European Commission

THE EU BLUE ECONOMY REPORT 2025

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FOREWORD

Dear reader,

I am glad to present to you the EU Blue Economy Report 2025 – the flagship publication providing the key trends and new developments in the EU's economic sectors based on, in and around the ocean.

This Report is published at a time when the EU faces significant challenges. Heightened geopolitical tensions, rapid technological developments and the increasingly visible effects of climate change – among other factors – require us to rethink how Europe can remain prosperous, competitive and secure in the future. Addressing these issues will be a central task for this Commission during the 2024-2029 period.

The importance of a strong EU Blue Economy becomes ever more clear. The Blue Economy sectors provide Europeans with healthy and sustainable food, clean and affordable maritime energy and they connect Europe to the rest of the world. Moreover, they are the breeding ground for blue innovation that will become the basis of the maritime technologies and sectors of the future.

In June 2025, I will present the European Ocean Pact. The Ocean Pact will set out an overarching framework for all ocean policies, enabling Europe to act together in achieving a more competitive Blue Economy, better maritime security whilst restoring the oceans and benefitting the people living in coastal communities.

Data analysis is crucial for this endeavour. This report and the EU Blue Economy Observatory support evidence-based policy making and can help monitor progress.

The 2025 edition introduces several innovations. Notably it features an enhanced methodology that goes beyond measuring only the direct impacts in key indicators such as employment and Gross Value Added, allowing also capturing indirect effects. The Report also makes progress in addressing data gaps within innovative sectors and enhances forecasting for nature-based solutions that address climate change impacts, such as coastal floods.

I invite you to explore the findings and analysis presented in the Report and the wealth of information available through the EU Blue Economy Observatory. I am confident that it will benefit the extensive community of maritime stakeholders – including researchers, policy makers, industry representatives and investors – as well as all EU citizens interested in the responsible management of our seas and oceans, grounded in marine knowledge, innovation and investment.

COSTAS KADIS,

EU Commissioner for Fisheries and Oceans

FOREWORD

The Blue Economy is a strong and growing set of dynamic and competitive industries, contributing around EUR 250 billion to the EU economy and employing nearly 5 million people. It offers a wealth of opportunities for innovation, economic diversification, job creation, competitiveness, climate neutrality and sustainability.

Innovation in the Blue Economy is a key driver for sustainability and growth. Starting from a handful of demonstration plants in the early 2000s, the EU now hosts a cumulative capacity of 18.9 GW of offshore wind, spread across 11 Member States – enough to power more than 6 million households – making it one of the fastest-growing sectors of the entire EU economy.

From 2000 to 2023, investments in Blue Economy sectors steadily increased, with activities such as Blue biotechnology growing around 7% annually. This underscores the importance of funding research and development for the success of new Blue Economy sectors.

We are leveraging our resources to attract public and private investment in our Blue Economy startups and scaleups, harnessing Europe's entrepreneurship and comparative advantage as a maritime powerhouse.

From fisheries to Maritime transport and coastal tourism, this report presents the innovative approaches being developed across the EU, for example sustainable marine fuels, maritime autonomous ship systems, wind-assisted propulsion systems, floating photovoltaic and offshore wind technologies, nature-based solutions, such as seaweed farming for bioremediation purposes, and digital twin technologies. The uptake of sustainable technologies and practices stimulates greater competitiveness, as well as greater resilience to shocks and climate change impacts.

I welcome this Report, which draws on the Joint Research Centre's strong scientific analysis to assess the performance and potential of the Blue Economy. We are on the right track, and I look forward to the progress that will be made in the years to come.

EKATERINA ZAHARIEVA,

European Commissioner for Startups, Research and Innovation

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THE EU27 BLUE ECONOMY

2022

Source: own elaboration based on Eurostat and DCF data

Employment	GVA	Gross Operating Surplus	Turnover
4.8 million people	€251 billion	€121 billion	€891 billion

Sector	Persons employed change	Persons employed	GVA	GVA change
Living Resources	+9%	1.1 M people	38 billion	+31%
Maritime Transport	+3%	393,000 people	62 billion	+81%
Non-living Resources	-49%	17,000 people	11 billion	+27%
Renewable energy	+200%	17,000 people	5 billion	+370%
Port Activities	+2%	423,000 people	33 billion	+25%
Shipbuilding and Repair	+23%	316,000 people	20 billion	+71%
Coastal Tourism	+37%	2.6 M people	82 billion	+54%

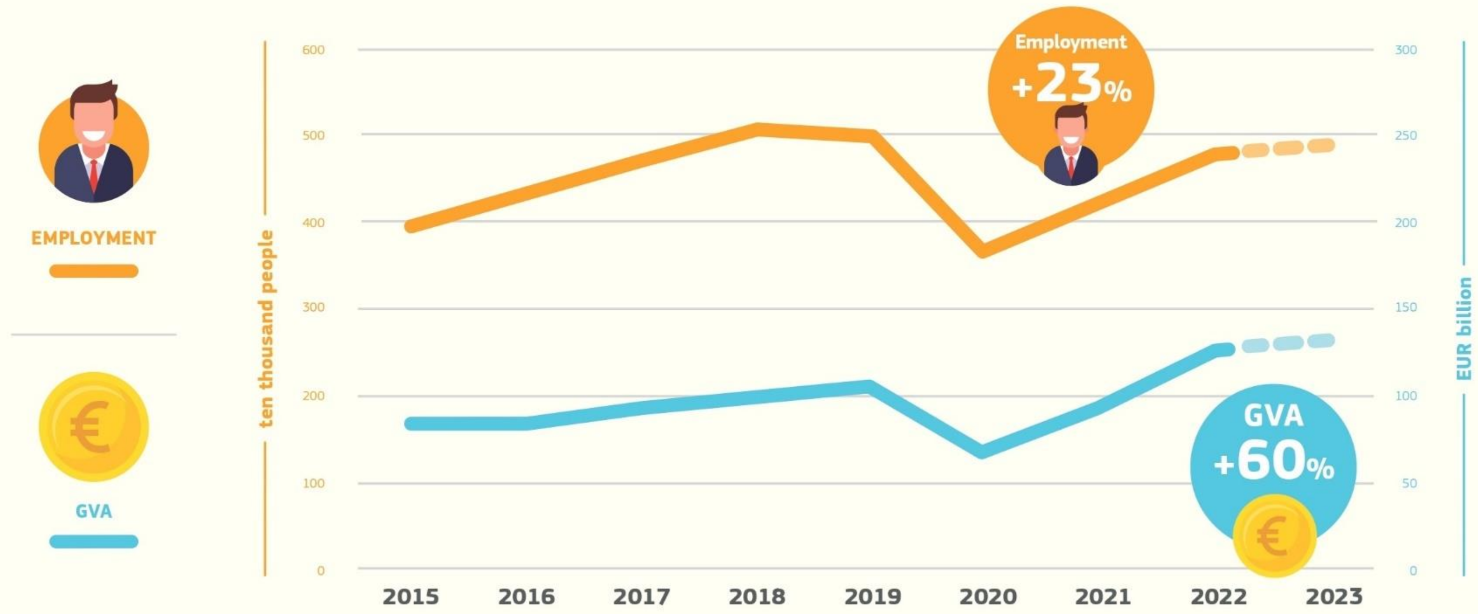
AQUACULTURE
Production volume
1.08M TONNES

MARITIME TRANSPORT
% of waterborne transport over total transport
68% (freight)

COASTAL TOURISM
% of nights spent in coastal areas over total nights spent
48%

Percentage changes refer to the **2015-22** period

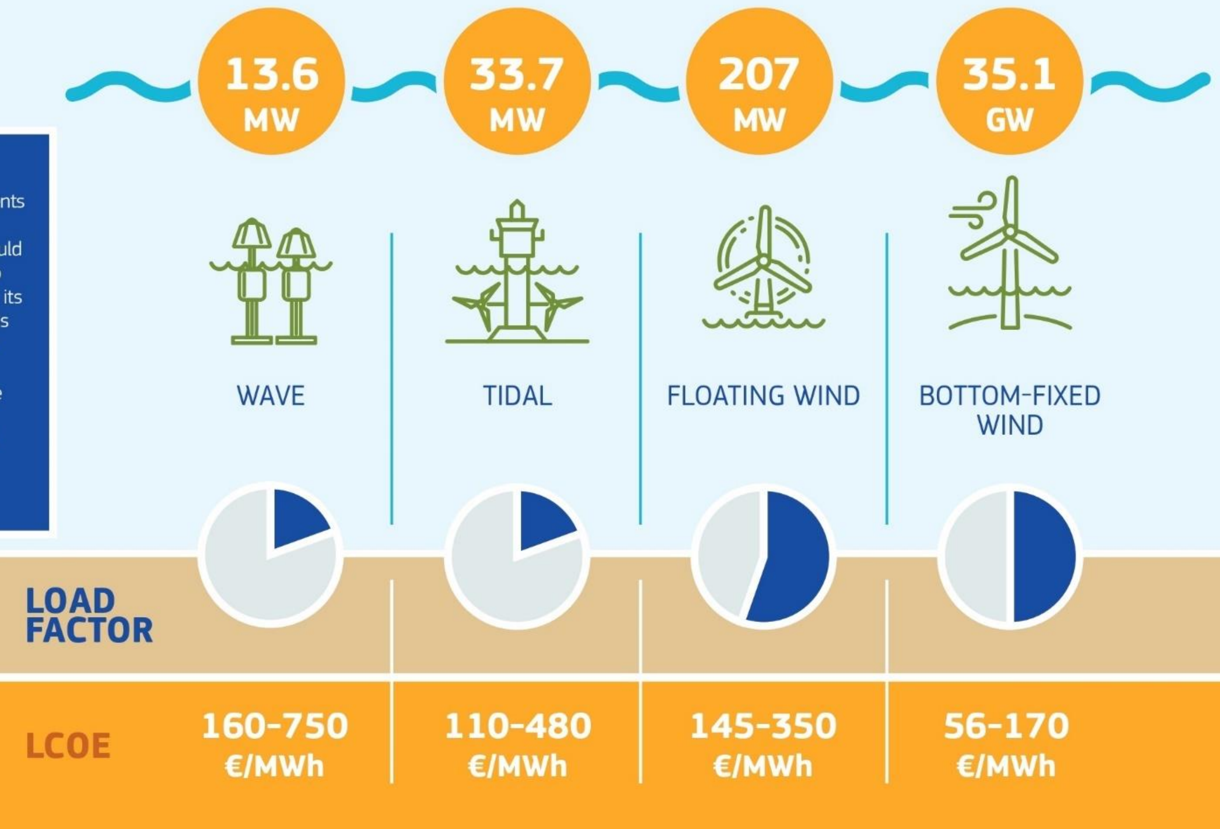
EVOLUTION OF EMPLOYMENT AND GVA IN THE BLUE ECONOMY (2015-2022)



(Data for 2023 are estimated)

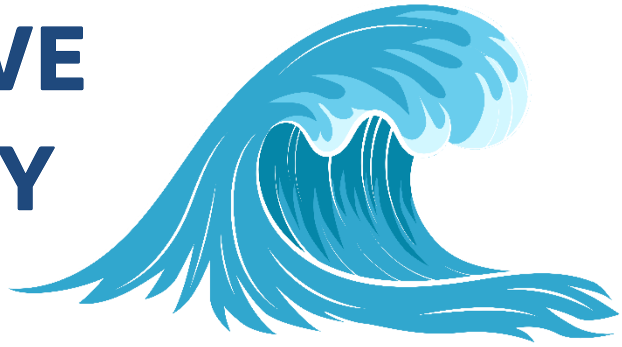
CUMULATIVE RENEWABLE ENERGY CAPACITY IN EUROPEAN SEA BASINS (2024)

The levelized cost of electricity (LCOE) represents the price at which the generated electricity should be sold for the system to break even at the end of its lifetime. The load factor is the percentage of power output an intermittent renewable energy source actually produces compared to its nominal capacity (i.e., the max output)



Source: 4COffshore, BNEF IRENA, Ocean Energy Europe

EXECUTIVE SUMMARY



The **eighth edition of the EU Blue Economy Report**, presented in a new layout, provides a thorough overview of the scale and breadth of the Blue Economy within the European Union (EU). Its primary aim is to offer guidance to policymakers and stakeholders in fostering the growth of ocean-based and maritime-related markets and the sustainable use of coastal and marine resources. The Blue Economy sectors play an increasingly important role in achieving the European Commission's key priorities to make the EU more competitive, sustainable, resilient and secure. By providing economic insights into the opportunities that emerge from the energy and digital transition, the Report also aims to attract investment in the Blue Economy sectors.

This new edition of the Report provides the reader with an analysis of the socio-economic performance, trends and drivers of the Blue Economy sectors. For the sectors denominated *Marine living resources* (fisheries and aquaculture), *Marine non-living resources* (marine extractive industry), *Marine renewable energy* (offshore wind), *Port activities*, *Shipbuilding and repair*, *Maritime transport* and *Coastal tourism*, the comprehensive analysis is based on data collected by the Commission from Member States via the European Statistical System. Specifically, fisheries and aquaculture socio-economic data originate from the EU Data Collection Framework (DCF). Data for the other sectors come from Eurostat Structural Business Statistics (SBS) and PRODuction COMmunautaire (PRODCOM) datasets, National Accounts and Tourism statistics, as well as few selected proprietary databases. Compared to previous editions, this Report deepens and broadens the scope of its analyses by incorporating *Blue biotechnology*, retail of seafood in non-specialised shops, seafood consumption outside households, and *Desalination* industries into the above-mentioned Blue Economy sectors. Furthermore, for the first time in this edition, the Report includes estimations of the sectoral performance for the current year -2, using Eurostat's preliminary socio-economic indicators data for 2023, thereby reducing the time lag by a year.

In addition, the Report provides complementary qualitative information about the growing importance and evolution of other Blue Economy sectors for which comparable socio-economic statistics at EU level are lacking. This refers to the production of ocean renewable energy from sources other than offshore wind – that is, tidal, wave, salinity gradient, floating photovoltaic, Ocean Thermal Energy Conversion (OTEC). These sectors have the potential to make a significant contribution to economic growth, employment creation, and sustainability transition in the EU. Our description of these economic sectors is based on information collected from various sources available in the public domain.

Lastly, this year's edition also includes special sections on the energy transition in the EU maritime transport and fishing fleet, and on the role and potential of nature-based solutions against the impacts of climate change in EU coastal areas.

Complementing the content of this Report, the online **EU Blue Economy Observatory** provides more timely and in-depth updates of relevant Blue Economy developments per economic sector and Member State. Throughout the year, additional analyses will be regularly published on the Observatory, together with information about relevant events, news and funding opportunities. Interactive dashboards are also available on the Observatory's website, facilitating access to the most recent Blue Economy data as they become available.

According to the official figures for 2022, the established sectors of the EU Blue Economy directly employed close to 4.82 million people, generated about EUR 890.6 billion in turnover and EUR 250.7 billion in gross value added (GVA) (Table 1). Furthermore, the estimates suggest that the EU Blue Economy sectors continued to grow in 2023, contributing EUR 263 billion to the EU GVA, and employing 4.88 million persons. The detailed methodology underpinning these analyses can be downloaded from the EU Blue Economy Observatory[1].

[1] METHODOLOGY FOR THE ESTIMATION OF THE ESTABLISHED SECTORS' DATA - European Commission

Table 1 - EU Blue Economy established sectors, main indicators, 2022

Indicator	EU Blue Economy 2022
Turnover	EUR 890.6 billion
Gross value added	EUR 250.7 billion
Gross operating surplus	EUR 120.6 billion
Persons employed	4.82 million
Net investment in tangible goods	EUR 8.8 billion
Net investment ratio	3.5%
Average annual salary	EUR 27 016

Notes: Turnover is calculated as the sum of the turnover in each sector; it may lead to double counting along the value chain. Nominal values. Direct impact only. Net investment excludes Maritime transport and Coastal tourism. Net investment ratio is defined as net investment to Gross Value Added.

Source: Eurostat (SBS), Data Collection Framework (DCF) and Commission Services.

These figures offer an **underestimated** picture of the full socio-economic value of the EU Blue Economy, as they refer to seven sectors for which accurate and comparable data are available at EU level, namely: *Marine living resources*, *Marine non-living resources*, *Marine renewable energy*, *Port activities*, *Shipbuilding and repair*, *Maritime transport* and *Coastal tourism*. Besides these sectors, the Blue Economy encompasses other marine-based and marine-related activities, including emerging and innovative sectors, for which a comprehensive analysis is more challenging due to the paucity of data. The inclusion of all economic activities with a maritime component, together with indirect and induced effects alongside the various supply chains, would significantly increase the above-mentioned figures.

Among the various sectors, there are several noteworthy results in this edition. The ***Coastal tourism*** sector, which remains the biggest Blue Economy sector, showed a full recovery in 2022 in terms of GVA and turnover, after a 64% and 59% decrease, respectively, in 2020 due to the COVID-19 pandemic. In 2022, the *Coastal tourism* sector represented 53% of total EU Blue Economy's employment and 33% of its total GVA. The relative size of this sector and its sensitivity to economic conditions and shocks makes the Blue Economy growing and shrinking faster than the overall EU economy. Within ***Marine renewable energy***, the EU offshore wind energy sector remains on its fast-growth trajectory, with its GVA increasing by 42% compared to 2021 to EUR 5.3 billion in 2022. This growth boosted the sector's profits, which reached EUR 4.1 billion in 2022, representing a 56% increase from 2021. With this performance, offshore wind is one the fastest growing sectors in the EU economy as a whole.

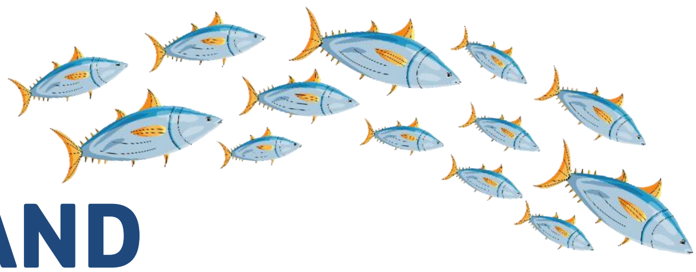
Within the EU-27, the four largest Member States (Germany, France, Italy, and Spain) are also the biggest contributors to the EU Blue Economy's socio-economic performance. Together, they account for 60% of the entire EU Blue Economy's GVA and 52% of its employment. Greece is the second largest provider of Blue Economy jobs in the EU, employing 12.4% of its workforce, after Spain (20%). The Blue Economy's contribution to national economies and employment varies significantly across EU countries, ranging from 7.3% in Croatia to 0.2% in landlocked Austria and Luxembourg.

The further sustainable development of the EU Blue Economy is becoming increasingly relevant, in light of the political priorities of the new Commission established in December 2024. The Blue Economy sectors can make a significant contribution to supporting economic growth and job creation, enhancing Europe's competitiveness, rebuilding the EU's defence industry, strengthening strategic autonomy, supplying clean and affordable energy, and ensuring access to healthy aquatic foods, amongst other. This also generates potential for new business opportunities and further advance the sustainability transition of all EU's established and emerging Blue Economy sectors, for example in the area of clean technologies, green port infrastructure, shipbuilding and repair and marine robotics. In this context, the European Ocean Pact will be the enabling framework to materialise these ambitions.

Furthermore, given the increasing impact of climate change on coastal regions, the Blue Economy can contribute to speeding up adaptation and strengthening the resilience of coastal communities. Currently, already approximately 72 000 people in the EU are affected by **coastal flooding** each year. Without an increase in current levels of coastal protection, annual damages are projected to escalate to between EUR 137 billion and EUR 814 billion by 2100, depending on alternative emissions and mitigation scenarios[2]. **Nature-based solutions** (NBSs) provide opportunities to strengthen coastal protection and reduce the risks of flooding and coastal erosion. Their benefits are estimated to outweigh the costs by a factor of more than 3.5.

[2] European Commission: Joint Research Centre, Feyen, L., Ciscar, J., Gosling, S., Ibarreta, D. et al., Climate change impacts and adaptation in Europe – JRC PESETA IV final report. Publications Office, 2020, https://data.europa.eu/doi/10.2760/171121

CHAPTER 1. GENERAL OVERVIEW AND ECONOMIC CONTEXT



This chapter describes the general context in which economic data presented in this Report should be interpreted, and provides the relevant background information, as well as a high-level overview of the established sectors of the EU Blue Economy.

1.1. GENERAL ECONOMIC CONTEXT

After a strong rebound following the recession triggered by the COVID-19 outbreak, economic activity in the EU expanded further in 2023 and 2024, although at a substantially slower pace. In 2023, the Gross Domestic Product (GDP) of the EU grew by 0.4%, with growth projected at 0.9% in 2024 – substantially below the 2.2% average annual expansion recorded from 2015 to 2019, before the COVID-19 pandemic[3]. Higher interest rates to counter inflation, as well as the effects of Russia's war of aggression against Ukraine on energy prices, continued to impede economic growth[4]. Although inflation remained high, it decreased from 9.2% in 2022 to 6.4% in 2023, and further to 2.6% in 2024. While the real wage per employee decreased in 2023 – by 0.5% compared to a 2.2%-decrease in 2022 – unemployment reached a record low of 6.1%. In 2024, real wage per employee is projected to have increased by 2.2%, and the unemployment rate is projected to have decreased further to 5.9%.

Several positive developments are expected to continue into 2025: decreased inflation, lower interest rates, sustained low unemployment, real wage and GDP growth. Labour shortages are showing signs of easing. However, uncertainty persists due to ongoing geopolitical tensions, including the Middle East crisis, trade disruptions in the Red Sea, the continued Russian war of aggression against Ukraine, and recent protectionist measures by trading partners, notably the recent tariff measures implemented by the United States. Moreover, structural weaknesses in the EU economy remains to be addressed. Slow innovation and a lack of business dynamism continue to pose challenges[5]; Mario Draghi's report on the future of European competitiveness stresses the need for more investment in the EU economy and states that the EU is facing an 'existential challenge'[6]. Low productivity growth and level of investment may make it increasingly difficult for firms to sustain wage growth, leading them to either reduce labour inputs or pass higher costs on to consumers[7].

In this macro-economic and geopolitical context, competitiveness, security and climate are key focus areas of the new European Commission. The Commission's will present its proposal for the next **multiannual financial framework** in July 2025. This should include a plan for each EU Member State with regard to key reforms and investments, and a plan for the establishment of a **European competitiveness fund** providing the Commission with the capacity to invest in supporting

[3] European Economic Forecast. Autumn 2024.

[4] European Economic Forecast. Autumn 2024, page 9.

[5] Autumn 2024 Economic Forecast: A gradual rebound in an adverse environment - European Commission.

[6] The future of European competitiveness.

[7] Autumn 2024 Economic Forecast: A gradual rebound in an adverse environment - European Commission.

strategic sectors and critical technologies[8]. The Commission's priorities are also reflected in the policy initiatives around the sectors of the Blue Economy, including the new **European ocean pact**, which is one of the focus areas in the portfolio of Commissioner Kadis. The European ocean pact aims to provide an overarching and consistent policy framework for all policy areas linked to oceans. It focuses on supporting resilient and healthy oceans; promoting a competitive Blue Economy; ensuring opportunities in coastal communities; developing a comprehensive agenda for marine knowledge, innovation and investment; and stepping up maritime security, and strengthening maritime spatial planning. In the light of current global and geopolitical challenges, the European Council also stressed the strategic importance of oceans, water resilience and the Blue Economy in strengthening the EU's competitiveness and resilience. It also welcomed the Commission's intention to put forward an ambitious, holistic and forward-looking European ocean pact[9].

Oceans and coastal areas offer a sea of opportunities for economic growth and development. Access to and management of the maritime space are key in developing these opportunities. To date, 20 out of 22 coastal Member States have adopted national maritime spatial plans, as requested by the **Maritime Spatial Planning Directive**. Most of them are revising their plans to accommodate conservation and restoration objectives and offshore renewable energy ambitions for 2030 and beyond. The EU's **biodiversity strategy** for 2030 is a comprehensive, ambitious and long-term plan to protect nature and reverse the degradation of ecosystems. It aims to legally protect a minimum of 30% of the EU's sea area[10]. In this context, the **Nature Restoration Regulation**, which is a key element of the EU biodiversity strategy, entered into force in August 2024[11].

1.2. THE EU BLUE ECONOMY

The concept of the Blue Economy is multifaceted and often subject to varying interpretations. As a result, definitions differ significantly. One of the primary challenges in defining the Blue Economy is delineating its scope, as it encompasses a broad range of coastal, marine, and ocean-related activities with complex socio-economic benefits and environmental impacts.

The delineation of the Blue Economy largely depends on the sectors included, and the extent to which indirect upstream and downstream effects can be identified and measured. Hence, deciding which sectors and activities to include when analysing the current state and size of the Blue Economy, is an important first step.

For the purposes of this Report, and for coherence with its previous editions published since 2018, the term Blue Economy includes economic activities that are:

- marine-based, including those undertaken in the ocean, sea and coastal areas, such as capture fishery and aquaculture, offshore oil and gas production, offshore wind energy production, ocean energy production, desalination, shipping and maritime transport, and marine and coastal tourism;
- marine-related, including those that use the products of and/or produce products and services for marine-based activities, such as seafood processing, marine biotechnology, shipbuilding and repair, port activities, maritime communication, use of maritime equipment, maritime insurance and maritime surveillance.

Yet, the Blue Economy also includes marine education and research, as well those segments of the public sector directly tied coastal and ocean stewardship – such as national defence, the coast guard, marine environmental protection.

A challenge in estimating the scope and size of the Blue Economy is the limited availability of data for certain maritime sectors. This lack of data, together with the lack of standardisation in data collection among Member States hinders the comparability and consistency of data across sectors and Member States. To address this challenge, we use the latest structural business statistics (SBS) published by Eurostat at the time of writing this Report, covering 2009-2022. These data are complemented with other data sources and preliminary data from Eurostat to estimate 2023 values and obtain a more comprehensive and up-to-date view of the EU Blue Economy.

In addition, the ocean delivers economic benefits that are difficult to quantify – ranging from its function as vital marine habitat and natural carbon sink to its roles in coastal protection, waste recycling and storage, and the regulation of climate and biodiversity.

Moreover, emerging and innovative sectors such as *Blue biotechnology* are developing rapidly. The activities in these sectors need to be included and measured, so as to comprehensively assess the scope and size of the Blue

[8] https://ec.europa.eu/commission/presscorner/api/files/document/print/en/ip_25_486/IP_25_486_EN.pdf

[9] https://www.consilium.europa.eu/media/viyhc2m4/20250320-european-council-conclusions-en.pdf.

[10] https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en.

[11] https://environment.ec.europa.eu/topics/nature-and-biodiversity/nature-restoration-regulation_en.

Economy. This work is undertaken through the **EU Blue Economy Observatory**. The Observatory provides a detailed analysis per sector and country, which is continuously updated.

1.3. OVERVIEW OF SECTORS OF THE EU BLUE ECONOMY

The EU Blue Economy activities analysed in this report are sorted into sub-sectors, which are then grouped in sectors (as presented in Table 2), in accordance with previous editions of this Report. These seven sectors are *Marine living resources*, *Marine non-living resources*, *Marine renewable energy*, *Port activities*, *Shipbuilding and repair*, *Maritime transport* and *Coastal tourism*.

Table 2 - The Established Blue Economy sectors and their subsectors

Sector	Sub-sector
Marine living resources	Primary production
	Processing of fish products
	Distribution of fish products
Marine non-living resources	Oil and gas
	Other minerals
	Desalination
Marine renewable energy	Offshore wind energy
Port activities	Cargo and warehousing
	Port and water projects
Shipbuilding and repair	Shipbuilding
	Equipment and machinery
Maritime transport	Passenger transport
	Freight transport
	Services for transport
Coastal tourism	Accommodation
	Transport
	Other expenditure

In addition to the economic activities in these seven sectors, for which comprehensive data are available, the 2025 Blue Economy Report analyses *Ocean energy*. This subsector includes marine renewable energy sources other than offshore wind energy. Since previous editions of this Report, the economic activities of blue biotechnology, retail of seafood in non-specialised shops, seafood consumption outside households, and desalination have now been incorporated into the seven main sectors. Hence, the values presented in the 2025 edition of the Blue Economy Report are not directly comparable with those of previous editions. As a result, the 2025 edition supersedes earlier versions. For the activities in the Blue Economy that have not been incorporated in the seven sectors, data availability is less comprehensive and comparable. This is partly due to their not being fully captured by the current statistical classification of economic activities, often because they are still emerging.

