervision Inspector	5 000 – 6 000	60 000 - 72 000
	Lease Agreement Specialist	7 000 – 1 0000	84 000 – 120 000
	Port Space Planner	7 500 – 9 500	90 000 – 114 000
Category	**Job position**	**monthly (PLN | min. - max.)**	**annualy (PLN | min. - max.)**
Basic positions	MIG Welder	4 800 – 6 800	57 600 – 81 600
	Crane Service Technician	5 000 – 7 000	60 000 – 84 000
	Service/Ship Mechanic	6 000 – 20 000	72 000 – 24 0000
	Electrician	4 800 – 7 000	57 600 – 84 000
	Electrical Fitter	4 800 – 6 800	57 600 – 81 600
Category	**Job position**	**monthly (PLN | min. - max.)**	**annualy (PLN | min. - max.)**
Basic positions	Warehouse Operative	3 800 – 5 000	45 600 – 60 000
	Forklift Operator	4 000 – 5 500	48 000 – 66 000
	Crane Operator	4 500 – 7 200	54 000 – 86 400
	Engine Department Member	6 000 – 10 000	72 000 – 12 0000

Category	Job position	monthly (PLN | min. - max.)	annualy (PLN | min. - max.)
Basic positions	Loader Operator	5 000 – 6 500	60 000 – 78 000
	Stevedore	5 200 – 6 500	62 400 – 78 000
	Transhipment Operative	5 000 – 6 000	60 000 – 72 000
	Port Shift Dispatcher	5 000 – 7 500	60 000 – 90 000
	Guard	4 000 – 5 500	48 000 – 66 000
	Siding Operative	5 000 – 6 500	60 000 – 78 000
	Administrator	6 000 – 8 000	72 000 – 96 000
	Dispatcher	4 200 – 6 000	50 400 – 72 000

5. Yachting industry_

Category	Job position	monthly (PLN | min. - max.)
Managerial	Engineering Manager	12 000 - 18 000
	Production Manager	10 000 - 13 000
	Production Coordinator	12 000 - 18 000
	R&D Manager	12 000 - 16 000
	Quality Manager	12 000 - 16 000
	Project Manager	10 000 - 12 000
	Change Management and BOM Supervisior	9 000 - 11 000

Category	Job position	monthly (PLN | min. - max.)
Specialist	Production Engineer	7 000 - 9 500
	Development Engineer	7 000 - 9 500
	Spare Parts and Accessories Specialist	6 000 - 8 000
	Boat Building Engineer	7 000 - 10 000
	Production Planner	5 000 - 8 000
	BOM Specialist	5 500 - 7 000
	Prototyping Engineer	10 000 - 12 000
	Electrical Engineer	6 000 - 8 000
	Maintenance Engineer	7 000 - 10 000
	Purchasing Senior Specialist	8 500 - 10 000
	Purchasing Specialist	7 000 - 8 500
	Strategic Buyer	10 000 - 14 000
	Logistics Specialist	7 000 - 8 000
	Junior Logistics Specialist	5 000 - 6 500
Category	**Job position**	**monthly (PLN | min. - max.)**
Blue collar	Quality inspector	7 000 - 8 000
	Electrician	5 000 - 7 000
	Finisher	4 000 - 5 000
	Painter	5 000 - 7 000
	Laminator	5 000 - 7 000
	Assembly worker	5 000 - 6 000

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