The analyses contained in this Report are based on Eurostat's SBS for all the above-mentioned sectors, with few exceptions. The primary production[12] activities in the *Marine living resources* sector are based on data originating from the EU data collection framework (DCF)[13]. In addition, data from the tourism expenditure survey and from the EU tourism satellite accounts were used to complement Eurostat's SBS for estimations for the *Coastal tourism* sector, as in previous editions of the Report. Similarly, different data sources, complemented with Eurostat's SBS data, have been used to estimate the socio-economic importance of blue biotechnology, retail of seafood in non-specialised shops, seafood consumption outside households, and desalination.

The Report provides indicators of the socio-economic performance of the sectors of the EU Blue Economy, and their contribution to the EU economy in terms of turnover, value added, operating surplus, and employment. Although only the direct contribution of the Blue Economy sectors is fully accounted for in this Report, all activities may have indirect and induced effects on the broader economy. For example, in a significant proportion of the value added for the *Shipbuilding and repair* sector is generated from activities upstream and downstream in the industry supply chain. This indicates that, beyond the sectors' direct contribution to the economy – detailed in this Report – there may be significant multiplier effects on income and employment across various other segments of the economy. Hence, work is ongoing to estimate the indirect and induced effects on the EU Blue Economy sectors. Some preliminary findings are presented in this edition of the report, with the aim of providing a more comprehensive overview in future editions of the report.

The direct gross value added (GVA) of the established sectors of the Blue Economy in **2022 was EUR 250.7 billion – contributing 1.7% to the EU-27 economy** – a 33% increase from EUR 188 billion in 2021. This shows a significant post-pandemic recovery, with the 2022 GVA surpassing the 2019 value of EUR 203 billion by 23% [14].

[12] Capture fisheries and aquaculture.

[13] https://stecf.jrc.ec.europa.eu/reports/dcf-dcr.

[14] All economic magnitudes in the report are expressed in nominal prices, unless stated otherwise.

Employment increased 16% from 4.16 million persons in 2021 to **4.82 million persons in 2022** – contributing **2.4% to the EU-27 economy**.

The contribution of the Blue Economy sectors to the overall EU economy in terms of employment and GVA declined to 1.8% and 1.2%, respectively in 2020. This decline in the overall contribution of the Blue Economy was due to the importance of *Coastal tourism*, which was one of the economic activities hardest hit by the COVID-19 pandemic – though the sector has recovered since then (Figure 1). According to the Organisation for Economic Co-operation and Development (OECD), the ocean economy contributed 3%-4% annually to GVA between 1995 and 2020, and its monetary value doubled in the same time span[15].

The Blue Economy grows and shrinks faster than the overall EU economy. This is explained by *Coastal tourism* having the largest share in the Blue Economy, and by this sector growing faster in periods of economic growth and shrinking faster during crisis.

Figure 1 - Contribution of the Blue Economy to the overall EU economy in terms of GVA and employment, 2009-2023 (%)

NB: Turnover and people employed in 2023 were estimated based on Eurostat's preliminary data.

Sources: Eurostat (SBS) data and authors' own calculations

Turnover in the EU Blue Economy increased 29% from EUR 689 billion in 2021 to **EUR 891 billion in 2022**.

Gross operating surplus (profit) at **EUR 121 billion** was **47%** higher in 2022 than in 2021.

The 2023 estimates confirm growth of the EU Blue Economy sectors. Preliminary data estimate that GVA reached **EUR 263 billion** and employment **4.89 million people** in 2023[16]. When accounting for the indirect and induced effects of the EU Blue Economy sectors, GVA would easily reach more than EUR 350 billion and more than 6 million people would be employed.

Box 1- Women in the Blue Economy

Within the Blue Economy, women are shown to encounter structural hindrances in male-dominated sectors such as fisheries, aquaculture, maritime transportation, and marine research. These include exclusionary workplace norms and hierarchies, as well as insufficient support for balancing work and personal life, which are considered to discourage women's entry and continued participation in these sectors.

Blue Economy statistics broken down by gender are only available for the fisheries, aquaculture and fish processing sectors. The data underlying these statistics are collected under the EU Data Collection Framework and analysed by the Scientific, Technical and Economic Committee for Fisheries (STECF). According to the latest statistics, women represented 3.63% of the workforce on board fishing vessels in 2020, 22% of employees in the aquaculture sector in 2020, and 56.2% of employees in the fish processing industry in 2021. The available gender-specific data thus only encompass the marine living resources sector within the Blue Economy.

The EU Gender Equality Strategy 2020-2025 seeks to close gender gaps in the labour market, ensure equal participation across various economic sectors, and promote gender balance in decision-making and politics. However, insufficient data hinders a full comprehension of gender-specific issues within the Blue Economy, and with that the formulation of targeted solutions to foster gender equality. The EU is however making efforts towards gender equality in the Blue Economy, with several projects financed by the EU, such as WINBLUE and WIN-BIG (EMFAF), she4sea (Erasmus +) and Women on board (Interreg Europe). The outcomes of these projects will assist the European Commission in advancing gender equality in the Blue Economy.

Read more about women in the Blue Economy on the EU Blue Economy Observatory.

In general, the latest available figures show that the EU Blue Economy fully recovered in 2022 from the impact of the COVID-19 pandemic in 2020, and the preliminary 2023 estimates confirm the upward trend (Figure 2 and Figure 3). During the period analysed, the growth in the

[15] OECD (2025). The Ocean Economy to 2050. OECD Publishing. Paris. https://doi.org/10.1787/a9096fb1-en.

[16] Persons employed and GVA in 2023 is an estimation based on Eurostat's preliminary data. GVA has been estimated assuming it follows the same trend as the preliminary turnover data.

Marine renewable energy, *Shipbuilding and repair*, *Marine living resources*, and *Port activities* sectors outpaced the overall Blue Economy average. *Coastal tourism* – hit hardest in 2020 with a 64 % drop in GVA and 47% in employment – fully regained its turnover and GVA, but employment still lags behind pre-pandemic levels.

Likewise, the *Marine non-living resources* sector has been experiencing a strong disinvestment in recent years, in line with the European Green Deal policies aiming to ensure a carbon-neutral, sustainable EU economy.

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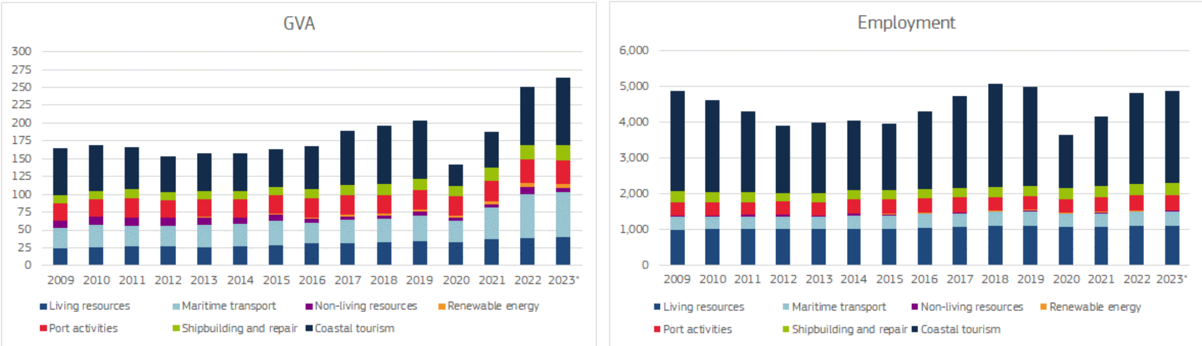
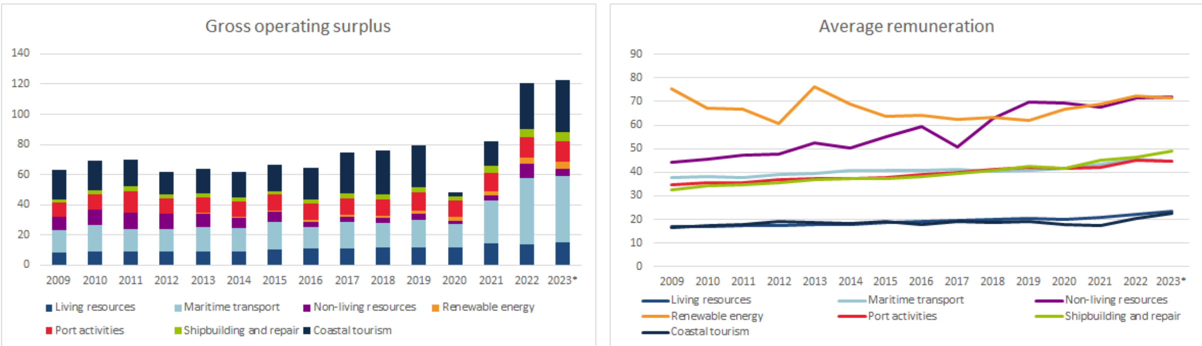
Figure 2 - GVA and gross operating surplus (billion EUR) in the EU blue economy, 2009–2023



NB: The 2023 data were estimated based on Eurostat's preliminary data, assuming that GVA follows the same trend as turnover.
Source: Authors' own calculations based on Eurostat (SBS) and DCF data.

Figure 3 - People employed (thousands) and gross remuneration per employee (thousand EUR) in the EU blue economy, 2009–2023



NB: The number of people employed in 2023 was estimated based on Eurostat's preliminary data, while average remuneration was estimated assuming that labour costs follow the same trend as turnover.
Source: Authors' own calculations based on Eurostat (SBS) and DCF data..

Despite being significantly affected by the pandemic, ***Coastal tourism*** continues to generate the largest shares of employment and GVA in the EU Blue Economy, at 53% and 33% respectively in 2022. The sector is followed by *Marine living resources* with 23% of employment and 15% of GVA; *Maritime transport,* with 8% and 25%; *Port activities,* with 9% and 13%; and *Shipbuilding and repair,* with 7% and 8%, respectively. *Marine renewable energy* generated 0.4% of total employment, and 2% of GVA, while *Marine non-living resources* contributed 0.4% and 4%, respectively (Table 3).

In relative terms, ***Marine renewable energy*** is the fastest-growing sector of the Blue Economy – and one of the quickest-expanding industries in the EU – having seen its turnover jump from EUR 65 million in 2009 to EUR 4.1 billion in 2022.

Since 2009, **gross remuneration** per employee across the EU Blue Economy sectors has risen steadily, with the lowest averages in *Coastal tourism* and *Marine living resources*, and the highest in *Marine non-living resources* and *Marine renewable energy*.

Employment trajectories diverge sharply between the *Marine non-living resources* and *Marine renewable energy* sectors: the latter, as a nascent, high-growth industry, contrasts with the former's mature, contracting profile – particularly in its oil and gas sub-sector – reflecting the EU's carbon-reduction objectives under the European Green Deal and European Climate Law.

Table 3 - Overview of the EU Blue Economy by sector

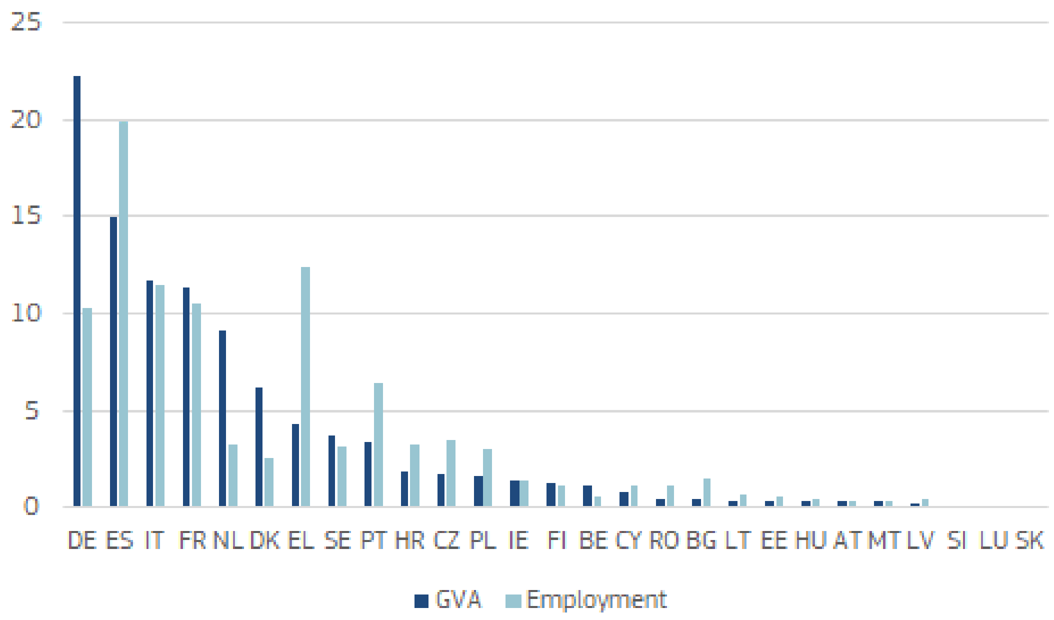
Persons employed (thousands)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Living resources	981,6	1.004,3	1.000,0	1.009,6	993,4	1.005,4	1.003,7	1.043,2	1.053,8	1.085,0	1.104,6	1.055,6	1.073,9	1.091,4
Non-living resources	37,0	35,7	34,7	35,3	33,1	33,1	33,3	24,3	19,8	18,3	17,0	16,8	16,5	17,0
Renewable energy	0,5	0,9	1,3	1,4	1,8	2,5	5,8	7,2	9,9	11,5	14,8	17,4	16,3	17,3
Port activities	383,6	374,5	361,5	369,4	365,6	405,3	415,9	420,2	417,7	387,2	384,7	387,7	410,6	423,1
Shipbuilding and repair	309,8	278,1	265,5	253,7	252,1	254,0	257,8	261,4	266,0	286,1	291,9	298,5	309,0	316,1
Maritime transport	356,1	351,2	362,9	354,7	360,5	385,7	381,6	381,9	385,1	398,6	403,6	372,0	376,4	392,8
Coastal tourism	2.805,7	2.585,7	2.276,4	1.893,7	1.986,3	1.965,7	1.863,1	2.170,0	2.597,3	2.888,0	2.778,4	1.483,3	1.954,5	2.560,2
Blue economy jobs	4.874,3	4.630,3	4.302,3	3.917,6	3.992,8	4.051,7	3.961,3	4.308,2	4.749,6	5.074,7	4.995,0	3.631,3	4.157,2	4.817,7
National employment	189.682	186.911	186.928	186.213	185.475	187.671	189.703	192.579	195.571	197.687	199.678	196.599	198.039	203.148
Blue economy contribution (%)	2,6%	2,5%	2,3%	2,1%	2,2%	2,2%	2,1%	2,2%	2,4%	2,6%	2,5%	1,8%	2,1%	2,4%
GVA (€ million)	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Living resources	24.444	25.851	26.668	26.433	26.258	27.163	28.858	30.973	31.781	33.373	34.080	32.307	36.561	37.885
Non-living resources	10.411	11.353	12.140	11.519	10.321	8.483	8.468	4.976	4.648	4.903	5.353	3.462	4.778	10.724
Renewable energy	106	202	280	346	463	596	1.133	1.536	2.041	2.212	2.915	3.407	3.739	5.319
Port activities	23.264	23.444	26.938	24.020	24.315	25.555	26.494	27.274	27.492	26.639	27.997	27.002	29.490	33.044
Shipbuilding and repair	12.075	12.581	12.449	11.560	11.492	12.081	11.636	12.699	13.796	15.200	15.947	14.760	18.522	19.907
Maritime transport	28.603	31.528	28.789	29.025	31.019	31.050	34.129	29.577	32.799	31.890	36.010	31.280	44.431	61.843
Coastal tourism	66.365	64.696	58.858	50.796	53.816	52.909	53.216	59.866	75.978	82.698	81.019	29.134	50.747	81.981
Blue economy GVA	165.269	169.655	166.123	153.699	157.684	157.837	163.934	166.900	188.536	196.915	203.321	141.352	188.267	250.703
National GVA	9.536.725	9.853.561	10.150.676	10.211.496	10.319.572	10.555.777	10.939.171	11.227.692	11.689.958	12.096.090	12.535.780	12.152.702	13.177.045	14.500.416
Blue economy contribution (%)	1,7%	1,7%	1,6%	1,5%	1,5%	1,5%	1,5%	1,5%	1,6%	1,6%	1,6%	1,2%	1,4%	1,7%

Source: Authors' own calculations based on Eurostat (SBS) and DCF data..

1.4. SECTORS OF THE BLUE ECONOMY ACROSS MEMBER STATES

Generally speaking, the four largest Member States, namely Germany, Spain, France, and Italy, are also the most significant contributors to the sectors of the EU Blue Economy in terms of both employment and GVA, with a combined contribution of 52% and 60% respectively. Greece is a notable exception: it ranks second behind Spain in Blue Economy employment, generating 12% of EU jobs, yet contributes just 4% of GVA.

Figure 4 - National contribution to the EU blue economy (%) (EU-27 = 100 %) in terms of employment and GVA, 2022

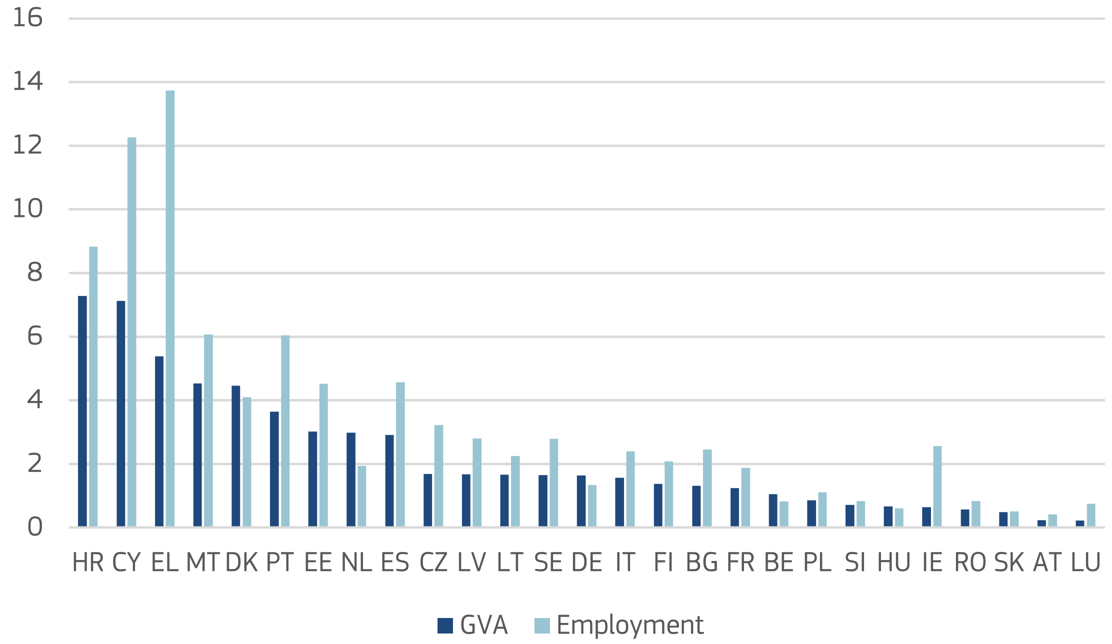


Source: Authors' own calculations based on Eurostat (SBS) and DCF data.

The contribution of the Blue Economy to the national economies varies widely across Member States. Employment shares span from 13.7% in Greece to 0.4% in Austria, whereas GVA contributions range from 7.3% in Croatia to 0.2% in Austria and Luxembourg (Figure 5).

Overall, the Blue Economy makes a larger contribution to GVA and employment in island and archipelagic Member States – namely Denmark, Greece, Croatia, Cyprus, Malta, and Portugal.

Figure 5 - Size of the blue economy as a percentage of blue jobs and GVA in the national economy, by Member State, 2022



Source: Authors' own calculations based on Eurostat (SBS) and DCF data.

More detailed analysis per Member State can be found on the EU Blue Economy Observatory's website.

CHAPTER 2. BLUE ECONOMY SECTORS

MARINE LIVING RESOURCES

The *Marine living resources* sector encompasses the exploitation of marine biological resources, from harvesting renewable organisms (**primary production**), and converting them into food, feed, bio-based products and bioenergy (**processing**), to their **distribution** along the supply chain. This the first edition of the EU Blue Economy Report in which the sector figures incorporate ***Blue biotechnology***, retail of seafood products in non-specialised shops (e.g. supermarkets) and out-of-home seafood consumption.

Covering around 2.1% of global production[17], the EU is the seventh-largest producer of fishery and aquaculture products, behind China, Indonesia, India, Vietnam, Peru, and the Russian Federation. Overall, EU production has been rather stable in the last few decades. In 2022, just over 52 800 landed about 3.9 million tonnes of seafood worth EUR 6.6 billion in 2022[18]; whereas aquaculture produced nearly 1.2 million tonnes valued at EUR 4.8 billion, making up nearly one quarter of total EU seafood production[19].

Over the past few years, several external shocks have had an impact on EU fisheries' landings. In 2020, the COVID-19 pandemic and associated public health interventions reduced demand and disrupted supply chains for many fishing businesses.[20] Russia's war of aggression against Ukraine, beginning in February 2022, triggered an increase in energy and fuel prices, as well as general inflation, throughout the year[21]. Fuel prices decreased to consistently below EUR 1 per litre only after November 2022, allowing the primary production subsector to recover its economic performance from 2023 onwards. The impacts of the shocks on the processing and distribution subsectors have been milder, as these have relied on imports to fill the gap in domestic production. The Trade and Cooperation Agreement, which came into force following Brexit, has gradually reduced the share of EU fishing opportunities in UK waters since 2021.

Seafood imports have contributed to sustaining the consumption of seafood products in the EU, and have had positive impacts on the economic activity of the processing and distribution subsectors, as well as on the general economy, especially in the presence of limited domestic supply. The EU's self-sufficiency is estimated to have decreased to 37.5% in 2022[22]; therefore, for each 10kg of fish that EU citizens ate, more than 6 kg came from outside the EU.

Size of the EU Marine living resources sector

This sector generated almost EUR 37.9 billion in GVA in 2022, a 4%-increase compared with 2021. While gross profits decreased by 5%, reaching almost EUR 13.6 billion, the turnover reported was about EUR 209.4 billion. Estimates for 2023 suggest that the economic performance of the sector has improved.

[17] FAO (2024). https://www.fao.org/statistics/data-collection/fishery-and-aquaculture/en.

[18] STECF. 2024. The 2024 Annual Economic Report on the EU Fishing Fleet. Publications Office of the European Union, Luxembourg. https://publications.jrc.ec.europa.eu/repository/handle/JRC139642.

[19] STECF. 2025. The 2024 Aquaculture Economic Report (STECF 24-14). https://publications.jrc.ec.europa.eu/repository/handle/JRC140767.

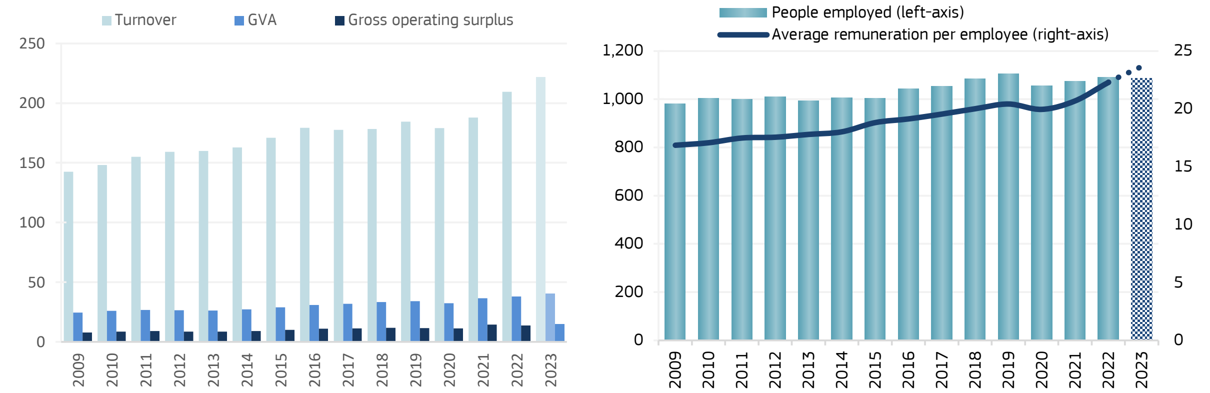
[20] Carpenter, G., Carvalho, N., Guillen, J., Prellezo, R., Villasante, S., Andersen, J. L., ... & Zhelev, K. (2023). The economic performance of the EU fishing fleet during the COVID-19 pandemic. Aquatic Living Resources, 36(2). https://doi.org/10.1051/alr/2022022.

[21] Guillen, J., Carvalho, N., Carpenter, G., Borriello, A., & Calvo Santos, A. (2023). Economic Impact of High Fuel Prices on the EU Fishing Fleet. Sustainability, 15(18), 13660. https://doi.org/10.3390/su151813660.

[22] Self-sufficiency is the capacity of a country to meet their consumption from their own production. Hence, self-sufficiency can be calculated as the ratio of domestic production over domestic consumption. EUMOFA. 2024. The EU fish market, 2024 edition. Luxembourg: Publications Office of the European Union.

The sector directly employed more than 1.09 million people, a 2%-increase from 2021. The annual average wage was estimated at EUR 22.300, an 8%-increase from 2021 (Figure 6).

Figure 6 - Size of the EU *Marine living resources* sector, 2009–2023: turnover, GVA and gross operating surplus (billion EUR); people employed (thousands); and average wage (thousand EUR)



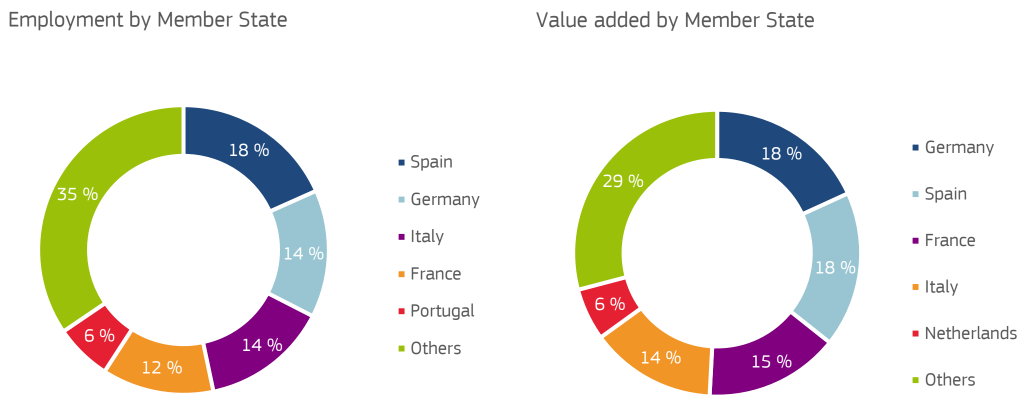
NB: Turnover and people employed in 2023 were estimated based on Eurostat's preliminary data; GVA, gross operating surplus and average remuneration were estimated assuming they follow the same trend as turnover. The 2023 estimations for fisheries are solely based on the estimations of the Scientific, Technical and Economic Committee for Fisheries.

Sources: DCF data and authors' own calculations..

Results by sub-sector and Member State

Spain leads the sector in employment with 18% of jobs, followed by Germany and Italy at 14% each, and France at 13%. In GVA terms, Germany and Spain each account for 18% of the GVA each, followed by France with 15% and Italy with 14% (Figure 7).

Figure 7 - Share of employment and GVA in the EU *Marine living resources* sector, 2022



Source: DCF data and authors' own calculations

Employment: in 2022, the distribution of fish products subsector employed more than 776 500 people, accounting for 71% of jobs, while primary production employed slightly more than 193 000 people (18%) and processing of fish products about 121 700 people (11%).

GVA: in 2022, the distribution of fish products subsector contributed EUR 26.9 billion in GVA, about 71% of the total for the sector, followed by processing of fish products with more than EUR 5.5 billion (15%) and primary production with slightly less than EUR 5.5 billion (14%).

Trends and drivers

In 2022, turnover, GVA, employment and average remuneration improved compared with 2021, reaching historical highs. However, the gross profit and other indicators of the economic performance of wild-capture fisheries worsened in 2022, due to an increase in fuel prices and inflation. Estimates for 2023 show an increase in all indicators of the performance of the sector.

In 2023, household expenditure on fishery and aquaculture products in the EU reached EUR 60.2 billion, a 4.5%-increase compared with 2022, continuing the upward trend observed in recent years[23]. Fishmongers accounted for roughly 12% of sales, while the remainder took place in non-specialised shops, such as supermarkets. The average consumption of fishery and aquaculture products per capita is estimated at 23.51 kg (measured in live weight equivalent) in 2022, down by under 1% from 2021[24]. A significant 70% of that consumption comprises imported wild-capture fishery products.

The EU's self-sufficiency continued to decrease – reaching an all-time low in 2022 – driven by increasing consumption of fishery and aquaculture products on the one hand, and a stable and limited domestic supply on the other. In 2022, EU imports of fisheries and aquaculture products totalled EUR 31.9 billion in value and 6.1 million tonnes in volume respectively (with average price of 5.2 EUR/kg), representing a 23%-increase in value, but a 3%-decrease in weight compared with 2021. The value of EU exports increased by 19%, reaching EUR 8.1 billion (with an average price of 3.5 EUR/kg), but their volume decreased by 5% to 2.3 million tonnes. EU trade flows in 2022 were influenced by several key factors. Chief among them was a surge in inflation – partly linked to the COVID-19 recovery, which fuelled stronger demand and led to higher prices. In addition, Russia's war of aggression against Ukraine had a profound impact, as it drove up energy and production costs, exacerbating global inflation and affecting currency exchange rates. Furthermore, supply constraints resulting from quota reductions and intensified competition for raw materials, such as fish, fishmeal and fish oil, contributed to a decline in trade volumes, which in turn, fuelled further price increases[25].

The EU fish processing industry strongly relies on imports from non-EU countries, such as salmon and cod from Norway and the United Kingdom, Alaska pollock from China, shrimp from South and Central America and South-East Asia, sardine from Morocco, squid, and tropical tuna.

The strategic guidelines for a more sustainable and competitive EU aquaculture[26] and the communication on the energy transition of the EU fisheries and aquaculture sector[27] aim to enhance the resilience of the fishery and aquaculture sector. In this context, measures have been taken to reduce the dependence of the sector on fossil fuels and lower its greenhouse gas (GHG) emissions (see Chapter 3). A major milestone for the energy transition in the fisheries and aquaculture sector will be the adoption of the energy transition roadmap by early 2026. The roadmap will be evidence-based and developed through consultation with stakeholders in a bottom-up approach in the framework of the Energy Transition Partnership[28]. Several workshops and seminars have been organised on finance, research and innovation and skills, to identify challenges and barriers, solutions and best practices for the different segments of the sector (small-scale coastal fisheries, large-scale fisheries, distant waters fleet, and offshore and inland aquaculture) in the short- and long-terms. Following up on the communication on the energy transition from February 2023, the Commission has released a dashboard on the EU Blue Economy Observatory[29]. This dashboard measures the incremental impact of fuel prices on the economic performance of the EU fishing sector.

In early 2025, the European Commission opened a public consultation to gather evidence, insights, concerns, ideas, and feedback on the effectiveness of the common fisheries policy (CFP) regulation from a range of stakeholders. This exercise forms part of a broader evaluation of how the CFP's performance in meeting its objectives and addressing certain challenges. The evaluation will assess the impact of the CFP Regulation on the conservation of marine biological resources and the management of fisheries and fleets that rely on them. It will also examine the policy's effects on the supply chain, consumers, and public authorities across all EU Member States over the past decade (2014-2024).

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[23] Eurostat. Purchasing power parities (PPPs), price level indices and real expenditures for ESA 2010 aggregates. https://doi.org/10.2908/PRC_PPP_IND.

[24] EUMOFA. 2024. The EU fish market, 2024 edition. Luxembourg: Publications Office of the European Union.

[25] EUMOFA. 2024. The EU fish market, 2024 edition. Luxembourg: Publications Office of the European Union.

[26] Strategic guidelines for a more sustainable and competitive EU aquaculture for the period 2021 to 2030

[27] Fisheries, aquaculture and marine ecosystems: transition to clean energy and ecosystem protection for more sustainability and resilience. Available at: https://ec.europa.eu/commission/presscorner/detail/en/IP_23_828.

[28] Energy Transition Partnership - European Commission.

[29] https://blue-economy-observatory.ec.europa.eu/fishing-fleet-fuel-analysis_en.

The new EU Fisheries Control Regulation[30] entered into force in early 2024, although most provisions will only apply after two or four years, to allow time for implementation. This revised regulation updates most of the rules for fishing vessels, taking into consideration modern technology, and promotes sustainability. The key changes involve the enhanced monitoring of fishing activities, better traceability of catches and harmonised sanctions for rule violations.

Another recent Commission initiative is the study on **fishers of the future**, an EU-wide multi-stakeholder foresight project that explores the changes that may occur in the profession, role and identity of fishers in the coming years and decades. The study's findings, along with discussions during and after its closing event, will inform the reflections planned throughout 2025 on the European ocean pact and the evaluation of the CFP regulation. It will also help inform a future vision for fisheries and aquaculture in 2040.

For more information, visit the section on ***Marine Living Resources*** within the EU Blue Economy Observatory.

2.1.1. BLUE BIOTECHNOLOGY

According to the OECD, blue or marine biotechnology is *'the application of science and technology to living organisms from marine resources, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services'*[31]. *Blue biotechnology* relies on biological material sourced from marine organisms, such as algae, cyanobacteria, fishery by-products, and microorganisms, and is a cross-cutting approach spanning multiple industries and applications. Unlike traditional seafood production, *Blue biotechnology* creates higher-value products through advanced biotechnological processes, thereby generating economic value[32]. Some applications include pharmaceuticals, cosmetics, feed ingredients, biomaterials, and specialised chemicals. *Blue biotechnology*'s conceptual framework has evolved beyond resource exploitation to incorporate marine ecosystem restoration and health, reflecting a growing awareness of ocean sustainability challenges[33].

Size of the EU Blue biotechnology sector

The sector generated a GVA of EUR 327 million in 2022, a 19%-increase compared with 2021. Gross profit, at EUR 168 million, increased by 21% compared with the previous year (Figure 8). The turnover reported for 2022 was EUR 942 million, an 18%-increase on the previous year.

Estimates for 2023 suggest increases of around 3% each for GVA, turnover and gross profit. In 2022, roughly 2 400 people were directly employed in the sector, 13% more than in 2021. The annual average wage was estimated at EUR 66 300, up 4% compared with 2021. While it is estimated that average remuneration remained similar in 2023, an increase of 3% in employment is estimated for the industry in the same year

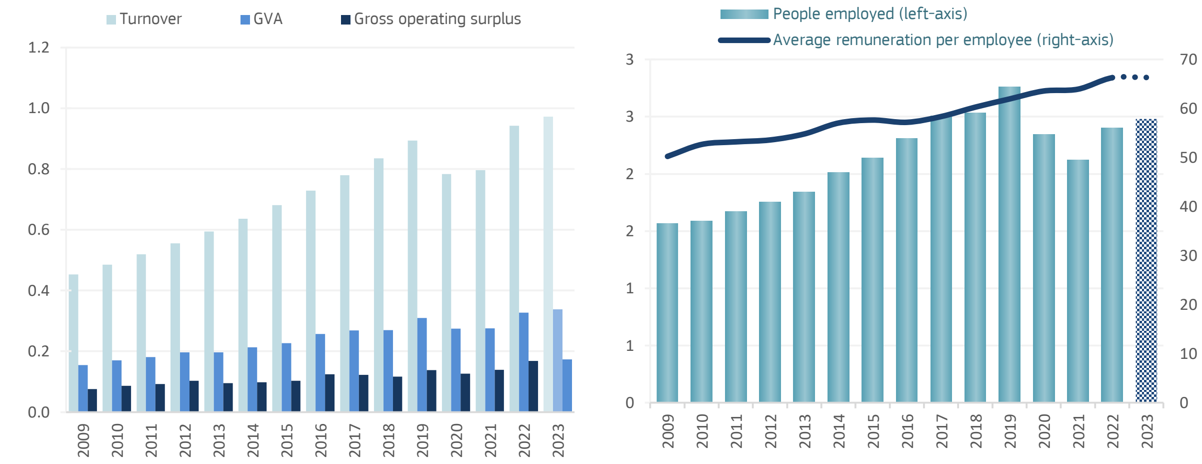
[30] Regulation (EU) 2023/2842 of the European Parliament and of the Council of 22 November 2023 amending Council Regulation (EC) No 1224/2009, and amending Council Regulations (EC) No 1967/2006 and (EC) No 1005/2008 and Regulations (EU) 2016/1139, (EU) 2017/2403 and (EU) 2019/473 of the European Parliament and of the Council as regards fisheries control.

[31] OECD, 2017 - Marine biotechnology: Definitions, infrastructures and directions for innovation, OECD Science, Technology and Industry Policy Papers, No. 43, OECD Publishing, Paris.

[32] European Marine Board, 2017 - Marine Biotechnology: Advancing Innovation in Europe's Bioeconomy.

[33] Blue Bioeconomy Forum, 2024 - Roadmap for the Blue Bioeconomy.

Figure 8 - Size of the EU *Blue biotechnology* sector, 2009-2023. Turnover, GVA ad gross operating surplus in EUR billion, persons employed (thousand), and average wage (EUR thousand)



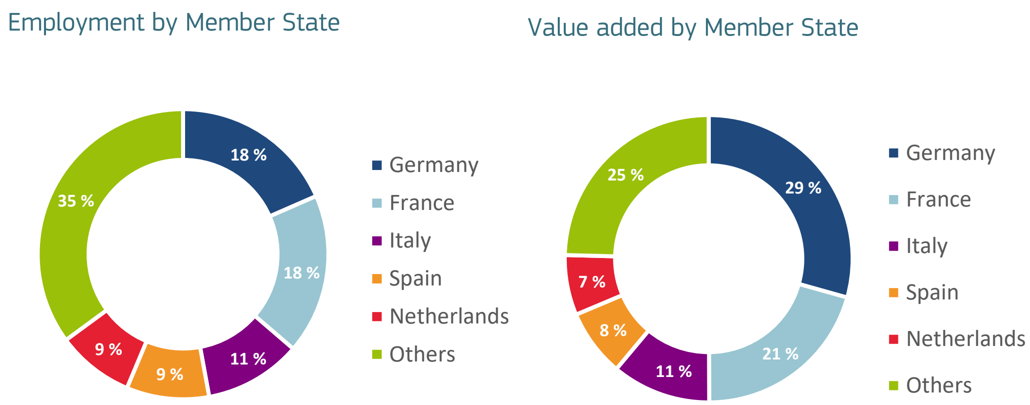
NB: Turnover and people employed in 2023 were estimated based on Eurostat's preliminary data; GVA, gross operating surplus and average remuneration were estimated assuming they follow the same trend as turnover.

Sources: DCF data and authors' own calculations.

Results by sub-sector and Member State

Germany leads the sector in employment, accounting for 18% of jobs and 29% of GVA, followed by France (18% of jobs and 21% of GVA), Italy (11% of jobs and 11% of GVA), Spain, and the Netherlands (both with 9% of jobs and 7% of GVA).

Figure 9 - Share of employment and GVA in the EU *Blue biotechnology* sector, 2022



Source: Authors' own calculations based on Eurostat (SBS) data.

Trends and drivers

From 2000 to 2023, the European *Blue biotechnology* industry attracted an increasing number of investments. Indeed, while between 2000 and 2018 the number of deals (i.e. investment agreements) closed was 90, from 2018 to 2023 the quantity increased to 114[34]. These deals totalled EUR 405 million, with an average value per transaction of EUR 5.1 million and a median value of EUR 1.3 million, most often in the form of grants and early-stage investments[35].

[34] Blue Invest, 2024 – Investor Report: Unlocking the potential of the blue economy

[35] Blue Invest, 2024 – Investor Report: Unlocking the potential of the blue economy

The evolving needs of society and new lifestyles create a demand for diverse and nutritious food options, improved health and well-being, novel biomedicines, natural cosmeceuticals, environmental conservation, and sustainable energy sources[36]. This demand is expected to fuel further research and development in the emerging field of *Blue biotechnology*.

For more information, visit the section on ***Blue Biotechnology*** within the EU Blue Economy Observatory.

MARINE NON-LIVING RESOURCES

The marine extractive industry is a large sector specialised in the commercial exploitation of non-living resources extracted from the ocean, seabeds and beneath the seafloor. These include hydrocarbons, minerals, metals, and water.

Marine non-living resources has been a significant sector of the EU's Blue Economy for many years. Most of the EU's domestic oil and gas is extracted offshore. Out of 16 264 kilotonnes of oil equivalent (ktoe) extracted from EU waters in 2022, 69 % was gas and 31 % oil. 80% of total EU offshore production was extracted in the North Sea and the Atlantic by the Netherlands (7 812 ktoe), Denmark (4 435 ktoe) and Germany (755 ktoe). 12% was extracted in the Mediterranean (mainly by Italy with 1 872 ktoe), 5.7% in the Black Sea (mainly by Romania) and 1.6% in the Baltic Sea (by Poland).

Over the past decade, the mature offshore oil and gas sector has experienced a decline, following the settling of ambitious EU decarbonisation goals and net-zero emission targets. The number of active platforms decreased by 36 units in 2022, and total offshore oil and gas production in the EU dropped from 18 187 ktoe in 2021 to 16 264 ktoe in 2022 (by -11%)[37].

For the purpose of this Report, the *Marine non-living resources* sector comprises three main subsectors:

Oil and gas: extraction of crude petroleum, extraction of natural gas, and support activities;

Other minerals: extraction of salt from seawater, operation of gravel and sand pits, mining of clays and kaolin, and support activities for other mining and quarrying;

Desalination: extraction of seawater and brackish water to produce desalinated water for civil, agricultural and industrial uses.

Unlike in past editions of the EU Blue Economy Report, *Desalination* is included as a subsector, rather than as a separate, emerging sector of the Blue Economy. This enables the more comprehensive coverage of the various segments of the industry extracting and commercially exploiting abiotic resources from our seas and ocean. Methodological challenges remain in isolating and quantifying the socio-economic performance of *Desalination* from the aggregated and undifferentiated SBS. Nonetheless, the Report can provide estimates of *Desalination* turnover, GVA and employment using complementary data sources. It should be noted that *Desalination* and other marine extractive activities can cause significant environmental impacts in terms of both ecosystem disturbance and impingement and entrainment of marine life, such as fish, algae, and larvae. Minimising and managing these environmental impacts is crucial for the Blue Economy's sustainability transition (See Chapter 3).

Size of the EU Marine non-living resources sector

In 2022, the sector contributed EUR 10.7 billion GVA, up from EUR 4.7 billion in 2021. This increase – driven by a similar year-on-year turnover jump to EUR 29.6 billion in 2022 from EUR 15 billion in 2021 – is the result of geo-political considerations following Russia's war of aggression against Ukraine. A number of installations that were designated for decommissioning resumed operation, with a view to bolstering the EU's energy security[38]. The good performance of the sector in 2022 is also demonstrated by a 2.6-fold increase in profits, which reached EUR 9.5 billion, up from EUR 3.6 billion in 2021.

Apart from the short-term effects of the geo-political situation, the oil and gas subsector kept shrinking. This is confirmed by the preliminary, estimated figures for 2023, which project fewer than 7 000 persons employed in total, that is the lowest value on record since 2009, with more than 800 job losses since 2022. A similar downward trend can be observed for average personnel costs, which decreased by 6% compared with 2022; this explains the continued, slight increase in average remuneration per employee (Figure 10).

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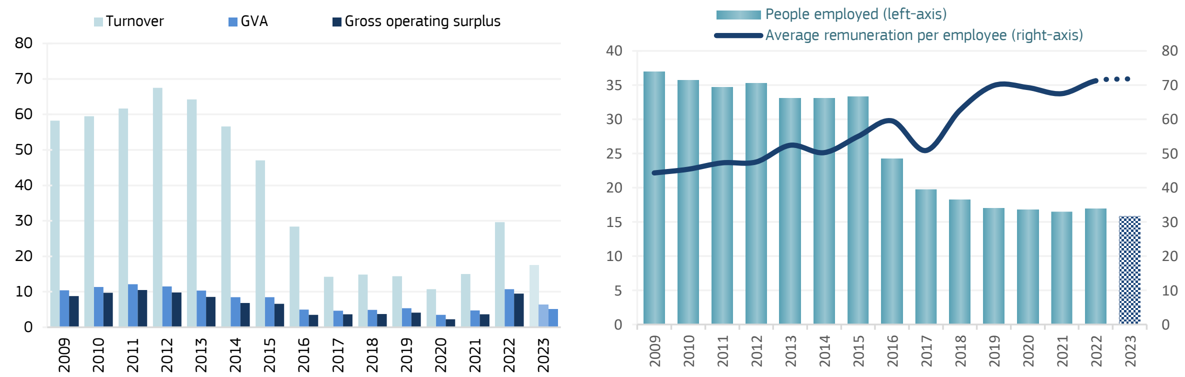
[36] Rotter, A., Barbier, M., Bertoni, F., Bones, A.M., Cancela, M.L., Carlsson, J., Carvalho, M.F., Cegłowska, M., Chirivella-Martorell, J., Conk Dalay, M. and Cueto, M., 2021 - The essentials of marine biotechnology. Frontiers in Marine Science, 8, p.629629.

[37] DG Energy. Safety of offshore oil and gas operations. https://energy.ec.europa.eu/topics/energy-security/safety-offshore-oil-and-gas-operations_en

[38] European Commission. Annual Report from the European Commission on the Safety of Offshore Oil and Gas Operations for the Year 2022. COM(2024) 187 final.

Figure 10 - Size of the EU *Marine non-living resources* sector, 2009–2023: turnover, GVA and gross operating surplus (billion EUR); people employed (thousands); and average wage (thousand EUR)



NB: Turnover and people employed in 2023 were estimated based on Eurostat's preliminary data; GVA, gross operating surplus and average remuneration were estimated assuming they follow the same trend as turnover.

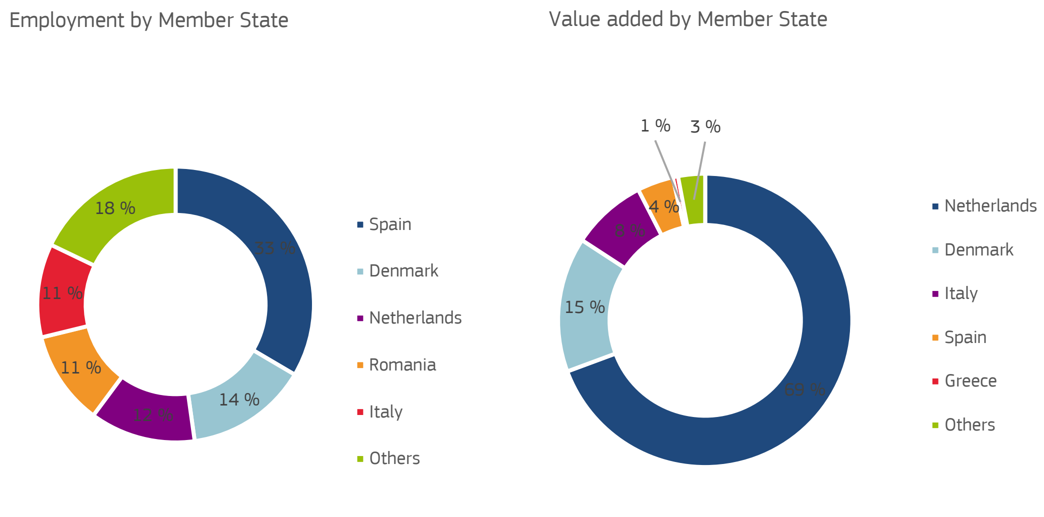
Source: Authors' own calculations based on Eurostat (SBS) data.

Driven by the decline of the oil and gas subsetor, the sector's turnover fell sharply between 2012 and 2017, before fluctuating between EUR 14 billion and EUR 15 billion until 2021, when there was a further decrease due to the COVID-19 pandemic. In 2023, the sector's workforce was down 43% compared with 2009, and turnover was about 26% of the all-time peak reached in 2012. In 2022, the *Marine non-living resources* sector accounted for 0.3% of jobs, 4.2% of GVA and 4.3% of profits of the entire EU Blue Economy.

Results by sub-sector and Member State

Spain, Denmark, the Netherlands, Romania and Italy (in order of contribution) have the highest employment in the *Marine non-living resources* sector, making up 82.1% of the sectoral workforce. The Netherlands and Denmark together produce by far the largest share of the sector's GVA (84.2%), followed by Italy (8.3%) and Spain (4%) (Figure 11).

Figure 11 - Share of employment and GVA in the EU *Marine non-living resources* sector, 2022



Source: Eurostat (SBS) data and authors' own calculations.

Employment: The EU *Marine non-living resources* sector employed fewer than 17 000 people in 2022, compared with nearly 37 000 in 2009. The industry is among the most affected by the transition to sustainability in the energy sector, hence the strong decline in workforce in line with global trends. 45% of the sector's workforce was employed in *Desalination* in 2022, followed by 27% in support activities for the oil and gas industry, 13% in the extraction of natural gas, and 6% in oil extraction.

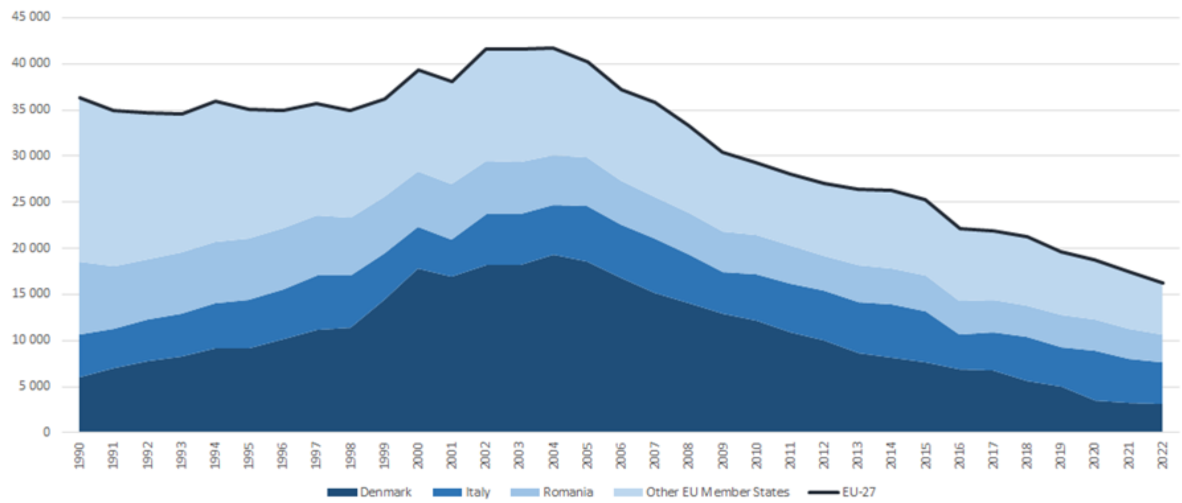
GVA: 69% of the sector's GVA was generated by the gas extractive industry (EUR 7.4 billion in 2022), followed by extraction of crude oil (17%, or EUR 1.7 billion in 2022). Oil and gas support activities contributed another 7% to the sector's GVA, while *Desalination* generated only 6% (EUR 611 million) in 2022.

Trends and drivers

The overall market performance of the *Marine non-living resources* sector over the past few years can be explained by several factors, such as the implications of relevant EU policies and regulations, the impact of exogenous shocks, like COVID-19, geo-political conflicts, trade disruptions, and the effects of changes in energy prices, production costs and tariffs on the demand and productivity of the EU marine extractive industry. These factors may have affected its sub-sectors in different ways.

Oil extraction: Crude oil production in the EU reached an all-time low in 2022: 16.3 million tonnes, compared with a peak of 41.7 million tonnes in 2004, representing a cumulative fall of more than 60%[39]. Italy (4.5 million tonnes), Denmark (3.2 million tonnes) and Romania (3.0 million tonnes) account for most of the production, mainly in offshore fields (Figure 12). The sustained decline is due to both resource depletion and a reduction in exploratory investment, in line with climate targets and environmental, social and governance policies. Crude oil production in the EU is expected to continue declining, with efforts focused on extending the life of mature fields, and no major new offshore developments planned for the 2025–2028 period[40].

Figure 12 - Domestic production of crude oil in the EU and for the top three producers (thousand tonnes), 1990–2022



Source: Eurostat (nrg_cb_oil), last updated 7 June 2024.

Gas extraction: Since 2021, demand for gas in the EU has decreased by around 15%, due to the advancement of renewables, the electrification of residential heating, and improvements in energy efficiency. Despite this structural decline, gas is still needed as a flexible back-up source for power generation, and as an indispensable input in industrial sectors that are difficult to decarbonise, such as chemicals, metallurgy, and cement[41] [42]. In 2025, natural gas continues to play a key role in the European energy system, albeit in a scenario marked by a transition to more sustainable sources. Natural gas reserves in the EU are estimated at 694 billion cubic metres (bcm). 90% of these reserves are held by six Member States (Figure 13): the Netherlands (25%), followed by Romania (21.2%), Poland (15.4%), Germany (10.2%), Italy (8.9%), and Denmark (8.3%)[43].

[39] Eurostat. (2023). Energy dependency in the EU – Statistics explained. https://ec.europa.eu/eurostat/statistics-explained/SEPDF/cache/43212.pdf

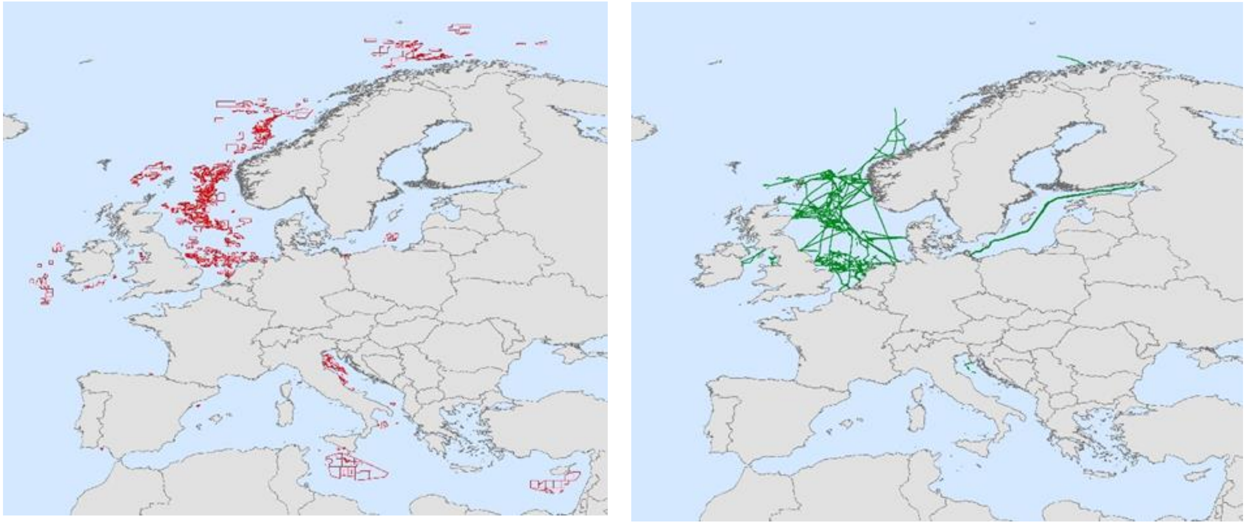
[40] International Energy Agency (IEA). Oil 2023: Analysis and Forecast to 2028. https://www.iea.org/reports/oil-2023

[41] International Energy Agency (IEA). Medium-Term Gas Report 2023. Medium-Term Gas Report 2023 - Including the Gas Market Report, Q4-2023. https://www.iea.org/reports/medium-term-gas-report-2023

[42] Neumann, A. et al. (2021): The role of natural gas in Europe towards 2050. NETI Policy Brief 01/2021, NTNU, Trondheim, Norway.

[43] International Association of Oil & Gas Producers. https://iogpeurope.org/european-gas-reserves/

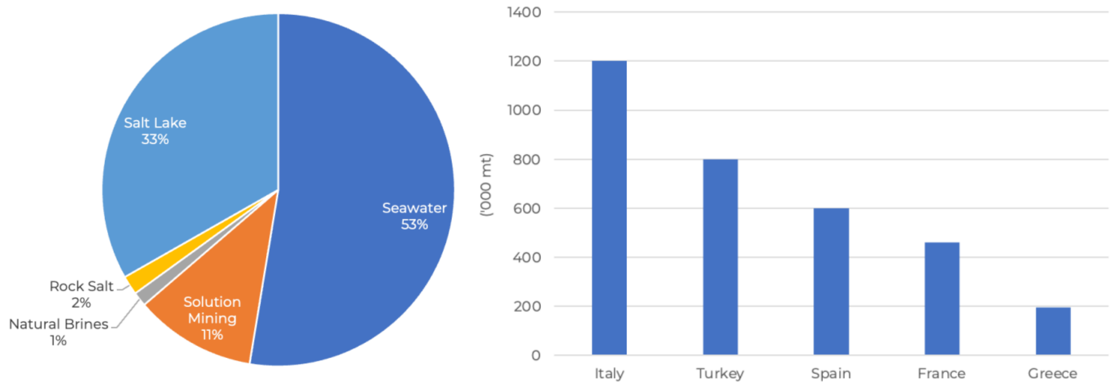
Figure 13 - Active offshore licenses (left) and pipelines (right), 2024



Source: Authors' own elaboration based on data from the EMODnet Map Viewer (https://emodnet.ec.europa.eu/geoviewer/).

Salt extraction: Sea salt is salt extracted from seawater through evaporation or thermal processes. While solar evaporation is the most common method for sea salt production, thermal processes (like vacuum evaporation) are also used in some regions or specific applications, especially when the climate is unsuitable for solar methods or for higher-purity industrial uses. With a share of 53%, seawater is the largest source of salt production by evaporation in Europe, followed by salt lakes (33%). Production typically takes place in open basins (natural or artificial), salt marshes or marine salt flats alongside the coastline. The crystallisation of salt requires a prolonged period of dry weather, as well as wind, sun and warm temperatures. The climatic conditions necessary to produce solar salt are met in Southern Europe, and the production of sea salt takes place along the Atlantic and Mediterranean coasts.

Figure 14 - Main sources of salt production by evaporation in Europe (%) (left), and top five European sea-salt-producing countries (thousand tonnes) (right)



Source: European Salt Producers' Association

Sea salt represents about 6% of total salt production in Europe. It is produced mainly for food processing, de-icing, and specialty retail markets. Despite its many uses, its application in certain industries is limited, mainly because of high volumes of demand and logistical constraints.

The total capacity for sea salt production in the EU is estimated not to exceed 5 million tonnes per year. However, weather conditions dictate the actual production volumes produced. In 2023, sea salt production reached approximately 3 million tonnes[44]. To meet EU demand,

[44] EUsalt, 2024. The European Sea Salt Industry - Navigating Production, Trends and Prospects.

mainly for de-icing, between 1 and 2 tonnes of sea salt are imported each year from non-EU countries[45].

A total of 25 large-scale industrial companies are active in sea salt production in the EU. Most of them (11) are from Spain. A total of 5 sea salt production companies are from Italy. Other companies are from Croatia, France, Malta, Bulgaria, Cyprus, Greece, Portugal and Slovenia.

The sea salt subsector in the EU employs more than 2 200 workers in total, two thirds of which are employed in large-scale industrial facilities. The subsector generated a turnover of EUR 432 million in 2023, of which only 11% came from small-scale producers[46]. Small-scale salt production generates approximately EUR 60 million in turnover and employs around 850 people[47].

Extraction of other minerals: the market can be broadly segmented into three main categories: gravel and sand pits, mining of clays, and deep seabed mining for other minerals.

Gravel and sand pits: the extraction of gravel and sand from EU seas is a well-established industry, with many Member States having a long history of offshore aggregate extraction. Most extraction operations take place in shallow waters, typically less than 20 metres deep, and are used to supply the construction industry with materials for building and infrastructure projects. Denmark and the Netherlands are among the largest producers of offshore aggregates in the EU, with the North Sea being a major hub for these activities.

Mining of clays: the mining of clays from EU seas is a smaller but still significant industry, with several Member States extracting clays for use in the ceramics, paper, and construction industries. This extraction often takes place in shallower waters, typically less than 50 metres deep, and operations are concentrated in areas with suitable geological formations. Germany and France are among the main producers of offshore clays in the EU.

Deep seabed mining: Deep seabed mining for other minerals is a relatively new industry, with several companies exploring the potential for extracting valuable minerals such as copper, zinc, gold, and rare earth elements from the deep seabed. Mining operations typically take place at much greater depths, often exceeding 1 000 metres, and require specialised equipment and technologies. However, deep seabed mining raises significant environmental and social concerns, including the potential impacts on marine ecosystems, the risk of pollution and habitat destruction, and the need for the careful management and regulation of these activities. For these reasons, the Commission has called for a ban on deep-sea mining until gaps in scientific knowledge are properly filled and it can be demonstrated that this activity has no harmful effects. The Commission's position on deep-sea mining is set out in the EU biodiversity strategy for 2030[48] and in the international ocean governance agenda[49]. The European Parliament has called three times for an international moratorium on deep-sea mining[50].

2.1.2. DESALINATION

Desalination is the process of removing dissolved salts and impurities from saline water – such as seawater, brackish water, and mineralised groundwater – to produce water that meets specific quality standards for human consumption, irrigation, industrial applications, and other uses. The freshwater output usually requires post-treatment – such as remineralisation and pH adjustment – to make it suitable and safe for drinking and to protect distribution systems from corrosion. The process generates a concentrated by-product (brine), which must be managed properly to minimise environmental impacts.

Two main types of processes are used to remove salt from water: thermal distillation and membrane processes. Thermal distillation processes work by applying heat to seawater or brackish water so that water evaporates and is then condensed as freshwater, leaving salts and impurities behind. In contrast, membrane processes use pressure to force water through a semipermeable membrane that blocks salts and contaminants while letting purified water pass. Thermal distillation is suitable for very high-salinity water, but is often more energy intensive than membrane processes (e.g., reverse osmosis), which typically consume less energy per cubic meter of water, are easier to scale, and have lower operating costs, but need careful pre-treatment to minimise membrane fouling.

Among distillation technologies, multi-stage flash distillation accounts for the majority of global installed

[45] Salt Market Information & Salt Research + Consulting. Report on the European Sea Salt Sector and Outlook. 29 March 2024.

[46] Data provided by EUsalt, originating from a survey commissioned to Salt Research + Consulting and Salt Market Information.

[47] Schlag, S. and Götzfried, F. 2024. Report on the European Sea Salt Sector and Outlook. March 29, 2024.

[48] https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en

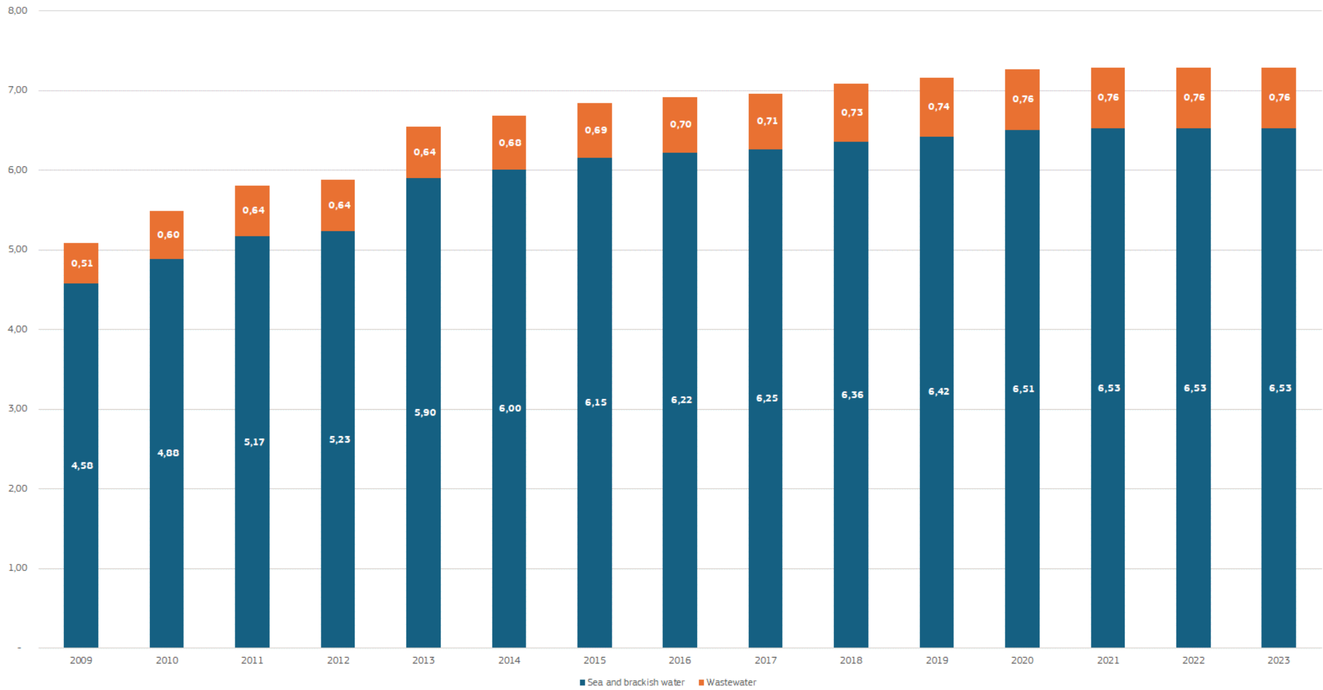
[49] https://oceans-and-fisheries.ec.europa.eu/publications/setting-course-sustainable-blue-planet-joint-communication-eus-international-ocean-governance-agenda_en

[50] European Parliament. Deep-sea mining in the EU (22.3.2023). https://www.europarl.europa.eu/doceo/document/E-9-2023-000945_EN.html

desalination capacity[51]. Reverse osmosis has surpassed thermal processes to become the most widely used desalination technology globally, especially for smaller-scale installations[52]. Electrodialysis and electrodialysis reversal have found niche applications for brackish water desalination but have limited potential for large-scale usage compared with reverse osmosis.

In 2023, there were 1 901 active desalination facilities in the EU, which could supply 7.29 million m³/day of freshwater (Figure 15). These include facilities fed by seawater (43%), inland and/or brackish water (47%), and wastewater (10%). Active capacity increased considerably by 43%, from 5.09 million m³/day in 2009 to 7.29 million m³/day in 2023.

Figure 15 - *Desalination* capacity (m³/d million) in the EU



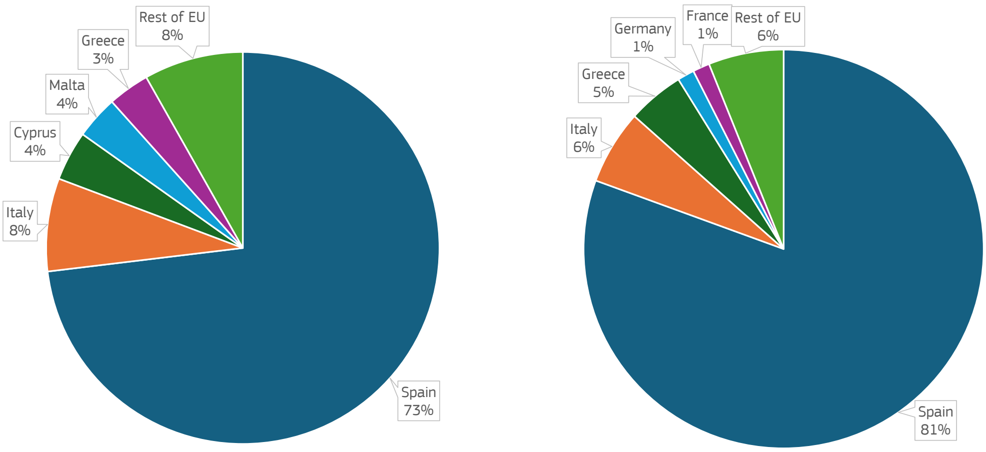
Source: Authors' own elaboration based on DesalData.

Spain is by far the largest market for *Desalination* in the EU, accounting for nearly three quarters of total active capacity. Other important markets are Italy, Cyprus, Malta and Greece (Figure 16).

Figure 16 - Distribution of installed capacity in the EU's seawater and brackish water (left) and waste water (right), 2023

[51] Chafidz, A., Al-Zahrani, A. A., Al-Otaibi, M. N., Hoong, C. K., Lai, K. C., & Prabu, M. (2019). Portable and integrated multilayer multieffect distillation system powered by solar photovoltaic electricity for seawater desalination. Desalination, 454, 82-93. https://doi.org/10.1016/j.desal.2014.04.017

[52] Greenlee, L. F., Lawler, D. F., Freeman, B. D., Marrot, B., & Moulin, P. (2009). Reverse osmosis desalination: Water sources, technology, and today's challenges. Water Research, 43(9), 2317-2348. https://doi.org/10.1016/j.watres.2009.03.010

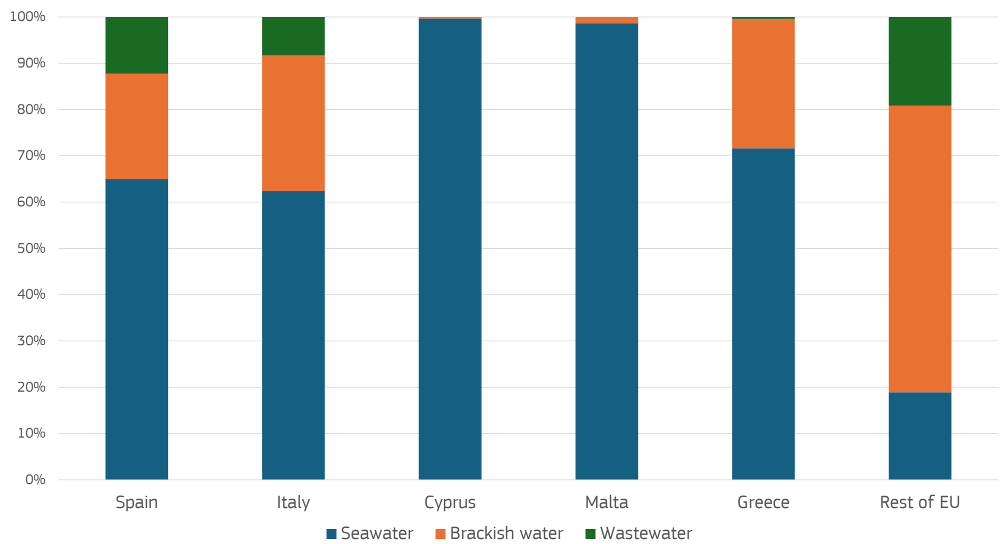


Source: Authors' own elaboration based on DesalData.

In terms of uses, 68% of capacity is deployed for municipalities and tourist facilities as drinking water, 18% for industry use and, 14% for irrigation; the rest is used in demonstration and discharge facilities. Italy ranks first for industrial use, taking up 28% of total capacity, closely followed by Spain, with 25%, and the Netherlands with 10%.

In the Mediterranean Member States, which also happen to be the largest market for *Desalination* in the EU, most facilities use seawater as feedwater. The situation is the opposite in the rest of the EU, with inland or brackish water used as the main source. Wastewater is a minor source of feedwater in the EU as a whole (Figure 17).

Figure 17 - *Sources of feedwater for desalination in the EU, 2023*

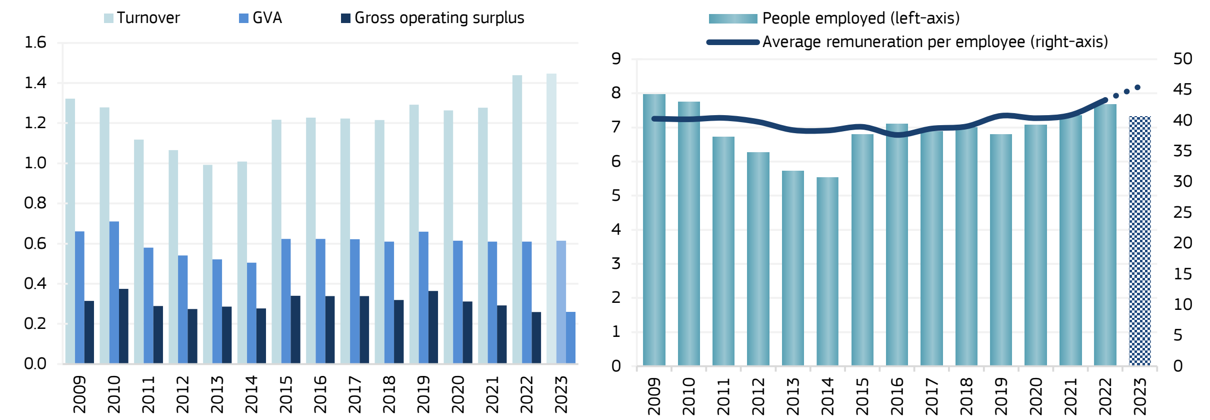


Source: Authors' own elaboration based on DesalData.

To estimate the size of the *Desalination* market in the EU requires estimating these complementary segments across its value chain. In the absence of official disaggregated statistics on turnover, value added and employment for each of these segments, for the purpose of this report we have estimated the turnover of the operation of *Desalination* plants using the average cost of producing desalinated water and installed capacity as reference indicators (Figure 18)[53].

[53] Based on data released by AEDyr, the Spanish desalination association (https://aedyr.com/en/) and DesalData, respectively.

Figure 18 - Size of the EU *Desalination* subsector, 2009–2023: turnover, GVA and gross operating surplus (billion EUR); people employed (thousands); and average wage (thousand EUR)

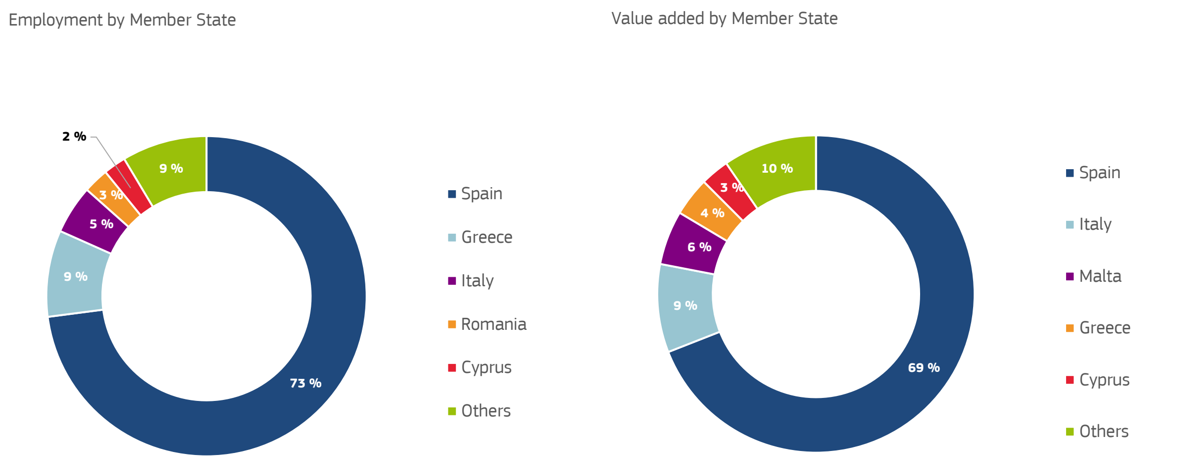


NB: Turnover and people employed in 2023 were estimated based on Eurostat's preliminary data; GVA, gross operating surplus and average remuneration were estimated assuming they follow the same trend as turnover.

Source: Authors' own calculations based on data from Eurostat (SBS), DesalData and the Spanish Desalination and Reuse Association (AEDyR).

Spain largely dominates the *Desalination* market, employing nearly 73% of the subsector's workforce (5 596 people) and generating 69% of its GVA (EUR 422 million) (Figure 19).

Figure 19 - Share of employment and GVA in the EU *Desalination* subsector, 2022



Source: Authors' own calculations based on data from Eurostat (SBS), DesalData and AEDyR

The evolution of the *Desalination* sector in the EU is characterised by the following main trends and drivers:

Cost reduction and technological advancements: improved membrane technologies (especially reverse osmosis) and energy recovery devices have driven down the cost of desalination significantly.

Integration with renewable energy: given that *Desalination* is an energy-intensive industry, there is a strong business case for using renewable energy sources, especially in the case of small decentralised and off-grid plants. In the EU, projects such as Prodes[54] (2005-2008), Desalife[55], Desolination[56], and SOL2H2O[57] illustrate the efforts being made in leveraging renewable energy to

[54] https://www.prodes-project.org/

[55] https://webgate.ec.europa.eu/life/publicWebsite/project/LIFE23-ENV-ES-DESALIFE-101147553/desalination-for-environmental-sustainability-and-life

[56] https://desolination.eu/

[57] https://www.sol2h2o.uevora.pt/the-project/

reduce the environmental footprint and costs of desalination.

Innovation in desalination methods: beyond conventional reverse osmosis, emerging technologies – such as membrane distillation[58], forward osmosis[59], capacitive deionisation[60] and nanofiltration[61] – are under development. Although unlikely to reach large scales in the short run, these methods aim to further improve energy efficiency and reduce environmental impacts, particularly in brine management.

Scale and efficiency: two main trends can be observed in the market. On the one hand, large-scale plants and long transmission pipelines are becoming more common, with capacities growing due to advancements that lower unit costs. On the other hand, smaller scale desalination plants are gaining traction for municipal purposes, often combined with architecturally elegant structures, in order to increase resilience and decrease energy costs due to far distance transportation. Increased automation and smart monitoring systems also help optimise performance and reduce downtime.

Green financing: numerous EU initiatives are encouraging investments in sustainable desalination technologies, among others. These initiatives include BlueInvest, the EU initiative aimed at accelerating innovation and investment opportunities in the sustainable Blue Economy. To date, the initiative has distributed grants for EUR 43.8 million, provided technical assistance to more than 70 companies, and supported blended finance instruments for Blue Economy startups and scaleups[62].

For more information, visit the section on ***Marine Non-Living Resources*** and on ***Desalination*** within the EU Blue Economy Observatory.

MARINE RENEWABLE ENERGY

Marine renewable energy includes both **offshore wind energy** and other sources of **ocean energy**. The most consolidated marine energy sector is the **offshore wind** industry, in which the majority of products still use bottom-fixed offshore technology, but there is a trend towards the use of floating offshore technologies, with less impact on the seabed. ***Ocean energy*** is a promising sector, in which the EU has taken a leading role.

Offshore wind energy

Offshore wind energy is currently the only commercially deployed marine renewable energy with wide-scale adoption. Although the EU had only a small number of demonstration plants[63] in the early 2000s, it now hosts a cumulative capacity of 18.9 GW of offshore wind, spread across 11 countries[64].

Size of the EU offshore wind energy sector

The sector generated more than EUR 5.3 billion in GVA in 2022, a 42%-increase compared with 2021. Gross profit accounted for EUR 4.1 billion, up 56% since 2021, and the turnover reported was about EUR 25 billion. Provisional data for 2023 show that growth continued for these three indicators.

The sector directly employed 17 300 people in 2022 – with the provisional estimation for 2023 being 18 400 people – continuing the general pattern of growth observed in the past decade. The average annual wage was EUR 72 100 in 2022, a 5%-increase compared with 2021 (Figure 20), and was estimated at EUR 71 500 for 2023.

[58] Orfi, J., Sherif, R., & AlFaleh, M. (2025). Conventional and Emerging Desalination Technologies: Review and Comparative Study from a Sustainability Perspective. *Water*, *17*(2), 279. https://doi.org/10.3390/w17020279

[59] Ray, S.S., Chen, SS., Sangeetha, D. *et al.* Developments in forward osmosis and membrane distillation for desalination of waters. *Environ Chem Lett* 16, 1247–1265 (2018). https://doi.org/10.1007/s10311-018-0750-7

[60] Elewa, M. M., El Batouti, M., & Al-Harby, N. F. (2023). A Comparison of Capacitive Deionization and Membrane Capacitive Deionization Using Novel Fabricated Ion Exchange Membranes. *Materials (Basel, Switzerland)*, *16*(13), 4872. https://doi.org/10.3390/ma16134872

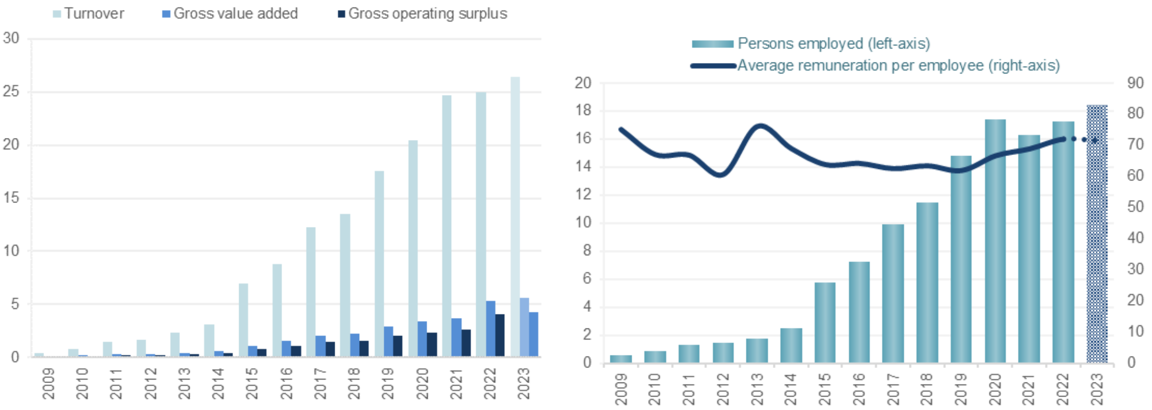
[61] Wafi, M.K., Hussain, N., El-Sharief Abdalla, O. *et al.* Nanofiltration as a cost-saving desalination process. *SN Appl. Sci.* **1**, 751 (2019). https://doi.org/10.1007/s42452-019-0775-y

[62] https://maritime-forum.ec.europa.eu/theme/investments/blueinvest_en

[63] The first offshore wind farm (Vindeby) was installed in Denmark in 1991 and decommissioned in 2017, after 25 years of useful life.

[64] JRC analysis based on GWEC (2025) and 4C OFFSHORE (2025) WIND FARMS DATABASE.

Figure 20 Size of the EU offshore wind energy subsector, 2009–2023 (provisional data for 2023): turnover, GVA and gross operating surplus (billion EUR); people employed (thousands); and average wage (thousand EUR)

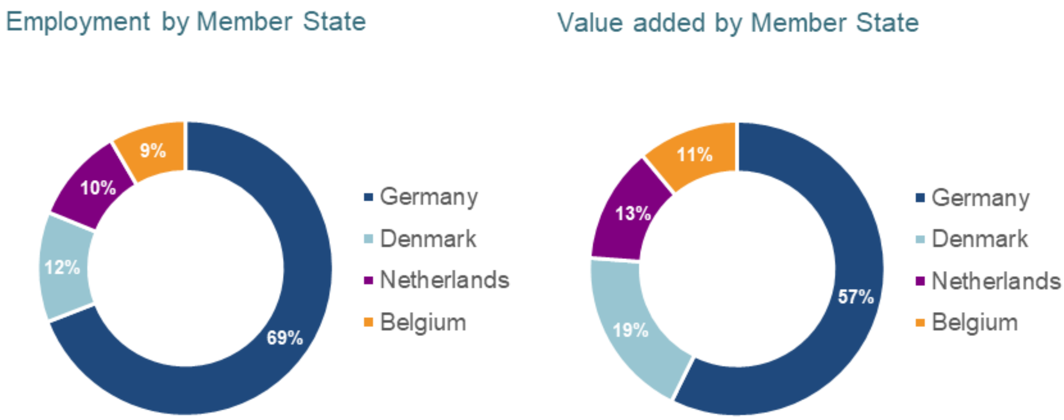


Source: Own estimations based on Eurostat (SBS). Turnover and persons employed in 2023 are estimated based on Eurostat's preliminary data; other variables such as GVA, Gross operating surplus and average remuneration are estimated assuming they follow the same trend as turnover.

Results by sub-sector and Member State

Using Eurostat data and accounting for the production, transmission and distribution of electricity, employment in the offshore sector can be estimated.

Figure 21 - Share of employment and GVA in the EU offshore wind energy subsector, 2022



Source: Authors' own estimations based on Eurostat (SBS) data.

Employment: the top contributors in 2022 were Germany at 69% (11 900 people), followed by Denmark, at 12% (2 100 people), the Netherlands, at 10% (1 800 people), and Belgium, at 9% (1 500 people). The distribution of employment across activities sees 59% of workers in the production of, 28% in the distribution of and 13% in the transmission of electricity.

Employment data for the wind energy industry vary significantly across different sources, which typically include different activities along the chain. 4C Offshore estimate that the offshore wind industry supported approximately 47 000 full-time equivalent (FTE) jobs in the EU in 2024, with 28 000 being direct jobs (Figure 22)[65]. Notably, this estimate is based on the relative proportions of annual installation activity and cumulative

[65] 4C Offshore, 2025 - based on European Wind Energy Competitiveness Report Adaptation and extension of calculations made by Deloitte for etipwind.eu

installations, which may differ from the methods used by WindEurope

GVA: The top contributors in 2022 were Germany, at 57% (EUR 3.1 billion); Denmark, at 19% (EUR 1 billion); the Netherlands, at 13% (EUR 0.7 billion); and Belgium, at 11% (EUR 0.6 billion). The production of electricity accounts for 68% of GVA, distribution for 20% and transmission for the remaining 12%.

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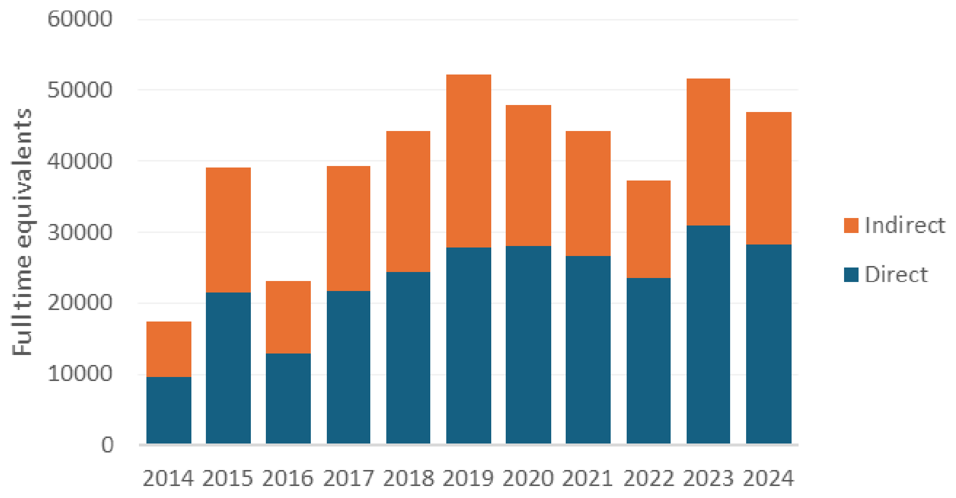
Figure 22 - Employment in the offshore wind energy subsector, 2014–2024



Source: 4C Offshore calculations based on European Technology & Innovation Platform on Wind Energy, European Wind Energy Competitiveness Report, 2024, https://etipwind.eu/wp-content/uploads/files/publications/20240606-european-wind-energy-competitiveness-report.pdf

Trends and drivers

The European offshore wind sector has undergone a significant transformation over the past 15 years, driven by a combination of technological innovations, economies of scale, and supportive policies. As a key component of the EU's energy mix, offshore wind has benefitted from the experience and expertise gained in the onshore wind sector, and from the development of new technologies and practices.

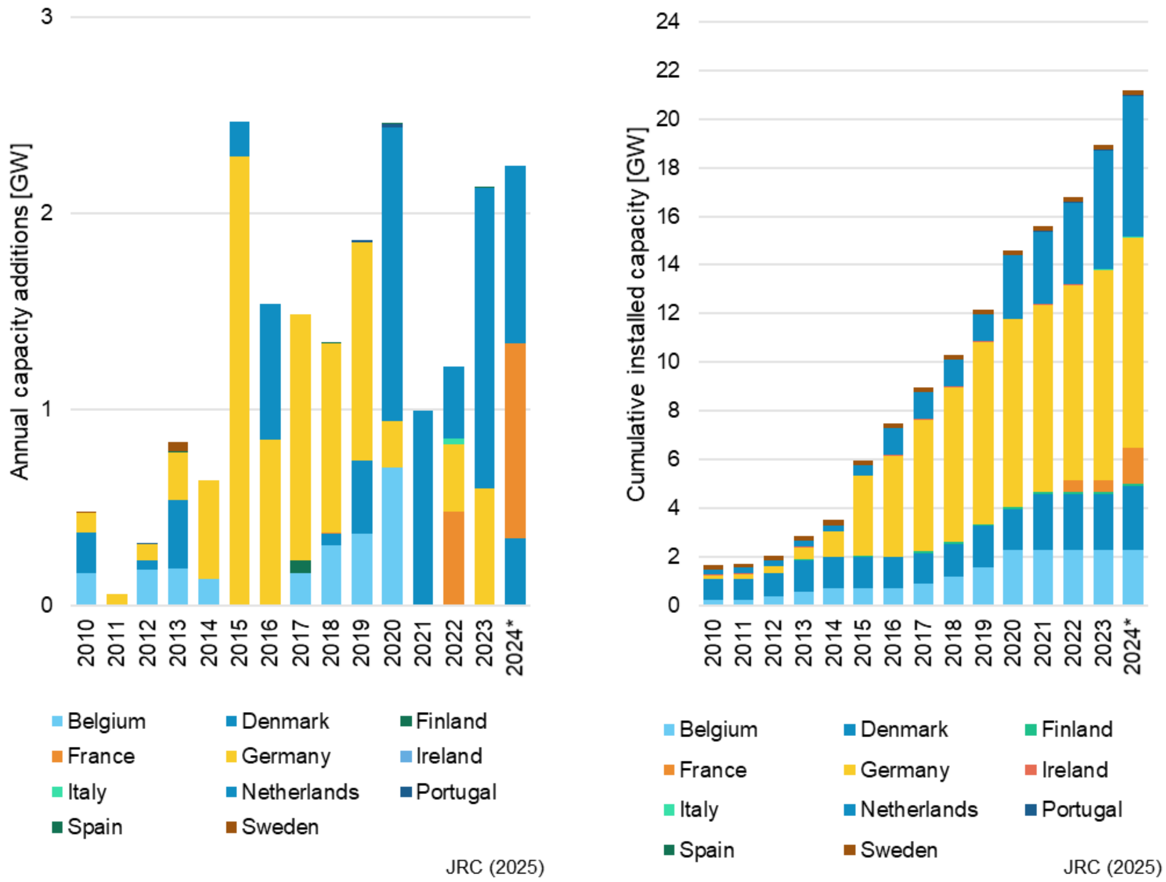
The EU has set ambitious targets for the offshore wind sector, aiming to deploy approximately 111 GW of capacity by 2030 and 317 GW by 2050, which will contribute to achieving a 42.5% share of renewables by 2030. This year, the EU has taken further steps to support the development of net-zero technologies, including offshore wind, through the introduction of the Net Zero Industry Act. This landmark legislation aims to boost the manufacturing of net-zero technologies within the EU, ensuring the region remains a leader in the global transition to a low-carbon economy.

By the end of 2023, the cumulative installed capacity for offshore wind energy production in the EU had reached 18.9 GW, with an increase of 2.1 GW compared with the previous year. Preliminary and provisional data for 2024 indicate a total addition of 2.2 GW, bringing the cumulative total to 21.2 GW (Figure 23).

EU-headquartered manufacturers dominate the EU's offshore wind market accounting for almost all new deployments in 2023. The United States is an important market for European suppliers, illustrated by the 5.8 GW of capacity currently in construction there, for which approximately 52% of capital expenditure was awarded to EU-headquartered companies[66]. Several EU-headquartered tier-1 suppliers (i.e. direct suppliers to the company that assembles or sells the final product) have made significant investments in United States-based facilities.

[66] 4cOffshore, 2025 - Analysis of tier-one component supply and installation contracts in TGS4C Offshore wind farms database, Q1 2025

Figure 23 - EU offshore wind energy capacity additions (left) and installed capacity (right) (GW), 2010–2024



(*) Preliminary data available at the end of 2024.

Source: Joint Research Centre analysis based on Global Wind Energy Council, Rystad Energy and 4C Offshore..

The levelised cost of electricity (LCOE) of bottom-fixed offshore wind energy has decreased as the deployment of larger offshore wind energy installations has increased. For 2024, LCOE for offshore wind is estimated at 56-102 EUR/MWh in Denmark, 62-109 EUR/MWh in Germany, 55-120 EUR/MWh in the Netherlands, and 114-170 EUR/MWh in France[67].

Floating wind energy

Floating wind energy is an emerging sector within the offshore wind industry that is progressing steadily toward commercial viability. Floating wind energy installations can be deployed in deeper water than bottom-fixed turbines, increasing the marine space and wind resources available.

Technological differences between projects are mainly linked with floating structures. Most projects use semi-submersible floating technologies, while fewer projects use spar-buoy, barge, tension-leg platforms or semi-spar floating technologies. Semi-submersible and spar-buoy technologies have already reached technology readiness level (TRL) 8-9, while the Floatgen pilot project in France upgraded concrete barge technology to TRL 7-8. Tension-leg platform technology was tested with a prototype (TRL 6) launched off the coast of the Canary Islands, as part of the PivotBuoy project by X1 Wind.

Current floating wind energy projects in the EU account for 29 MW of operating projects with an additional 90 MW underway in France[68]. Installed capacity is expected to grow to 3 GW by 2030 and over 40 GW by 2040. The floating wind energy sector is also expanding worldwide, with an installed capacity expected to reach almost 7 GW by 2030 and over 70 GW by 2040.

The LCOE of floating wind energy is currently higher than that of bottom-fixed wind energy. This is partly due to the more intensive manufacturing and engineering

[67] Analysis based on 4cOffshore and BNEF.

[68] 4C Offshore, 2023 - Floating wind: Industry focus.

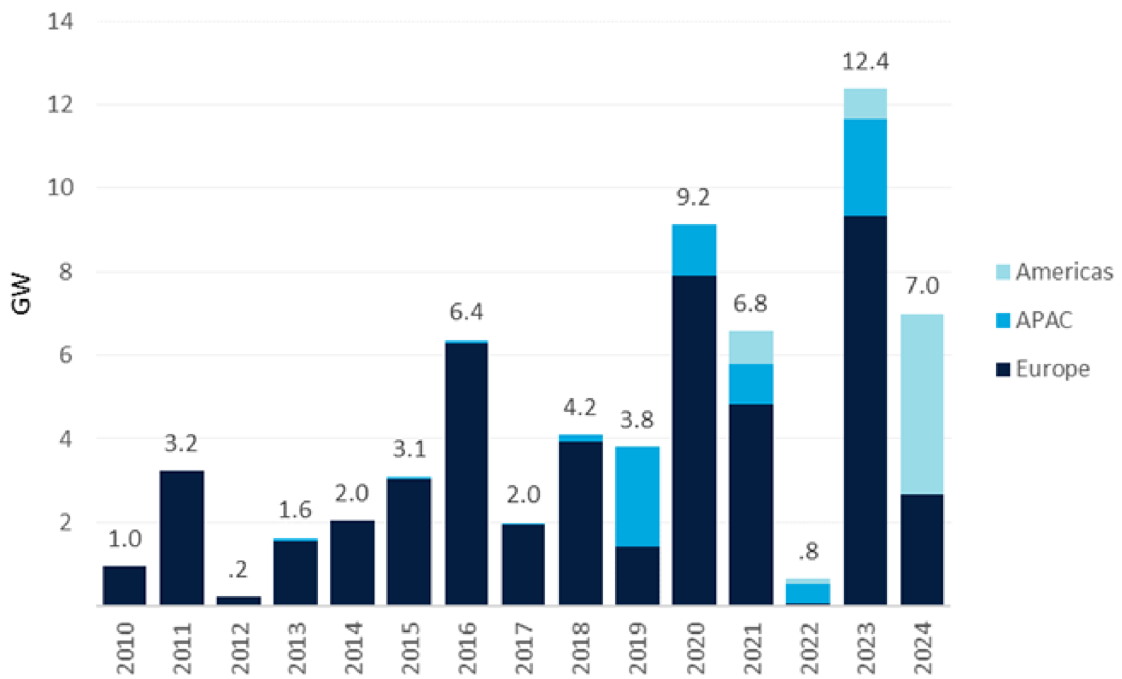
requirements but also due to low-deployment levels, which have restricted economies of scale and learning opportunities to date. Additionally, multiple competing floating substructure technologies are in development, further preventing standardisation. The time frame for the commercialisation of floating wind has moved from before 2030 to mid-2030s.

The LCOE is also project-dependent. In 2020-2023, LCOE ranged from 145 EUR/MWh (for the Hywind Tampen project in Norway) to 350 EUR/MWh (for the Fuyao project in China), with the Windfloat Atlantic project in Portugal having an intermediate LCOE of 240 EUR/MWh[69]. Obtaining a clear understanding of the LCOE for floating wind energy is challenging, due to the limited deployments of and high variability in offtake contracts[70].

Market attractiveness and auction outcomes

As a result of the COVID-19 pandemic, the world was faced with global supply-chain shortages, logistical challenges brought on by travel restrictions, and rising energy costs, which were then exacerbated by Russia's war of aggression against Ukraine. High inflation, tight supply chains and rising interest rates disproportionately affected the capital-intensive offshore wind market, eroding the business case for many projects. In 2022, a record low value of final investment decisions was observed. Although 2023 and 2024 showed investments increase to above pre-pandemic levels (Figure 24), some markets have been slow to adjust to the new risk and cost environments, meaning forecast growth is below previous trajectories.

Figure 24 - Final decisions on investments in offshore wind energy (GW), 2010–2024



Source: 4C Offshore, TGS4C Market Overview Report Q4 2024, 2024, https://www.4coffshore.com/windfarms/.

Offshore grid development

Meeting European offshore wind goals will require the rapid and concentrated deployment of projects. Rather than radial connections to the grid, European transmission system operators are pursuing a strategy involving cooperation and coordinated planning, facilitated by standardisation and interoperability. The industry has settled on a 2GW 525kV high voltage direct current (HDVC) platform-based grid connection as the basic concept for this system design.

To facilitate deployment, contracting has moved from a link-by-link basis to large multi-year framework agreements for the supply and installation of multiple platforms, their foundations and connecting cable systems.

[69] 4C Offshore, 2023 - Floating wind: Industry focus.

[70] A binding agreement in which a buyer agrees to purchase a portion or all of a producer's future output at predetermined terms

Several countries have awarded or are in the process of awarding framework contracts for offshore HVDC coordinated grids (Netherlands, Germany, Netherlands, France and the United Kingdom). Given the high demand for offshore HVDC connections, securing the supply of high-voltage equipment has become critical for timely project delivery. Historically, HVDC systems have taken 4-5 years to deliver, but with current global supply chain constraints and high demand, timelines are now 6-7 years from contract finalisation, with contracting taking an additional year. Transformers are particularly challenging as they connect to the local alternating current grid and therefore require customisation.

The shift to framework contracts provides visibility regarding long-term revenues, and therefore gives original equipment manufacturers, such as Hitachi, the confidence they need to invest in facilities and training.

2.1.3. OCEAN ENERGY

State of play of technologies and projects in the ocean energy sector

Ocean energy projects employ a range of technologies that harness tides, wave, ocean thermal energy conversion, and salinity gradient from the oceans. These projects attract both public and private investments, with some of the more advanced projects reaching high TRLs and LCOEs slowly approaching those of more established offshore energy sectors. Notwithstanding the substantial investment in *Ocean energy*, the commercial viability of this sector remains hindered by numerous obstacles that impede the widespread adoption of ocean energy technologies, such as the considerable upfront costs, the technological uncertainties and the evolving regulatory framework which does not provide clear guidelines for the industry. The 2020 EU strategy on offshore renewable energy aims to increase the contribution of *Ocean energy* to the EU's offshore installed capacity targets, from 1 GW in 2030 to 40 GW in 2050[71].

Tidal energy was the first of the ocean energy technologies to be implemented at a large scale, with barrages in France (1966), China (1975, 1985) and South Korea (2011). These barrages make use of tidal range technology, which captures the potential energy stored between a basin and the external sea. While tidal range projects are commercially viable – thanks to their similarity to those in the hydropower sector – their deployment has been limited by the availability of suitable locations and by the significant local environmental impacts. New alternative technologies have emerged, exploiting tidal streams rather than tidal ranges. These tidal stream technologies include horizontal axis turbines (TRL 9), tidal kites (TRL 9), enclosed tips (TRL 7), vertical axis turbines (TRL 7), undulating membrane (TRL 7) and oscillating hydrofoils (TRL 6). In 2024, SeaQurrent tested a new tidal kite (TRL 6) in the Netherlands[72]. EEL Energy is pursuing the tests of its oscillating hydrofoils (TRL 6) in several locations in France.

Harnessing the surface motion of ocean waves, **wave energy** technologies include oscillating water columns (TRL 9), point absorbers (TRL 9), oscillating wave surge converters (TRL 8), overtopping (TRL 8), attenuators (TRL 8), pressure differential devices (TRL 7), rotating masses (TRL 7) and Archimedes screws (TRL 6). In recent years, some of these technologies have been installed and operated in Spain and Italy (oscillating water columns) and in Portugal and Sweden (point absorbers). Others are being tested in the UK (point absorber and attenuator system), France and Italy (oscillating surge converters). In 2024, a new point absorber, built by Seaturns (TRL 6), was tested in France[73]. Dutch company Wavepiston has finalised the installation of its oscillating wave surge converter (TRL 8) on the Oceanic Platform of the Canary Islands in Spain[74]. The connection of the system with energy collectors was completed in 2025[75]. The C4 point absorber (TRL 7) built by Swedish company CorPower is undergoing on-land inspection and upgrades, ready for redeployment off the coast of Portugal. The Slow Mill Sustainable Power wave device in the Netherlands also underwent dry testing in 2024; it is set to start producing electricity in 2025[76].

Salinity gradient power (or osmotic power) uses differences in salt content between freshwater and saltwater. This technology has mainly been tested in EU sea basins, with a reverse electrodialysis demonstration plant commissioned in 2014 by REDstack in the Netherlands (TRL 7), and electricity production started in 2024 in a new demonstration plant built in France by Sweetch Energy (TRL estimated at 5-6).

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[71] COM(2020) 741.

[72] https://www.seaqurrent.com/news-insights/successful-test-period/

[73] https://lemarin.ouest-france.fr/energie/energies-marines/tests-reussis-le-houlomoteur-de-seaturns-est-pret-a-changer-dechelle-9723725a-eef7-11ef-8bac-a9deb4a5b776

[74] https://plocan.eu/en/wavepiston-successfully-installs-its-wave-energy-device-at-the-plocan-test-site

[75] https://wavepiston.dk/23674-2/

[76] https://www.offshore-energy.biz/dutch-firms-wave-energy-tech-delivers-first-kilowatts-in-north-sea-gallery/

Ocean thermal energy conversion exploits the temperature difference between deep cold water (at 800 to 1 000 metres depth) and surface warm water. The technology has been tested by developers in Japan and the United States (TRL 8), and at a smaller scale in China and India[77].

While not part of either the *Offshore wind* or the *Ocean energy* sector, **floating photovoltaic technologies** are considered as part of the Blue Economy due to their use of maritime space, and owing to their integration into maritime value chains and port infrastructures. The Netherlands is particularly active in testing and installing these technologies. The North Sea-2 farm, commissioned by the Dutch company Oceans of Energy, reached full capacity in 2023. In 2024, a new solar floating farm was installed by the Dutch-Norwegian company SolarDuck. Several installations are planned by Oceans of Energy in the Netherlands and Belgium for 2025. The technology is being developed in France by SolarinBlue, which is currently testing its anchoring system.

Operational ocean energy production capacities

At the end of 2024, the **emerging operational ocean energy capacity** in the EU (i.e. ocean energy capacity excluding the already-established tidal range technology projects) was 2.82 MW, including 1.63 MW for tidal energy, 1.12 MW for wave energy and approximately 70 kW for salinity gradient[78]. In 2024, 770 kW of emerging ocean energy capacities were installed or tested in the EU, slightly above the 715 kW of additions in 2023 (see Figure 25). There is currently no operating capacity in the EU or in Europe for ocean thermal energy conversion technologies. EU-based companies have also been active outside EU waters, with 1 200 kW of capacity added in the Faroe Islands (Figure 25).

The only established ocean energy project in Europe, the La Rance tidal barrage (240 MW), has experienced capacity losses in recent decades due to the aging of the installation[79]. This has resulted in the **total ocean energy capacity** in the EU (including emerging and established capacities that are operational) remaining relatively stable over the past 10 years (2014-2023), despite new additions through emerging ocean projects. The barrage should recover part of its initial capacity after the current phase of renovation (2021-2026)[80]. Since 2011, no new projects using tidal range technology have been developed. In 2023, according to the International Renewable Energy Agency (IRENA), the total operational ocean energy capacity – both emerging and established – reached 508 MW globally[81]. Europe accounts for approximately half of global capacity (243 MW out of 508 MW).

Ocean energy is also becoming increasingly significant in terms of **energy production**. In 2024, with the advancement of renovation works, electricity production from the La Rance tidal barrage was expected to be restored to a level of 520 GWh[82], compared with an average of 500 GWh over the past years. This production is equivalent to electricity consumption in the nearby regional capital of Rennes (with over 200 000 inhabitants). Some of the emerging ocean energy capacities have also been operating for several years and have proved their reliability in providing electricity to the grid (e.g. in Spain and in France).

[77] https://www.ocean-energy-systems.org/publications/oes-annual-reports/document/oes-annual-report-2023/

[78] https://www.ocean-energy-systems.org/publications/oes-annual-reports/document/oes-annual-report-2023/

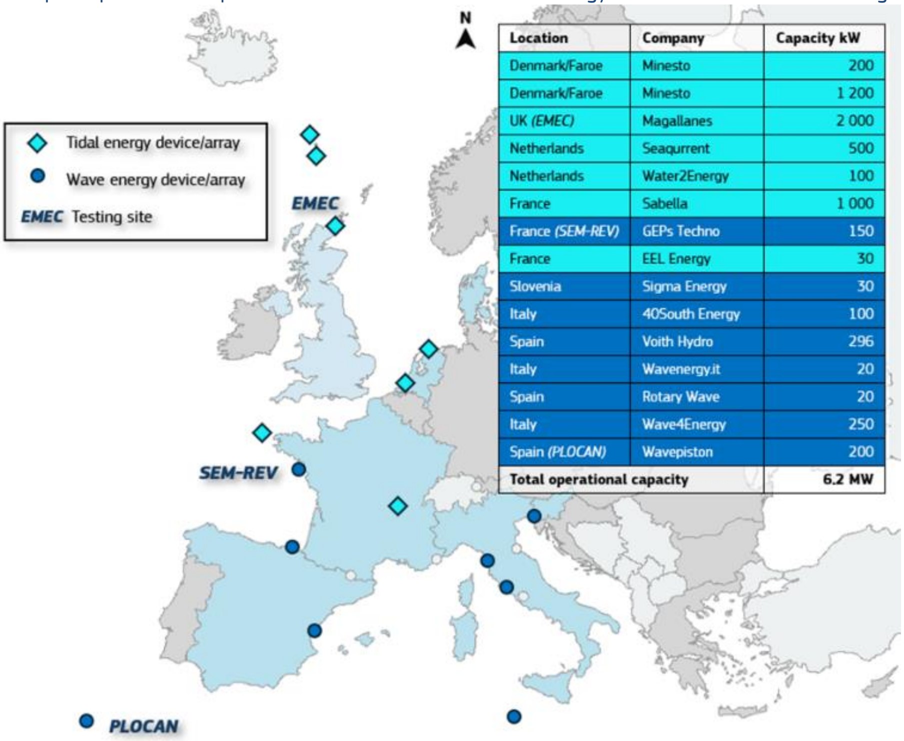
[79] https://www.cairn.info/revue-l-information-geographique-2017-4-page-103.htm

[80] https://www.edf.fr/rance-i-communique-un-chantier-titanesque-sous-la-mer-en-cours

[81] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Jul/IRENA_Renewable_Energy_Statistics_2024.pdf

[82] https://www.edf.fr/usine-maremotrice-rance/produire-de-lelectricite

Figure 25 - Map of operational capacities for tidal stream and wave energy in the EU and the United Kingdom, 2024



Location	Company	Capacity kW
Denmark/Faroe	Minesto	200
Denmark/Faroe	Minesto	1 200
UK (EMEC)	Magallanes	2 000
Netherlands	Seaqurrent	500
Netherlands	Water2Energy	100
France	Sabella	1 000
France (SEM-REV)	GEPs Techno	150
France	EEL Energy	30
Slovenia	Sigma Energy	30
Italy	40South Energy	100
Spain	Voith Hydro	296
Italy	Wavenergy.it	20
Spain	Rotary Wave	20
Italy	Wave4Energy	250
Spain (PLOCAN)	Wavepiston	200
Total operational capacity		6.2 MW

NB: Operational capacities deployed by EU-based companies (including Magallanes in the United Kingdom and Minesto in the Faroes). EMEC, European Marine Energy Centre; PLOCAN, Oceanic Platform of the Canary Islands.
Source: Authors' own calculations based on public databases (database of the European Marine Observation and Data Network, Open Energy Information) and statements from companies.

Economic indicators and employment in the Ocean energy sector

Emerging ocean energy technologies are not established enough to be commercially viable based on their revenue from energy production. According to the IRENA (2019)[83], the **LCOE** range from 110 to 480 EUR/MWh for tidal energy, and from 160 to 750 EUR/MWh for wave energy. In 2022, OceanSET estimated the average LCOE for whole-system TRL 7-9 at 200 EUR/MWh for tidal energy and at 270 EUR/MWh for wave energy[84]. As tidal energy projects progress toward the market, a **reference price** at which electricity will be sold to the grid becomes available for the most advanced projects. The reference price for the Flowatt tidal farm in France will be determined within a range of 255 to 310 EUR/MWh[85]. The UK government awarded reference prices for several tidal projects in 2023 and 2024. The common price awarded for all projects in 2024 was 204 EUR/MWh. This reference price decreased by 33% compared with 2023 (303 EUR/MWh), signalling significant progress in terms of cost reduction, and a decrease in LCOE for tidal energy[86].

Ocean energy projects receive significant amounts of **investment** from public and private sources. A total of 70 ocean energy projects were funded under Horizon 2020 between 2014 and 2022, totalling EUR 183 million – including EUR 94 million for tidal energy and EUR 89 million for wave energy. Since the beginning of the Horizon Europe financing period in 2021, 15 projects have been funded by the EU, with a total amount of EUR 51 million – including EUR 10 million for tidal energy and EUR 41 million for wave energy. These amounts are complemented by private and national public funding. According to the International Energy Agency, public investment in R&D in the *Ocean energy* sector reached EUR 48 million in Europe in 2022, accounting for 53% of the global investment[87].

The EU also accompanies the most advanced projects on their path to commercial readiness, notably through the

[83] https://www.irena.org/publications/2021/Jul/Offshore-Renewables-An-Action-Agenda-for-Deployment.

[84] https://setis.ec.europa.eu/publications-and-documents/clean-energy-technology-observatory/ceto-reports-2024_en

[85] https://www.consultations-publiques.developpement-durable.gouv.fr/consultation-publique-sur-les-aides-apportees-a-un-a3134.html

[86] https://www.gov.uk/government/publications/contracts-for-difference-cfd-allocation-round-6-results

[87] https://setis.ec.europa.eu/publications-and-documents/clean-energy-technology-observatory/ceto-reports-2024_en

Box 2 – EU *Ocean energy* export potential

*Progress in ocean energy technology development opens prospects for EU-based specialised companies to export technologies on the global market, including beyond European waters. Over the past few years, global patent flows have already been indicating EU-based companies' export potential, with more EU actors seeking protection for their technologies on the extra-EU market than extra-EU companies in the EU *.*

** The EU Blue Economy Report, 2022.*

EU Innovation fund (EUR 31.3 million for Normandies Hydroliennes) and the European Innovation Council Accelerator program (EUR 17.5 million for CorPower). EU-based ocean energy companies secured significant amounts of national funding for their most advanced projects. Investments from the private sector materialise in cooperation between specialised SMEs and energy majors, notably through venture companies. According to Joint Research Centre's strategic energy technology plan information system, a total amount of EUR 922 million has been invested by EU companies in 2010-2020. Over this period, 64% of investors were venture companies[88].

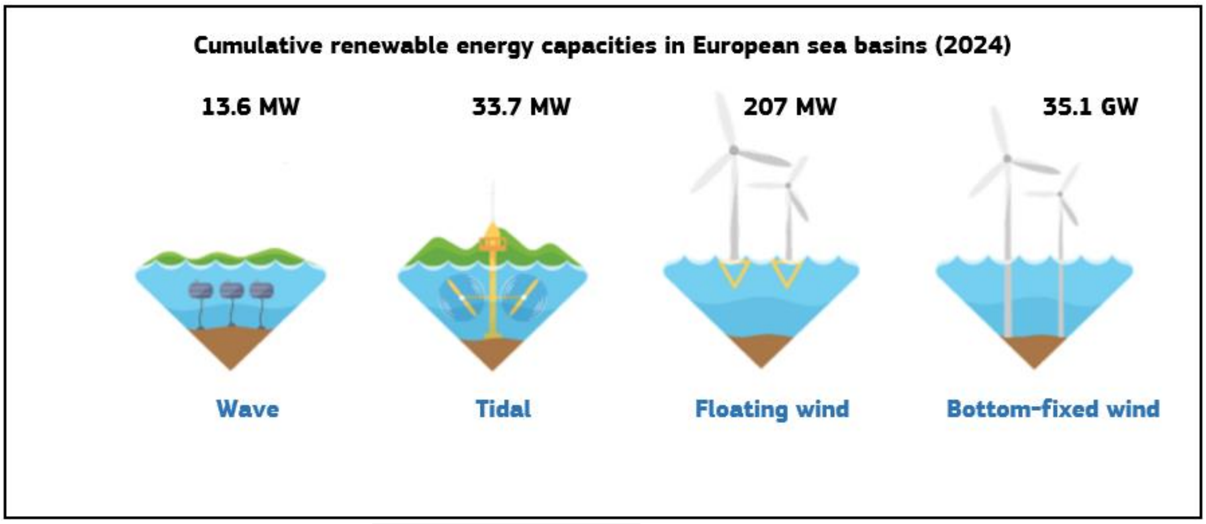
The *Ocean energy* sector already provides economic benefits by directing public and private investment towards creation of **jobs**. The nature of these jobs depends on the readiness level of technologies. At the early stages of development, ocean energy projects tend to finance jobs in R&D. In the next stage, when an innovation is promising, the creation of specialised SMEs generates additional jobs dedicated to management, administrative tasks and communication. The scaling-up of projects and energy device deployment on sea mobilise further work in financing, civil engineering and maintenance. In 2023, ocean energy projects were estimated to mobilise at least 415 FTEs in the EU within specialised ocean energy companies (energy device providers)[89]. On average, the companies identified employ 10 FTEs (13 FTEs for tidal energy, 9 FTEs for wave energy). The largest of these specialised companies, such as CorPower or Minesto, employ over 50 FTE, both in their main industrial facilities and near testing locations.

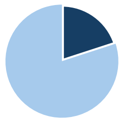
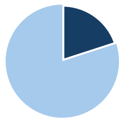
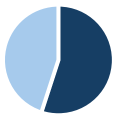
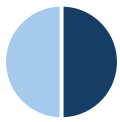
For more information, visit the section on ***Marine renewable energy*** within the EU Blue Economy Observatory.

[88] https://setis.ec.europa.eu/publications-and-documents/clean-energy-technology-observatory/ceto-reports-2024_en

[89] This estimate represents only part of the workforce within the *Ocean energy* sector, for which data was available (employees of ocean energy device provider companies). It does not include jobs within either civil engineering companies or larger energy companies (for example in the offshore fossil industry).

Figure 26 - Overview of offshore renewable energy technologies



Load factor				
LCOE	**160-750 EUR/MWh[1]**	**110-480 EUR/MWh[2]**	**145-350 EUR/MWh[3]**	**56-170 EUR/MWh[4]**
Est.				Established
TRL 9	Point absorber OWC	Horizontal axis turbine Tidal kite	Semi-submersible Spar-buoy	
TRL 8	OWSC Attenuator Overtopping		Barge	
TRL 7	Rotating mass Pressure differential	Enclosed tips Vertical axis turbine Undulating membrane		
TRL 6	Archimedes screw	Oscillating hydrofoil	Tension-leg platform Semi-spar	

NB:

TRL, technology readiness level (see National Aeronautics and Space Administration (NASA), 'Technology readiness levels', NASA website, 27 September 2023, accessed 24 April 2025, https://www.nasa.gov/directorates/somd/space-communications-navigation-program/technology-readiness-levels/).
Sources: Cumulative capacities for tidal and wave energy from OEE, and for floating and bottom-fixed wind energy from 4C Offshore; LCOE for tidal and wave energy from IRENA (2019) (global data), for floating wind energy from 4C Offshore (global data) and for bottom-fixed wind energy from BNEF (2023) (EU data).[90]

[90] NASA – Technology Readiness Level

PORT ACTIVITIES

The *Port activities* sector plays a crucial role in the European economy. Europe's ports are vital gateways, linking its transport corridors to the rest of the world. 74% of goods entering or leaving Europe are transported by sea, and Europe boasts some of the most advanced port facilities in the world. Nearly 400 million passengers embark and disembark in European ports every year[91]. Ports play an equally important role in supporting the exchange of goods within the internal market, and in linking peripheral and island areas with mainland Europe. Not only are ports fundamental for transporting goods, but they also serve as hubs for both conventional and renewable energy[92]. The EU port system is embedded within the trans-European transport network (TEN-T), whose maritime pillar includes a wide network of strategically located ports. Among these, a subset is identified as 'core ports'. These ports play a central role in both cargo transit and the deployment of clean infrastructure, such as onshore power supply (OPS) systems, and alternative fuel distribution, reinforcing Europe's commitment to sustainable transport and the energy transition.

For the purposes of this Report, the *Port activities* sector comprises two main subsectors, further broken down into the following activities:

Cargo and warehousing: comprising cargo handling, and warehousing and storage activities;

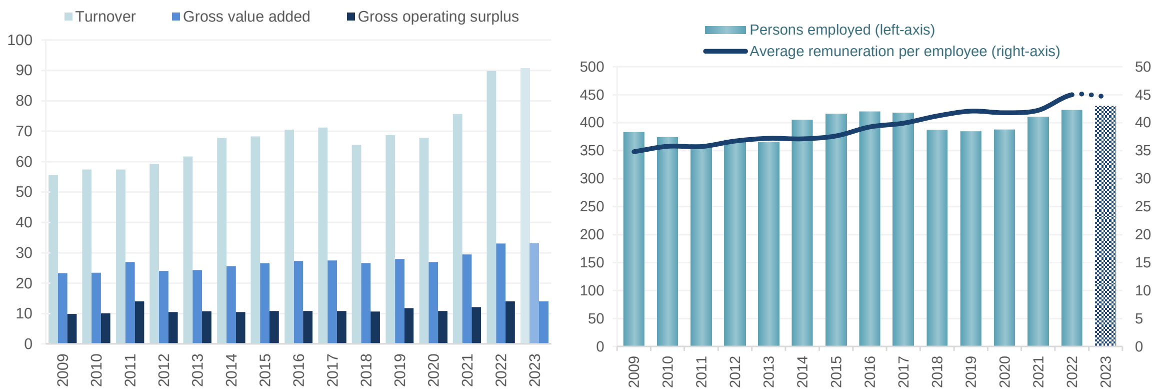
Port and water projects: comprising construction of water projects and service activities incidental to water transportation.

Size of the EU Port activities sector

In 2022, the GVA generated by the *Port activities* sector amounted to EUR 33 billion, representing a 12%-increase from 2021 and a 42%-increase from 2009 (EUR 23.3 billion), in current prices. Reported turnover, at EUR 89.8 billion in 2022, marked the sharpest year-on-year increase (19%) on record (EUR 14.2 billion). This led to a considerable increase in gross profit, which reached the highest value on record (EUR 14 billion). According to preliminary estimations, the growth of the sector continued in 2023, albeit more moderately, with turnover reaching EUR 90.7 billion, and GVA increasing to EUR 33.1 billion. At the same time, gross operating profits are estimated to have slightly decreased to EUR 13.9 billion, with a gross profit margin of 15.6% (compared with 16.1% in 2022).

In 2022, the *Port activities* sector employed 423 000 people – that is 3% more than in 2021 (410 600 people). This trend appears to be confirmed in 2023, when it is estimated that the sector employed slightly more than 430 000 people (+1.6%). The average annual gross remuneration per employee increased from EUR 42 200 in 2021 to EUR 45 000 in 2022 (by 6.6%), then decreased to almost EUR 44 700 (by 0.6%) in 2023 (Figure 27).

Figure 27 - Size of the EU *Port activities* sector, 2009–2023: turnover, GVA and gross operating surplus (billion EUR); people employed (thousands); and average wage (thousand EUR)



NB: Turnover and people employed in 2023 were estimated based on Eurostat's preliminary data; GVA, gross operating surplus and average remuneration per employee were estimated assuming they follow the same trend as turnover.

Source: Authors' own calculations based on Eurostat (SBS) data.

Overall, the sector's turnover has been growing steadily since 2011, except for in 2018 and 2020. The large rebound registered in 2021-2022 shows that the sector has fully recovered from the impacts of the COVID-19

[91] Eurostat. 9 December 2024. https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20241209-2

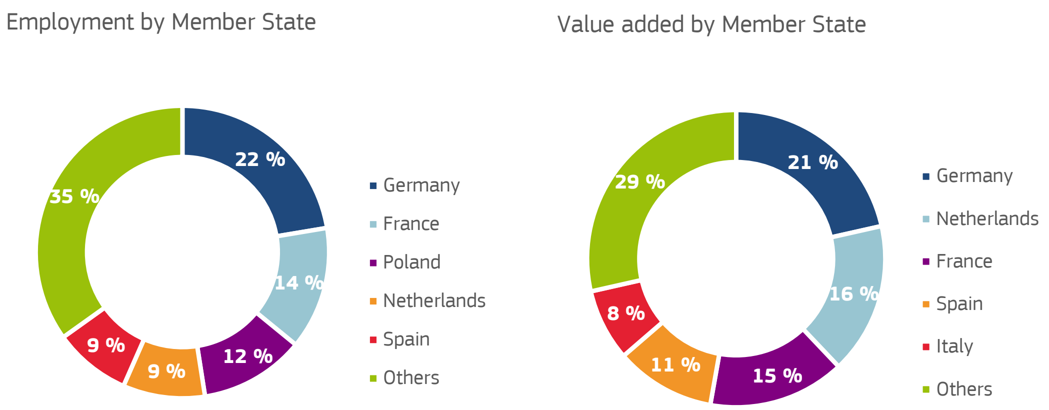
[92] European Commission. Mobility and Transport. https://transport.ec.europa.eu/transport-modes/maritime/ports_en

pandemic. In 2022, the *Port activities* sector accounted for 8.5% of jobs, 13% of GVA and 11.5% of profits in the EU Blue Economy.

Results by sub-sector and Member State

Germany has the highest employment and GVA in the *Port activities* sector, representing more than one fifth of the sectoral workforce (22%) and GVA (21%) in 2022. Another 43% of the sector's workforce is employed in France, Poland, the Netherlands and Spain (in order of contribution). After Germany, the Netherlands, France, Spain and Italy (in order of contribution) generate 50% of the sector's GVA (Figure 28).

Figure 28 - Share of employment and GVA in the EU *Port activities* sector, 2022



Source: Authors' own calculations based on Eurostat (SBS) data.

Employment: the *Port activities* sector directly employed more than 423 000 people in 2022. 62% of the workforce is employed in the cargo and warehousing subsector, the vast majority of which (79%) are employed in warehousing and storage activities. One fourth of the sector's workforce (25%) is employed in service activities incidental to water transportation, and the remaining 13% in the construction of water projects.

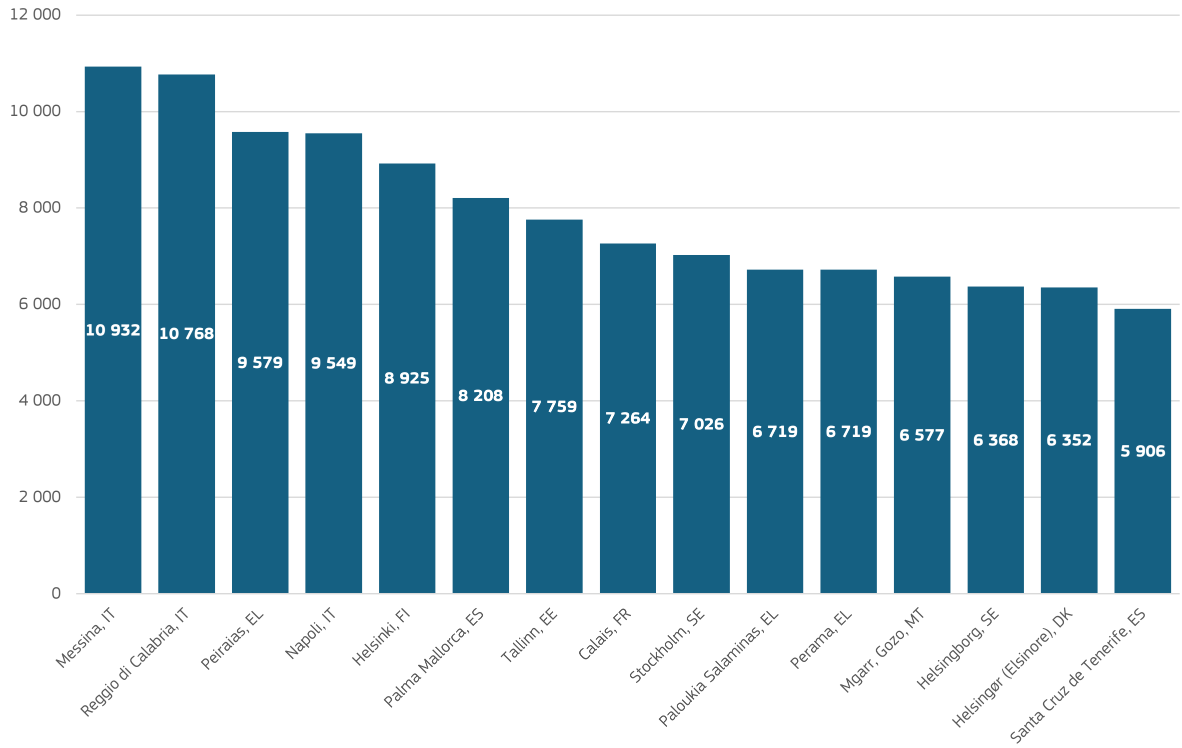
GVA in 2022, the *Port activities* sector generated the largest GVA on record since 2009, almost equally shared between the cargo and warehousing (49%) and port and water projects (51%) subsectors. Service activities incidental to water transportation and warehousing and storage activities generated more than EUR 12 billion GVA each, while cargo handling and construction of water projects generated approximately EUR 4 billion GVA each.

Trends and drivers

Disparities in port performance and competitiveness: EU ports handle a significant proportion of total port calls globally. In 2022, more than 12 million port calls were made worldwide, with almost 3 million (approximately 23%) occurring in EU and European Economic Area ports[93]. In 2023, the main EU ports registered 2.2 million calls from cargo and passenger vessels, representing a 1.5%-increase from the year before. According to Eurostat, a total of 395.3 million passengers embarked and disembarked in EU ports in 2023, corresponding to a 5.8%-increase from 2022 (374 million), with 11 Member States handling more than 10 million passengers each, equating to 97% of all EU seaborne passenger transport. Italy's ports led the way with 85.4 million passengers (22% of the EU's total), followed by Greece with 75.0 million (19%) and Denmark with 41.2 million (10%).

[93] European Maritime Safety Agency (EMSA) & European Environment Agency (EEA). (2025). European Maritime Transport Environmental Report 2025 (EMTER 2025). Publications Office of the European Union. Retrieved from https://www.emsa.europa.eu/emter-2025/full-report.html

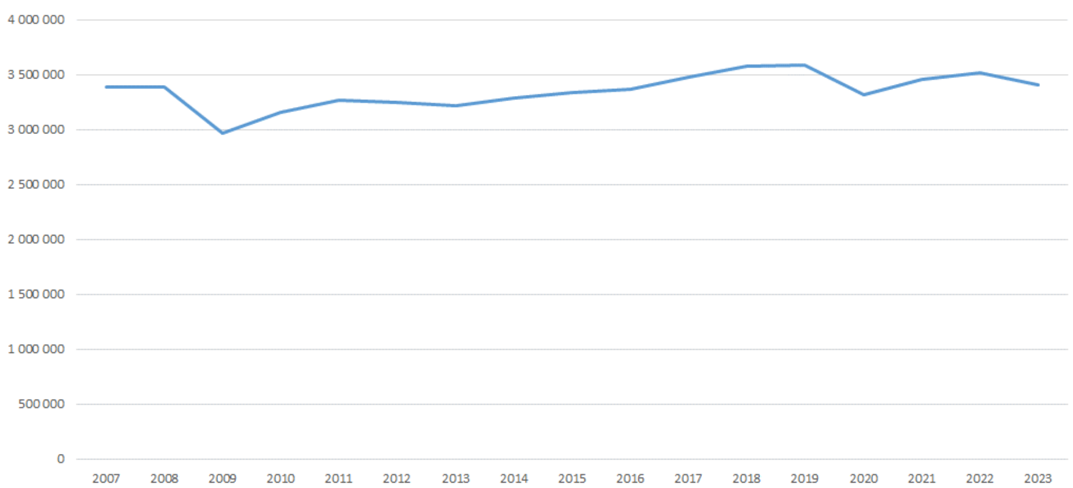
Figure 29 - Passengers embarked and disembarked in the top 15 EU ports, 2023 (thousand people)



Source: Eurostat (mar_mp_aa_pphd), last updated 6 December 2024.

As regards seaborne freight transport, EU ports handled a total of 3.37 billion tonnes (gross weight) in 2023, marking a 0.4%-decrease from 2022 (3.51 billion tonnes) (Figure 30). The Netherlands retained its position as the leading EU Member State for maritime freight transport, with the ports of Rotterdam, Amsterdam, and Zeeland handling 565 million tonnes in total (16% of the EU total). This represents a 9-million-tonne-increase from 2021. The top three EU ports in 2022 were Rotterdam (401.6 million tonnes), Antwerp-Bruges (242.2 million tonnes), and Hamburg (99.6 million tonnes) (Figure 31). Collectively, these three North Sea ports handled 22% of the total gross weight and volume of large containers[94].

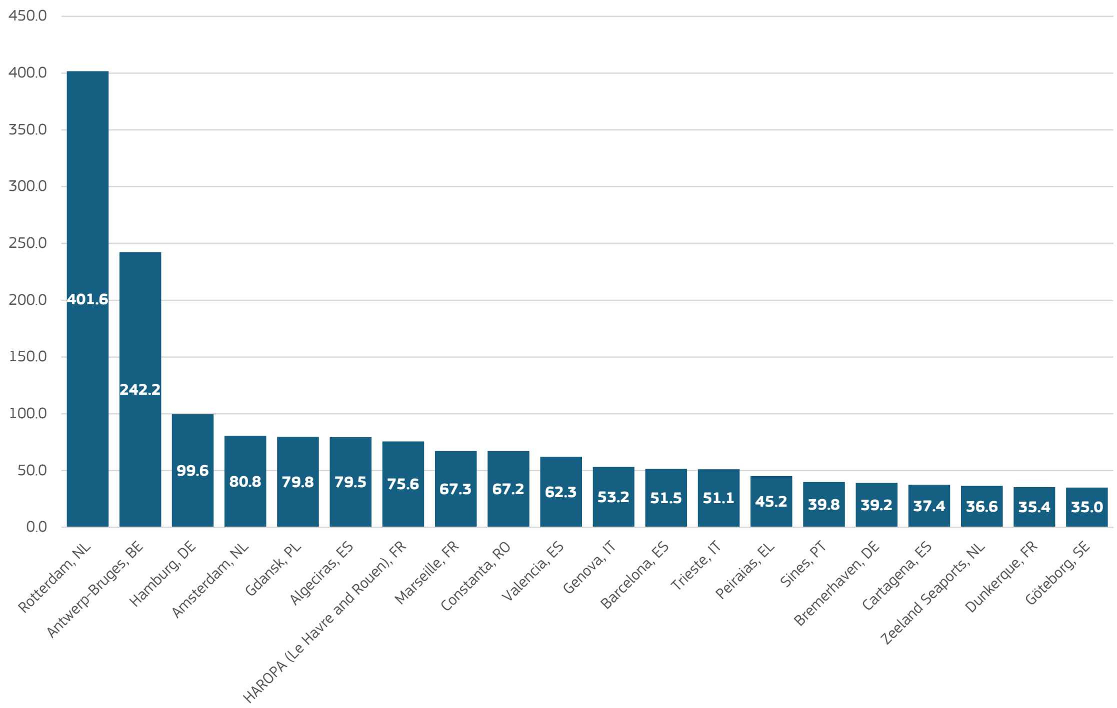
Figure 30 - Gross weight of goods handled in all EU-27 ports (thousand tonnes), 2007–2023



Source: Eurostat (mar_mp_aa), last updated 25 November 2024.

[94] Eurostat. 5 December 2023. https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20231205-2

Figure 31 - Gross weight of goods handled in the top 20 EU ports (thousand tonnes), 2023



Source: Eurostat (mar_mg_aa), last updated 25 November 2024.

Port expansion: between 2000 and 2018, the port area in Europe increased by 12.5%, with the most prominent expansion in absolute terms in the north-east Atlantic Ocean (53 km^2) and in relative terms in the Black Sea (17%)[95]. This expansion underscores the increasing importance of ports as territorial and logistical nodes.

Ecological and digital transition: key regulatory drivers for this transition are the following:

- The Alternative Fuels Infrastructure Regulation (Regulation EU 2023/1804)[96] requires ports included in the TEN-T to have clean infrastructure such as OPS systems, refuelling points for alternative fuels (hydrogen, liquified natural gas, methanol), and charging solutions for intermodal transport.
- The FuelEU Maritime Regulation (Regulation EU 2023/1805)[97] regulates the use of renewable fuels by maritime transport, with a direct operational dimension in ports, requiring them to have the facilities necessary to supply ships with these new fuels. It has applied since 1 January 2025 and obliges passenger and container ships over 5,000 gross tonnes calling at core TEN-T ports to use OPS systems or alternative zero-emission technologies from 2030[98].
- The regulation on the European maritime single window environment (Regulation EU 2019/1239)[99] introduces a mandatory digital system for managing documentation for all port operations. From August 2025, ports will need to become integrated in this single window, replacing fragmented systems with a single interoperable channel for maritime data reporting.
- The regulation on electronic freight transport information (Regulation EU 2020/1056)[100] establishes the obligation for the digital exchange of data across all transport modes, including maritime/port operations.

[95] European Maritime Safety Agency (EMSA) & European Environment Agency (EEA). (2025). European Maritime Transport Environmental Report 2025 (EMTER 2025). Publications Office of the European Union. Retrieved from https://www.emsa.europa.eu/emter-2025/full-report.html

[96] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R1804

[97] https://eur-lex.europa.eu/eli/reg/2023/1805/oj/eng

[98] European Commission. Mobility and Transport: https://transport.ec.europa.eu/news-events/news/new-eu-rules-aiming-decarbonise-maritime-sector-take-effect-2025-01-10_en

[99] https://eur-lex.europa.eu/eli/reg/2019/1239/oj/eng

[100] https://eur-lex.europa.eu/eli/reg/2020/1056/oj/eng

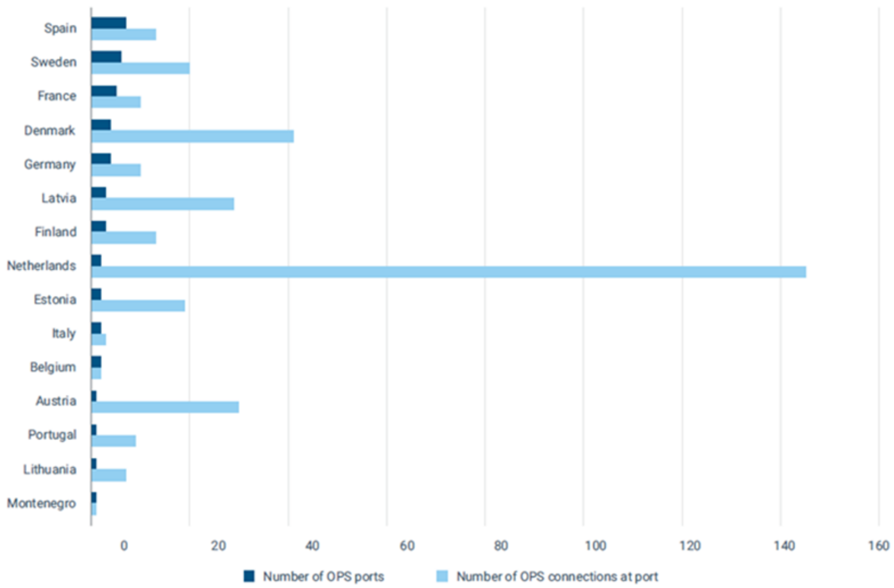
- The Network and Information Systems (NIS2) Directive (Directive EU 2022/2555)[101] considers ports to be critical infrastructures, requiring them to implement cybersecurity plans, periodic audits, specialised training, and incident response mechanisms.
- The directive on port reception facilities for ship-generated waste (Directive EU 2019/883)[102] continues to be a key instrument for ensuring the proper management of the waste generated by ships in ports, including oily waste, ballast water, scrubber waste, and solid waste.

Integration: the transformation of the EU port sector reflects a broader shift toward the integration of logistics, energy systems, digitalisation and sustainability. This evolution aligns port development with the EU's long-term economic and environmental objectives, consolidating their role as critical infrastructure for climate-neutral and resilient maritime transport[103].

Decarbonisation: as part of the transition towards a low-emission European port system, OPS has become a strategic element of infrastructure in 2025 for the decarbonisation of berth operations. This technology allows ships to connect to the land-based electricity grid while at berth, eliminating the need for auxiliary diesel generators and significantly reducing local emissions of CO_2, nitrogen oxides (NO_x), sulphur oxides (SO_x), and particulate matter.

At least 44 ports across 15 Member States have already implemented OPS infrastructure, with a total of 352 berths equipped with shore-to-ship power supply facilities (Figure 32)[104]. In the cruise sector, six European ports had at least one OPS-enabled berth as of April 2023, with four additional installations funded and 14 more planned.

Figure 32 - European ports with OPS infrastructure and number of berths with OPS connections



Source: European Commission, 'Maritime', European Alternative Fuels Observatory, 2024, https://alternative-fuels-observatory.ec.europa.eu/transport-mode/maritime-sea.

[101] https://eur-lex.europa.eu/eli/dir/2022/2555/oj/eng

[102] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L0883

[103] EEA, EMSA. European Maritime Transport Environmental Report (EMTER) 2025. https://emsa.europa.eu/emter-2025/

[104] EEA, EMSA. European Maritime Transport Environmental Report (EMTER) 2025. https://emsa.europa.eu/emter-2025/

Security and competitiveness: in recent years, the growing complexity of port operations and the increasing reliance on digital infrastructure have highlighted the need for robust cybersecurity measures, enhanced surveillance and digital infrastructure[105], and coordinated response protocols[106] to enhance overall resilience. In 2025, the Commission will present an EU port strategy, looking at all major issues facing ports, with a focus on security[107] and competitiveness[108].

For more information visit the section on ***Port activities*** within the EU Blue Economy Observatory.

SHIPBUILDING AND REPAIR

The fleet flagged under Member States accounts for approximately 12% of the global fleet, with 15 096 vessels registered as of the second quarter of 2024. In terms of gross tonnage, the EU fleet constitutes over 14% of the global fleet, amounting to 236.3 million gross tonnes, while it represents approximately 13% of deadweight tonnage, totalling 298.8 million tonnes[109].

As of the second quarter of 2024, the fleet registered to Member States included a diverse range of vessel types, both in absolute numbers and percentage. It accounted for nearly 27% of the global roll-on/roll-off passenger fleet (transport of passengers and vehicles, 912 ships), almost 23% of the world's passenger vessels (1 226) and more than 18% of the global containership fleet. In absolute terms, the most prevalent ship type was fishing vessels (2 540), followed by tugs/dredgers (2 007) and general cargo ships (1 468).

The EU's shipbuilding industry comprises approximately 150 major shipyards engaged in the construction of various types of vessels, both civilian and naval, along with platforms and other maritime equipment. According to the European Maritime Safety Agency (EMSA), in 2023 around 1 in 11 ships was built in an EU shipyard, with the majority consisting of tugs/dredgers (38), fishing vessels (29), general cargo ships (29), and passenger ships (26).

In 2023, a total of 437 ships were recycled worldwide. Among them, 22 were dismantled at EU ship recycling facilities, while four EU-flagged vessels were scrapped outside the EU.

For the purposes of this Report, the *Shipbuilding and repair* sector includes the following sub-sectors:

- **Shipbuilding**: building of ships and floating structures, building of pleasure and sporting boats, and repair and maintenance of ships and boats;
- **Equipment and machinery**: manufacture of cordage, rope, twine and netting; manufacture of textiles other than apparel; manufacture of sports goods; manufacture of engines and turbines (except aircraft); and manufacture of instruments for measuring, testing and navigation.

Size of the EU Shipbuilding and repair sector

The sector generated a GVA of EUR 19.9 billion in 2022, a 7%-increase compared with 2021 (Figure 33). Gross profit, at EUR 5.2 billion increased by 14% on the previous year. The turnover reported for 2022 was EUR 70.7 billion, a 5%-increase on the previous year.

In 2022, about 316 000 people were directly employed in the sector (2%-increase on 2021), and the annual average wage was estimated at EUR 46 400, up 3% compared with 2021.

Estimates for 2023 indicate increases in GVA, gross profit and turnover of between 8% and 10%. In addition, the increase in persons employed and average remuneration is estimated to be between 3% and 5%.

[105] EEA, EMSA. European Maritime Transport Environmental Report (EMTER) 2025. https://emsa.europa.eu/emter-2025/

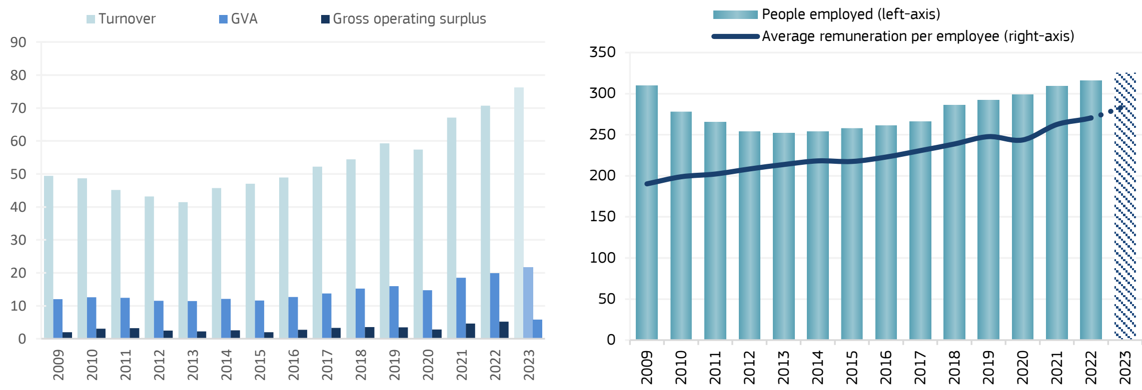
[106] European Sea Ports Organisation (ESPO). Annual Report 2023–2024. https://www.espo.be/media/Annual%20Report%202023-2024.pdf

[107] European Commission (2024). Mission letter for the Commissioner-designate for Sustainable Transport and Tourism.

[108] European Commission (2025). A Competitiveness Compass for the EU (COM(2025) 30 final).

[109] European Maritime Safety Agency - The EU Maritime Profile – the maritime cluster in the EU

Figure 33 - Size of the EU shipbuilding and repair sector, 2009–2023: turnover, GVA and gross operating surplus (billion EUR); people employed (thousands); and average wage (thousand EUR)



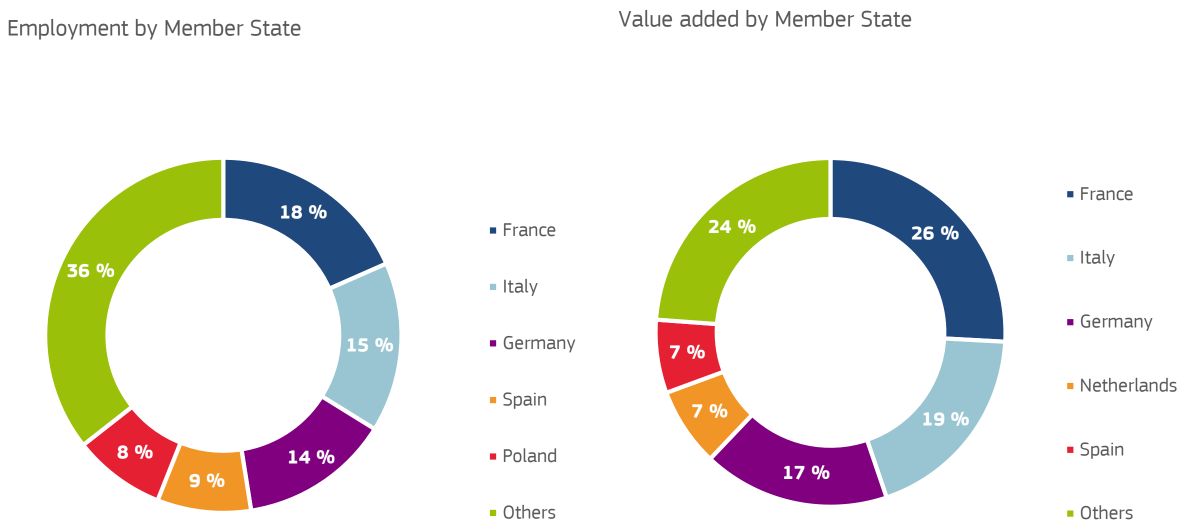
NB: Turnover and people employed in 2023 were estimated based on Eurostat's preliminary data; GVA, gross operating surplus and average remuneration were estimated assuming they follow the same trend as turnover.

Sources: Authors' own calculations based on Eurostat (SBS) data.

Results by sub-sector and Member State

France leads employment within the *Shipbuilding and repair* sector, accounting for 18% of jobs, followed by Italy and Germany (15% and 14%, respectively). In terms of GVA, France generates 26% of Member States' GVA in the sector, followed by Italy (19%) and Germany (17%).

Figure 34 - Share of employment and GVA in EU *Shipbuilding and repair* sector, 2022



Sources: Authors' own calculations based on Eurostat (SBS) data..

Shipbuilding generated about 85% of jobs and about 79% of the sector's GVA; while equipment and machinery generated the remaining 15% of jobs and 21% of GVA.

Trends and drivers

The European shipbuilding industry experienced a surge in 2023, with a total of 101 new orders being placed at European shipyards[110]. This represents a 9%-increase on the previous year, driven primarily by a surge in demand for dry cargo vessels, which accounted for 71 of the new orders, and cruise ships, for which 11 new orders were recorded. This growth is second to Chinese orders (+29% on a year-on-year basis), which confirms its position as the top shipbuilding nation globally. Other major shipbuilding countries continue to experience a decline in new orders: South Korea recorded a decline of 19%, and

[110] The figures are based on the BRS Group, 2024 – Shipping and Shipbuilding Markets – Annual Review 2024 edition. The European market under examination includes the following countries listed by decreasing number of cumulative orders on the book: Italy, France, Germany, Finland, Turkey, the Netherlands, Poland, Croatia, Spain, Romania, Azerbaijan, Portugal, Ukraine, UK, Greece and Norway.

Japan a staggering 31%, while their respective market shares declined by 4.1% and 6.9%[111].

Italy accounted for the highest number of orders in 2023, with more than 2.7 million gross tonnes (a total of 351 ships), followed by France, with 1.6 million gross tonnes (a total of10 ships). This is mainly due to Fincantieri (Italy), which is the largest builder of cruise ships in the world, with 30 ships on order – roughly 45% of the global cruise ship orderbook – and to Chantiers de l'Atlantique, which has 10 cruise ships on order[112].

Some factors currently influencing the *Shipbuilding and repair* sector are also expected to have a significant impact on it in the near future. The geopolitical instability, resulting from Russia's war of aggression against Ukraine, has affected the shipbuilding industry. Uncertainties surrounding shipping routes in the region have led some companies to postpone long-term investment decisions. The geopolitical instability has led the European Commission to publish the joint white paper 'European defence – Readiness 2030'[113], which is likely to have a positive impact on the shipbuilding industry. Finally, the roadmap to a greener industry affects shipbuilding and the retrofitting of ships, but also the disposal of ships at end of their life.

Naval defence ship orders

The joint white paper 'European defence – Readiness 2030' calls for "a massive increase in European defence spending" to support the development of a stronger, more resilient industrial basis for defence and an ecosystem of technological innovation for the defence industries[114]. The document identifies seven priority areas of capability, including some with relevance to the Blue Economy, such as an EU-wide network of seaports that facilitates the seamless and fast transport of troops and military equipment across the EU and partner countries (i.e. military mobility), and strategic enablers and critical infrastructure protection in the maritime domain.

In 2024, **total defence** spending by Member States is expected to exceed EUR 326 billion, marking an increase of more than 30% compared with 2021, and reaching a record 1.9% of EU GDP. Between 2021 and 2027, real-term growth is projected to surpass EUR 100 billion, exceeding previous estimates. Investments in research, development, and the procurement of new defence capabilities were also predicted to rise significantly between 2021 and 2024, from approximately EUR 59 billion to EUR 102 billion[115].

The **naval sector** plays a crucial role in EU defence capabilities, offering a wide array of vessels, from aircraft carriers to nuclear submarines. The EU naval vessels market is highly consolidated, with leading companies such as Navantia SA SME., the Naval Group, Fincantieri SpA, ThyssenKrupp AG, SAAB Kockums, Damen Naval, and Naval Vessels Lürssen dominating the industry. These key players have joined forces as part of the SEA Defence project, aimed at preserving the competitiveness of the European naval industry by focusing on the use of emerging technologies to enhance naval capabilities and increasing operability among European navies[116].

In 2023, members of the Aerospace, Security, and Defence Industries Association of Europe[117] reported that the naval sector accounted for EUR 37.9 billion of the revenue, representing 24% of total European defence expenditure. This marks a 17.7% increase compared with 2022[118]. Similar estimates are reported by Mordor Intelligence, which estimates the value of the European naval vessels market to be EUR 36 billion in 2025, and projects an increase to EUR 58 billion by 2030, with a compound annual growth rate of 10.21%[119].

The increase in defence spending, aligned with the joint white paper 'European defence – Readiness 2030', is expected to drive the sector's growth in the medium to long term.

Green shipbuilding and recycling

Developing zero-emission vessels requires a **life-cycle approach** to assess key environmental impacts across all stages, including design, construction, operation, and disposal. Shipyards, as industrial production facilities, rely

[111] BRS Group, 2024 – Shipping and Shipbuilding Markets – Annual Review 2024 edition

[112] BRS Group, 2024 – Shipping and Shipbuilding Markets – Annual Review 2024 edition

[113] European Commission, 2025 – Commission unveils the White Paper for European Defence and the ReArm Europe Plan/Readiness 2030 – Press Release.

[114] European Commission, 2025 - Joint White Paper for European Defence Readiness 2030.

[115] European Defence Agency - Defence Data 2023-2024.

[116] SEA Defence – Press release: European naval shipbuilders join forces to ensure security of the EU.

[117] ASD includes non-EU countries, such as UK, Norway and Turkey. Their contribution to turnover and employment is 25% and 31%, respectively.

[118] Aerospace, Security and Defence Industries Association of Europe - 2024 Facts & Figures.

[119] Mordor Intelligence – Europe Naval Vessels Market Size.

on materials and energy-intensive processes such as cutting, bending, welding, sandblasting, painting, and coating. These processes are complex and contribute significantly to environmental and climate impacts. The shipbuilding industry is responsible for approximately 4-8% of the total CO_2 emissions of diesel-powered ships throughout their life cycle, and accounts for 29% of carbon monoxide emissions. In addition, the industry generates volatile organic compounds, which contribute to the formation of tropospheric ozone, posing risks to both human health and the environment[120].

The Energy Efficiency Design Index and the Carbon Intensity Indicator of the International Maritime Organisation (IMO) are pushing shipbuilders to create more energy-efficient vessels that meet strict emissions targets.

Finally, **responsible recycling** at the end of a ship's life is essential. Between 1 January 2019 and 31 December 2021, Member States and Norway reported a total of 90 ships receiving a ready-for-recycling certificate, confirming they met the environmental and safety standards for dismantling and recycling in EU-approved yards. Of these, 41 vessels completed the recycling process – which took place in seven facilities – with Türkiye handling the largest share (50%). In 2022, vessels flagged under Member States represented 13.2% of the global fleet, but only 7% of end-of-life vessels recycled were flagged under a Member State at the time of recycling. This indicates that the goal of ensuring safe and environmentally sound recycling, as outlined by EU legislation, is still challenged by the practice of **re-flagging**[121].

Retrofitting for the Energy Transition

Retrofitting has gained strategic and economic importance as a key solution for transforming high-emission ships into climate-friendly vessels, ensuring compliance with international and EU environmental regulations.

Retrofitting solutions – such as exhaust gas cleaning systems (scrubbers), alternative fuel systems (for LNG, hydrogen, and ammonia), and energy efficiency enhancements (air lubrication systems, hull coatings) – can significantly lower emissions and ensure compliance with the IMO's 2020 sulphur cap and the Carbon Intensity Indicator requirements[122]. Beyond compliance, these technologies also improve fuel efficiency, reduce operational costs, and enhance the **competitiveness of shipping companies**.

Among all retrofit options, the most impactful in terms of both shipyard and GHG emissions is the installation of a new engine and fuel system capable of running on **alternative fuels** like methanol, ammonia, or hydrogen. However, engine replacement is a technically complex process requiring skilled labour, specialised facilities, and significant investments. It also involves integrating new fuel systems and tanks, which can be challenging and costly depending on the fuel type[123]. As an alternative, ships can be supplemented with battery systems to reduce diesel dependency. Other retrofitting measures include expanding **shore power capabilities** to reduce emissions while at berth and exploring **wind-assisted propulsion** to cut fuel consumption.

For more information visit the section on ***Shipbuilding and repair*** within the EU Blue Economy Observatory.

MARITIME TRANSPORT

Globally, approximately 13 billion tonnes of traded goods were transported by sea in 2023, a 2.4%-increase from the previous year[124].

However, the EU-27 picture is different, as the gross weight of goods handled in ports declined by 3.9% in 2023, dropping from 3.5 billion tonnes in 2022 to 3.4 billion tonnes[125]. After experiencing growth in the first three quarters of 2022 compared with the previous year, a decline was observed from the final quarter of 2022 through the last quarter of 2023[126]. The decrease in goods handled is primarily due to restrictions on goods transport to and from Russia, owing to its military aggression against Ukraine.

When focusing on the Member State level, the year-on-year (2023 over 2022) change in gross weight of goods handled is very heterogeneous, spanning from -31% in

[120] The Royal Institution of Naval Architects, 2023 – Promoting clean, green shipyards for a zero-emission future.

[121] European Environmental Agency, European Maritime Safety Agency, 2025 – European Maritime Transport Environmental Report 2025.

[122] Kolios, A., 2024. Retrofitting technologies for eco-friendly ship structures: a risk analysis perspective. Journal of Marine Science and Engineering, 12(4), p.679.

[123] Sea Europe, 2025 – Retrofitting of Ships in Europe.

[124] UNCTAD, 2024 - Review of Maritime Transport 2024.

[125] EUROSTAT - mar_mg_aa

[126] EUROSTAT. Gross weight of goods transported to/from main ports by direction and type of traffic (national and international) - quarterly data – mar_go_qm, https://ec.europa.eu/eurostat/databrowser/product/page/MAR_GO_QM.

Estonia (23 million tonnes) to +47.5% in Malta (7.2 million tonnes). The Netherlands recorded the largest gross weight of goods handled at 545 million tonnes (-7.6% from 2022), followed by Italy with 500 million (-1.7%) and Spain with 471 million (-3.7%).

Liquid bulk goods (e.g. oil) represented roughly 37.9% of the total goods handled in the EU (1.26 billion tonnes), followed by large containers with 22.7% (757 million tonnes) and dry bulk goods (e.g. grain) with 21.6% (720 million tonnes)[127].

Short sea shipping (SSS) is defined as the maritime transport of goods between ports in the EU (sometimes also including candidate countries and European Free Trade Association countries) on the one hand, and ports situated in geographical Europe, on the Mediterranean Sea and Black Sea, on the other hand. In 2023, 1.6 billion tonnes of goods were transported by SSS, 5.4% less than in the previous year. The busiest region for SSS was the Mediterranean Sea, where roughly 39% of the goods were transported in terms of gross weight (628 million tonnes), followed by the North Sea (29% and 472 million tonnes) and the Baltic Sea (18% and 285 million tonnes)[128].

In 2023, 386 million passengers (excluding cruise passengers) embarked and disembarked in all EU ports, a 6.8%-increase compared with 2022. Cruise passengers were roughly 16 million, almost 34% more than the previous year, surpassing pre-pandemic levels for the first time (15 million in 2019)[129].

The sector *Maritime transport* includes the following sub-sectors:

- **Passenger transport**: sea and coastal passenger water transport and inland passenger water transport;
- **Freight transport**: sea and coastal freight water transport and inland freight water transport;
- **Services for transport**: renting and leasing of water transport equipment.

Size of the EU Maritime transport sector

The sector generated a GVA of EUR 61.8 billion in 2022, a 39%-increase compared with 2021. Gross profit, at EUR 43.9 billion, increased by 56% on the previous year. The turnover reported for 2022 was EUR 228 billion, a 29% increase on the previous year.

Estimates for 2023 suggest a stable performance, with GVA, turnover and gross profit increasing less than 1%.

In 2022, almost 392 800 people were directly employed in the sector, 4% more than in 2021. The annual average wage was estimated at EUR 45 700, up 6% compared with 2021.

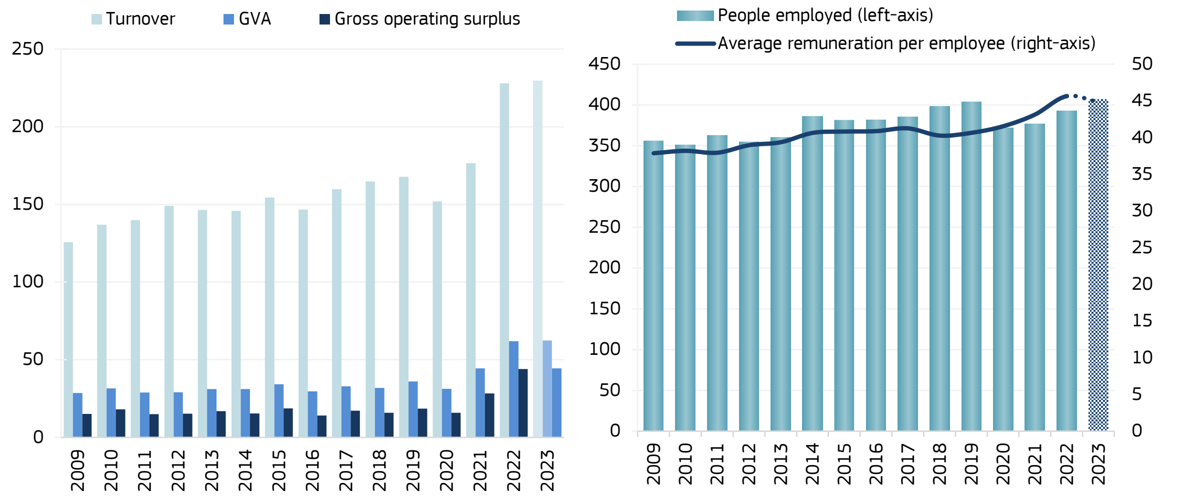
The estimate for the people employed in 2023 is 407 400, while the estimated average remuneration is EUR 44 800.

[127] EUROSTAT. Country level - gross weight of goods handled in main ports, by type of cargo. - mar_mg_am_cwhc. https://ec.europa.eu/eurostat/databrowser/product/page/mar_mg_am_cwhc.

[128] EUROSTAT - mar_sg_am_cws

[129] EUROSTAT – Passengers embarked and disembarked in all ports by direction – annual data - mar_pa_aa

Figure 35 - Size of the EU *Maritime transport* sector, 2009-2023. Turnover, GVA ad gross operating surplus in EUR billion, people employed (thousand), and average wage (EUR thousand)



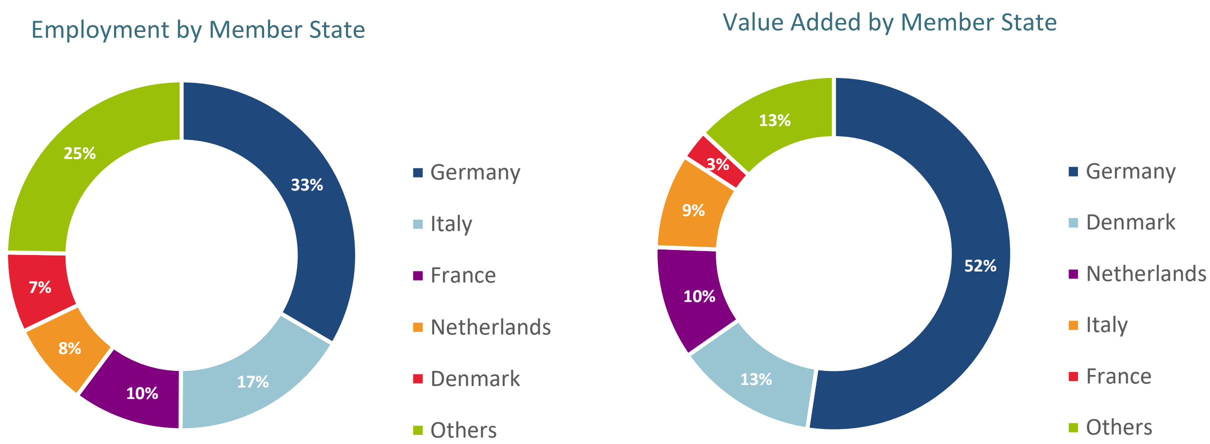
NB: Turnover and people employed in 2023 were estimated based on Eurostat's preliminary data; GVA, gross operating surplus and average remuneration were estimated assuming they follow the same trend as turnover.

Source: Authors' own calculations based on Eurostat (SBS) data.

Results by sub-sector and Member State

Germany has the highest employment within the *Maritime transport*, accounting for 33% of jobs in the sector, followed by Italy (17%) and France (10%). Germany generates 52% of the Member States' GVA in the sector, followed by Denmark (13%) and the Netherlands (10%).

Figure 36 - Share of employment and GVA in EU *Maritime transport* sector, 2022



Source: Authors' own calculations based on Eurostat (SBS) data.

In 2022, about 50% of jobs (197 700) were within the services for transport subsector, while passenger transport (102 700) and freight transport (92 500) employed 26% and 24% of people, respectively.

Freight transport generated about 65% of the sector's GVA (EUR 40.6 billion), followed by services, with 25% (EUR 15.3 billion), and then passenger transport, with 10% (EUR 6 billion).

Connectivity of the EU shipping network

Based on the Liner Shipping Connectivity Index, which indicates a country's integration into global liner shipping networks, the most-connected European economies in the last quarter of 2024 were Spain (up 3.4% from the last quarter 2023 2023), the Netherlands (-5.4%) and Belgium (-1%)[130].

[130] UNCTAD - Liner shipping connectivity index, quarterly.

The most connected EU ports in the last quarter of 2024 were Rotterdam (Netherlands, -6.8% compared with the same quarter in 2023), Antwerp (Belgium, -0.1%) and Hamburg (Germany, -0.5%)[131], according to the Port Liner Shipping Connectivity Index, which measures a port's integration into global liner shipping networks.

Trends and drivers

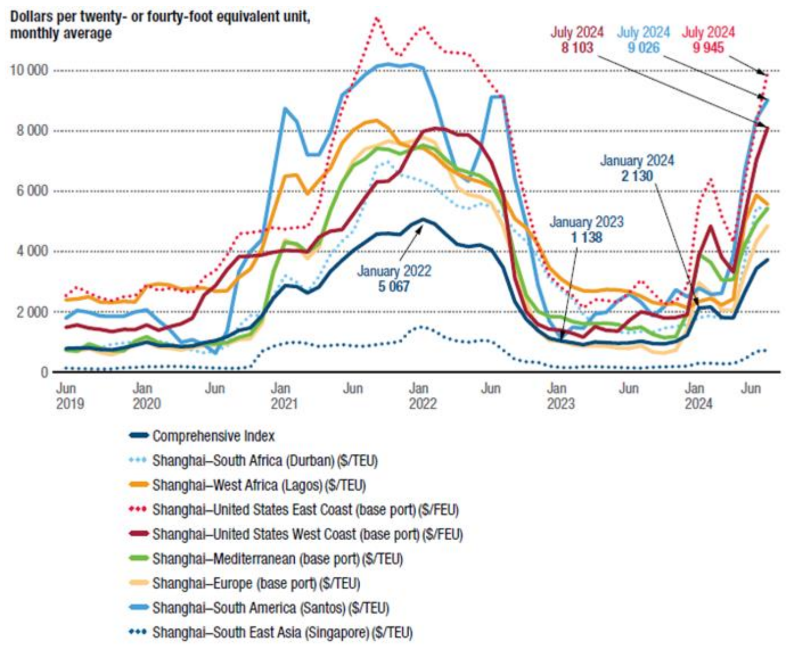
The EU *Maritime transport* sector is undergoing significant transformation driven by evolving geopolitical dynamics, digitalisation, the energy transition and increasing climate risks.

Route changes due to geopolitical factors and climate change: over the past two decades, the *Maritime transport* sector has undergone a significant structural transformation. The combination of climate change and geopolitical tensions represents one of the most significant risks to global maritime trade in decades.

Maritime chokepoints, which serve as essential arteries for global commerce, are particularly vulnerable. With few viable alternatives, disruptions at these strategic passages can have far-reaching consequences, affecting food security, energy supplies, and economic stability worldwide. For example, the **Turkish Straits** faced disruptions in 2023 and 2024 due to geopolitical tensions, rising maritime traffic, environmental concerns, and infrastructure-related challenges. Meanwhile, climate change is exerting pressure on another critical trade corridor – the **Panama Canal**. A severe drought has led the Panama Canal Authority to impose transit restrictions to conserve water, significantly reducing vessel traffic. In May 2024, the total number of transits declined by 19.2% compared with May 2023 and by 24.3% compared with May 2022[132,133]. Adding to these challenges, since mid-November 2023, escalating security risks in the Red Sea have led major shipping companies to suspend transits through the **Suez Canal**. In response, a significant share of ships on the Asia–Europe trade route has diverted around the Cape of Good Hope[134]. This shift has heightened costs for Europe, which remains heavily reliant on imports from Asia.

Spot freight rates on the Asia–Europe corridor, the EU's main import route, have risen sharply since late 2023 (see Figure 37). Average costs per container (20-foot equivalent units) have approached levels seen during the peak of the pandemic. On the Europe–America corridor, freight rates have also increased considerably, reflecting accumulated stress across European and global logistics chains.

Figure 37 - Spot rates for the Shanghai Containerised Freight Index



NB: FEU, 40-foot equivalent unit; TEU, 20-foot equivalent unit.
Source: Calculations of the United Nations Conference on Trade and Development based on data from Clarksons Research's Shipping Intelligence Network.

[131] UNCTAD - Port liner shipping connectivity index, quarterly.

[132] UNCTAD, 2024. Navigating Troubled Waters: Impact to Global Trade of Disruption of Shipping Routes in the Red Sea, Black Sea and Panama Canal. UNCTAD Rapid Assessment.

[133] Panama Canal Authority (2024). Transit statistics

[134] UNCTAD News, 2024. Red Sea, Black Sea and Panama Canal: UNCTAD raises alarm on global trade disruptions.

Addressing these vulnerabilities requires urgent action to strengthen the resilience of global supply chains and ensure uninterrupted maritime trade. **Diversifying shipping routes** is crucial to reducing dependency on a limited number of critical passages, while **greater cooperation** among shippers, providers of logistics services, and ports can help optimise supply chain efficiency. At the same time, **leveraging technology**, data, and predictive analytics will improve demand forecasting, enhance early warning systems, and enable better capacity management at chokepoints, ultimately mitigating the risks posed by geopolitical instability and climate change.

Digitalisation

One main driver of the digital transformation is **artificial intelligence** (AI). AI can for example optimise routes based on historical data and current traffic conditions, thereby minimising costs and reducing delivery times. In addition, it can be employed in forecasting demand, optimising inventory levels and reducing stock-outs, and in predicting when equipment may need maintenance, minimising downtime and extending the lifespan of assets. Some European companies, such as Maersk, are already employing AI to facilitate certain processes.

Another digital technology that could have an impact on the maritime transport industry is **blockchain**. Blockchain-based digitalisation tools (e.g. CargoX, created by a Slovenian company) can improve supply chain transparency and cargo tracking, execute smart contracts, increase cybersecurity and prevent fraud.

Digitalisation is also driving advancements in the area of **autonomous ships**. These advancements range from steering and navigational assistance to full automation of navigation, potentially reducing operational costs, improving working conditions, saving fuel by optimising routes, and reducing human errors and accidents. The EU-funded Autoship project showcased how cutting-edge innovation on two vessels could support navigation as well as mooring and docking[135].

Digitalisation also plays a fundamental role in **emissions monitoring**. In this context, digitalisation has advanced substantially, pushed by stricter and stricter EU regulations that promote a greener shipping industry, such as the EU emission trading system (ETS) and the FuelEU Maritime Regulation. The monitoring, reporting and verification (MRV) system, introduced in 2015, provides detailed fuel-based data on vessel-level CO_2 emissions. From 2025, MRV coverage will expand to include general cargo vessels and offshore ships between 400 and 5 000 gross tonnage (GT). The MRV is complemented by other emissions monitoring frameworks, including the United Nations Framework Convention on Climate Change (UNFCCC) GHG inventories and the Ship Traffic Emissions Assessment Model (STEAM). These systems use different methodologies: the MRV system tracks onboard fuel consumption per vessel, the UNFCCC applies the principle of territorial accounting, and STEAM uses ship activity data from the automatic identification system.

Despite growing operational and environmental demands, the digitalisation of European maritime logistics remains uneven and largely underdeveloped. According to the European Maritime Transport Environmental Report 2025[136], digital technologies are still treated as a secondary tool rather than an essential infrastructure component.

In this context, the Commission's Digital Transport and Logistics Forum[137] provides a platform for structural dialogue, the provision of technical expertise, and cooperation and coordination between the Commission, Member States and the transport and logistics sector, with the objective of developing and implementing digital interoperability and data exchange within the industry.

Decarbonisation

Maritime transport is facing increasing environmental scrutiny. In 2022, the industry accounted for 14.2% of transport-sector emissions in the EU. Its CO_2 emissions were on the rise – reaching 137.5 million tonnes, up 8.5% from the previous year. In addition, the expansion of the LNG fleet has been linked to increasing methane emission, and there has been a 10%-rise in NO_x emissions over the past decade, with notable increases in the Atlantic and Arctic regions[138].

In response, the European Commission has initiated a profound regulatory transformation of the maritime sector, with *Maritime transport* now a key pillar of the European Green Deal and the fit for 55 legislative

[135] Autonomous Shipping Initiative for European Waters - https://www.autoship-project.eu/.

[136] European Maritime Transport Environmental Report 2025 - https://www.eea.europa.eu/en/analysis/publications/maritime-transport-2025

[137] Digital Transport and Logistics Forum - https://transport.ec.europa.eu/transport-themes/digital-transport-and-logistics-forum-dtlf_en

[138] European Maritime Transport Environmental Report 2025 - https://www.eea.europa.eu/en/analysis/publications/maritime-transport-2025

packages. The inclusion of shipping in the EU ETS[139] starting in 2024 – shipping companies must purchase and surrender emission allowances for each tonne of CO_2 or CO_2 equivalent reported – and the enforcement of the FuelEU Maritime regulation[140] – ships above 5 000 gross tonnes calling at EU ports must respect limits on GHG intensity, which will gradually increase until 2050 – from 2025 signal a turning point. In parallel, sulphur emission controls are tightening, with the designation of the Mediterranean Sea as a sulphur emission control area from May 2025[141]. The development of supporting infrastructure is addressed through the Alternative Fuels Infrastructure Regulation[142], which requires European ports to be equipped with LNG bunkering infrastructure – for which the deadline was January 2025 – and to plan for the deployment of hydrogen, methanol, and ammonia refuelling infrastructure. Furthermore, the revised Renewable Energy Directive[143] sets binding targets for the use of renewable fuels in the transport sector, including e-fuels and advanced biofuels. Finally, the ongoing revision of the Energy Taxation Directive seeks to eliminate existing tax exemptions for fossil fuels used in intra-EU maritime transport, aligning fiscal policy with EU climate objectives[144].

However, the effective adoption of clean technologies in maritime transport is still progressing slowly. In 2023, only 0.77% of the active fleet in Europe used alternative fuels, highlighting the gap between regulatory objectives and the actual transformation of the sector[145]. This energy transition poses a significant challenge to the workforce: it is estimated that over 800 000 seafarers will require specific training in new technologies and alternative fuels by 2035[146].

For more information, visit the section on ***Maritime transport*** within the EU Blue Economy Observatory.

[139] European Commission, 2023 - EU Emissions Trading System (EU ETS) for Shipping

[140] European Commission, 2023 - FuelEU Maritime Regulation

[141] European Maritime Transport Environmental Report 2025 - https://www.eea.europa.eu/en/analysis/publications/maritime-transport-2025

[142] European Commission, 2023 - Alternative Fuels Infrastructure Regulation (AFIR)

[143] European Commission, 2023 - Renewable Energy Directive (RED III).

[144] European Commission, 2021 - Proposal for a Council Directive restructuring the Union framework for the taxation of energy products and electricity.

[145] European Maritime Transport Environmental Report 2025 - https://www.eea.europa.eu/en/analysis/publications/maritime-transport-2025

[146] European Maritime Transport Environmental Report 2025 - https://www.eea.europa.eu/en/analysis/publications/maritime-transport-2025

COASTAL TOURISM

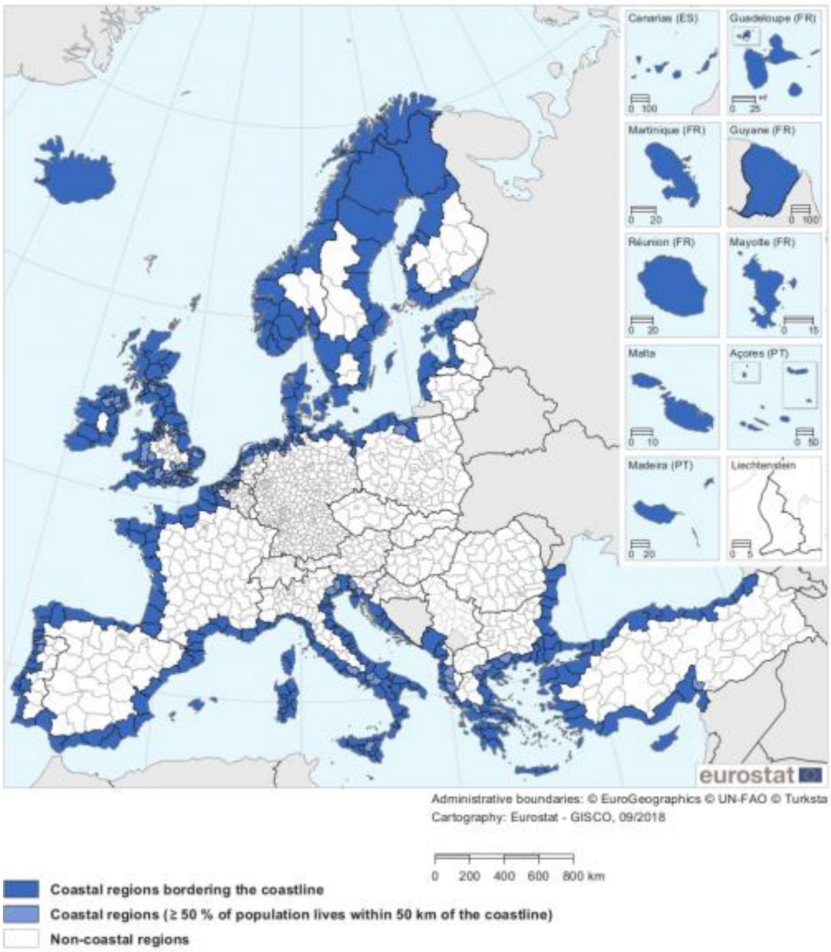
The coastal and maritime tourism industry dominates the EU Blue Economy, driving significant economic growth and employment.

In 2023, more than 1.4 billion nights were spent in tourist accommodation (i.e. hotels, holiday and other short-stay accommodation, camping grounds, recreational vehicle parks and trailer parks) in coastal regions, a 6.4%-increase from the previous year and above the 2019 peak (+3.5%)[147].

The Member State that attracted the most visitors to coastal areas was Spain with 363 million, followed by Italy, with 238 million, and France, with 163 million.

In 2023, 57% of tourism in coastal areas was driven on average by foreign residents, reporting an increase of almost 3% on the previous year. However, large differences emerge when looking at Member State level, with some countries able to attract more than the average number of foreign residents. The highest shares of foreign tourists in coastal areas are recorded by Cyprus (94%), Croatia and Malta (93%), and Greece (86%). Conversely, the lowest shares are reported in Romania (3%), Germany (7%) and Lithuania (15%).

Figure 38 - Coastal typology in Europe and its outermost regions



N.B.: based on the Geostat population grid from 2011, and data from Columbia University, the Centre for International Earth Science Information Network (2015): (Global Human Settlement's population grid) and NUTS (nomenclature of territorial units for statistics) 2016.
Sources: Eurostat and European Commission (including its Joint Research Centre).

[147] EUROSTAT - Nights spent at tourist accommodation establishments by degree of urbanisation and coastal/non-coastal area – tour_occ_ninatdc.

The socio-economic statistics presented in this section cover three typologies of activities typically undertaken by tourists (as reported by EU Member States), attributed to coastal areas on the basis of a specific computational methodology:

- **Accommodation**, that is nights spent at tourist accommodation in coastal areas;
- **Transport**, reflecting the maritime proportion of sea-borne, road, rail and air passenger travel;
- **Other expenditures**, covering specific tourist expenditures in coastal areas (e.g., food and beverage services, cultural and recreational goods, purchase of water-sport equipment and clothing, etc.).

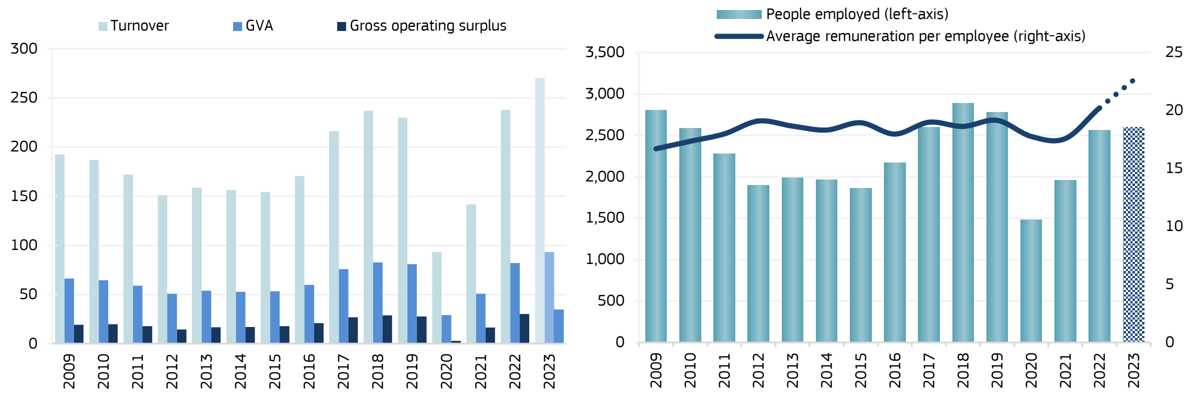
Size of the EU Coastal tourism

In 2022, the *Coastal tourism* sector recorded a performance similar to the pre-pandemic level. The GVA generated by the sector amounted to EUR 82.0 billion, up from EUR 50.7 billion in 2021 (i.e., a year-on-year 62%-increase) and above the pre-pandemic level (EUR 81.0 billion in 2019). Gross profit, at EUR 30.3 billion, increased by 84% compared to 2021. The sector's turnover, resulting from the aggregation of the abovementioned sub-sectors, amounted to EUR 238 billion (Figure 39).

Estimates for 2023 suggest that overall economic performance increased by about 14%.

In 2022, almost 2.56 million people were directly employed in the sector, 31% more than in 2021. The annual average wage was estimated at EUR 20 200, up 15% compared with 2021.

Figure 39 - Size of the EU *Coastal tourism* sector, 2009-2022: turnover, GVA ad gross operating surplus (billion EUR), people employed (thousands), and average wage (thousand EUR)



NB: Turnover and people employed in 2023 were estimated based on Eurostat's preliminary data; GVA, gross operating surplus and average remuneration were estimated assuming they follow the same trend as turnover.

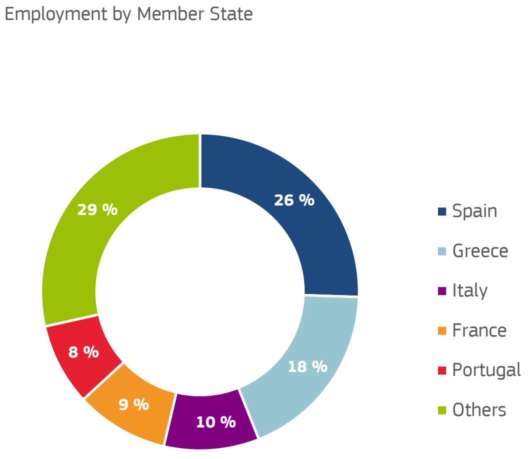
Source: Authors' own calculations based on Eurostat (SBS) data.

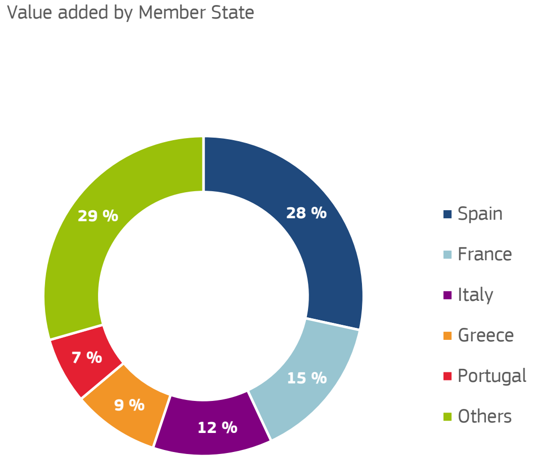
Results by sub-sector and Member State

In 2022, Spain led the *Coastal tourism* sector in terms of employment contributing 26% of jobs, followed by Greece, with 18%, Italy, with 10%, and France with 9% (Figure 40). The accommodation subsector employed almost 1.1 million people, accounting for about 44% of jobs; while about 1.13 million people (42%) were employed in other services (e.g. restaurants), and almost 350 000 people (14%) were employed in transport.

In terms of GVA, Spain led with 28%, followed by France, with 15%, and Italy, with 12% in 2022. The accommodation subsector generated EUR 42.4 billion in GVA, about 52% of the sector's GVA, while the other services subsector generated EUR 25.1 million (31%), and transport EUR 14.5 million (18%).

Figure 40 - Share of employment and GVA in the EU *Coastal tourism* sector, 2022





Source: Authors' own calculations based on Eurostat (SBS) data.

Trends and drivers

A few years after the COVID-19 pandemic, the industry has fully recovered in most EU regions, with *Coastal tourism* showing greater resilience than urban and rural destinations, having been less affected by the crisis[148]. Several noteworthy trends are currently emerging in the tourism sector, with sustainable tourism and digitalisation being particularly significant. To this end, the European Commission published the transition pathway for tourism[149], a framework designed to create a more sustainable and resilient tourism ecosystem in the EU through a green and digital transition. As part of the transition pathway for tourism, the European Commission developed the EU Tourism Dashboard[150], an online knowledge tool to monitor indicators measuring the green, digital and socio-economic aspects of tourism. The EU Tourism Platform[151] was also developed as a one-stop shop to enable all tourism stakeholders to follow the progress of the transition pathway. Finally, climate change is projected to have a profound impact on the *Coastal tourism* sector, posing significant challenges to the industry's sustainability and resilience[152].

Sustainable tourism

Sustainable tourism has become a critical priority for coastal destinations in the EU, as the industry seeks to balance economic growth with environmental and social responsibility. It presents a dual opportunity. First, it enables the sector to contribute to the transition towards a **greener economy**, aligning with global efforts to mitigate environmental degradation. Second, embracing sustainable tourism practices can yield significant benefits for the industry itself, given its intrinsic dependence on the preservation of natural resources.

The **demand for sustainable tourism** is rising, as evidenced by numerous academic and industry surveys[153,154]. A Eurobarometer survey on the attitudes of European tourists revealed that 43% of travellers consider the natural environment a key factor when choosing their destination, while 82% of respondents are willing to adopt more sustainable practices[155]. With regard

[148] Curtale, R., e Silva, F.B., Proietti, P. and Barranco, R., 2023. Impact of COVID-19 on tourism demand in European regions-An analysis of the factors affecting loss in number of guest nights. Annals of Tourism Research Empirical Insights, 4(2), p.100112.

[149] European Commission, 2022 – Transition Pathway for Tourism

[150] European Commission – EU Tourism Dashboard

[151] EU Tourism Platform | EU Tourism Platform

[152] García-León, D., Matei, N.A., e Silva, F.B., Barranco, R., Dosio, A. and Ciscar, J.C., 2025. European tourism demand in the face of climate change: asymmetric impacts, demand reallocation, and deseasonalisation strategies. Environmental Research Letters, 20(2), p.024043.

[153] Booking.com, 2024 - Booking.com Launches the Next Phase of its Sustainability Program for Accommodation Partners

[154] Galati, A., Thrassou, A., Christofi, M., Vrontis, D. and Migliore, G., 2023. Exploring travelers' willingness to pay for green hotels in the digital era. Journal of Sustainable Tourism, 31(11), pp.2546-2563.

[155] European Commission, 2021 - Attitudes of Europeans towards tourism

to **supply**, an increasing number of businesses, including SMEs, recognise the importance of sustainability and seek formal recognition for their efforts. The **EU Ecolabel**[156], a mark of environmental excellence awarded by the EU, or other EN ISO-14024 Type-I ecolabels, serve as instruments to support this transition. The competitiveness of the EU tourism industry will largely depend on its ability to align with these evolving consumer expectations and sustainability requirements.

The European tourism agenda for 2030 also sets out a strategic vision for advancing the **green transition of the tourism ecosystem**, encompassing transport, attractions, and hospitality services. It encourages the creation of conditions and incentives to enhance the circularity of tourism services, including waste management, water conservation, and energy efficiency[157].

Digitalisation

Digitalisation is a key driver of competitiveness and sustainability in the EU's *Coastal tourism* sector. The transition pathway for tourism emphasises the importance of technical implementation for a **tourism data space**, as well as research and investment in innovative digital tools such as virtual reality, augmented reality, and AI. Furthermore, **raising awareness** among SMEs about the benefits of digitalisation is crucial, as it can help them leverage technology to enhance their operations, improve customer experiences, and stay competitive in the market[158].

The increasing prevalence of digitalisation is already having a significant impact on the tourism industry, giving rise to a new paradigm in business operations. A key aspect of this trend is the growing reliance of tourists on online platforms and mobile applications to facilitate various aspects of their travel planning, including searching for destinations; comparing destinations; booking trips, and activities and experiences to enjoy at their chosen location; interacting with businesses in real time; accessing personalised recommendations; and sharing experiences through digital channels.

From a supply perspective, this shift towards digitalisation is driving the transformation of business models, with a greater emphasis on digital presence, online reviews, and sponsored content as key components of marketing strategies.

Climate change

Climate change is projected to have a profound impact on the *Coastal tourism* sector, posing significant challenges to the industry's sustainability and resilience. Rising global temperatures, rising sea levels, and increased frequency of extreme weather events will alter the physical environment, ecosystems, and amenities that underpin *Coastal tourism*. The erosion of beaches and coastal infrastructure is a major concern, as rising sea levels and increased storm intensity will lead to the loss of tourist facilities, such as hotels, restaurants, and recreational areas. Furthermore, the decline or loss of iconic attractions, such as coral reefs, can have a notable impact on the industry.

Changes in water quality and temperature will also have a significant impact on the industry, as decreased water quality and increased risk of waterborne illnesses will make it difficult for tourists to engage in water-based activities.

A study on the regional impact of climate change on the demand for tourism in Europe has shed light on the potential effects of a warmer climate on tourist flows. The study, which simulates future impacts up to 2100, reveals that in a scenario of a 1.5°C temperature increase, only 20% of European regions will experience a minor impact, with tourist numbers remaining relatively stable (changing by -1% to +1%). However, in a high-emission scenario, the consequences are more pronounced. Certain coastal regions will be hit particularly hard, with the Greek Ionian Islands expected to experience a 9.12%-decline in tourist numbers. Additionally, several other popular destinations, including Spain, Italy, Cyprus and Portugal, can expect to lose around 5% of their tourist traffic[159].

The consequences of climate change will be far-reaching, and will affect not only the tourism industry but also the livelihoods of communities that depend on *Coastal tourism*.

In the short term, investments in infrastructure, such as sea walls, dunes, and green roofs, are necessary to protect tourist facilities and amenities. Furthermore, developing and implementing climate change adaptation and resilience plans, including early warning systems and

[156] EU Ecolabel – Tourist accommodation

[157] Council of the European Union, 2022 – European Agenda for Tourism 2030

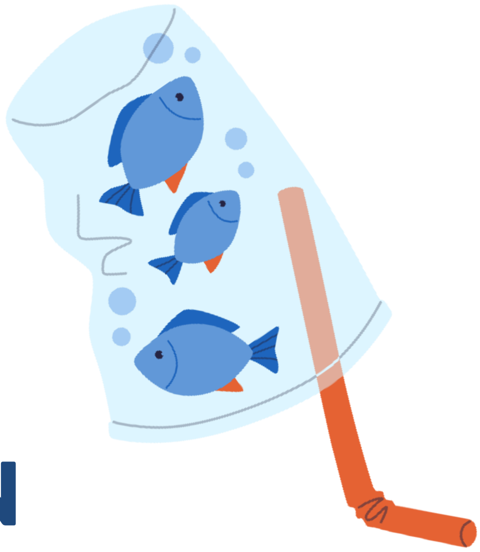
[158] Curtale, R., e Silva, F.B., Proietti, P. and Barranco, R., 2023. Impact of COVID-19 on tourism demand in European regions-An analysis of the factors affecting loss in number of guest nights. Annals of Tourism Research Empirical Insights, 4(2), p.100112.

[159] Joint Research Centre, European Commission, 2023 - Global warming to reshuffle Europe's tourism demand, particularly in coastal areas

emergency response plans, is crucial for minimising the risks associated with climate-related events.

For more information, visit the section on ***Coastal tourism*** within the EU Blue Economy Observatory.

CHAPTER 3. CLIMATE CHANGE, ENVIRONMENTAL IMPACTS AND SUSTAINABILITY IN THE EU BLUE ECONOMY



Europe's seas are experiencing drastic changes due to climate change. These include sea warming, rising sea levels, acidification, deoxygenation, changes in nutrient availability, wind stresses, increasing risk of extreme weather events (e.g. marine heatwaves and Mediterranean hurricanes), changes in surface waves and the mixing layer, and sea ice melting[160].

Besides the threats of ongoing climatic impact drivers, marine ecosystems are already significantly affected by non-climatic impact driver. The cumulative effects undermine their resilience and capacity to provide ecosystem services essential for human life[161].

The EU is making important strides in fostering the transition to a sustainable Blue Economy, based on the agenda outlined in the 2021 Commission communication entitled 'Transforming the EU's blue economy for a sustainable future'[162]. This transition contributes to the dual objectives of making the EU economy more resource efficient, resilient and competitive, while simultaneously reducing net emissions of GHGs and protecting natural capital, as enshrined in the European Green Deal[163].

The European Green Deal[164] serves as a comprehensive roadmap for the EU's achievement of climate neutrality by 2050. A key component of this initiative is the fit for 55 package, which comprises legislation designed to reduce the EU's net GHG emissions by at least 55% by

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[160] IPCC, 2022: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, USA. https://doi.org/10.1017/9781009325844.

[161] EEA (European Environment Agency), Marine messages II: Navigating the course towards clean, healthy and productive seas through implementation of an ecosystem-based approach. https://www.eea.europa.eu/en/analysis/publications/marine-messages-2.

IPBES (2018): The IPBES regional assessment report on biodiversity and ecosystem services for Europe and Central Asia. Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. https://files.ipbes.net/ipbes-web-prod-public-files/2018_eca_full_report_book_v5_pages_0.pdf.

[162] European Commission Communication on a new approach for a sustainable blue economy in the EU "Transforming the EU's Blue Economy for a Sustainable Future" (COM(2021) 240 final).

[163] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions on the European Green Deal. COM(2019) 640. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52019DC0640.

[164] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions on the European Green Deal. COM(2019) 640. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52019DC0640.

2030[165]. This long-term strategy sets out a comprehensive package of measures ranging from ambitious GHG emission reductions to cutting-edge research and innovation in low-carbon technologies, along with efforts to preserve Europe's natural environment[166]. The EU's commitment to achieving climate neutrality by 2050 is driving change and attracting investment in all economic sectors.

Moreover, the pursuit of environmental sustainability is inextricably linked with long-term competitiveness. As outlined in the EU Competitiveness Compass[167], sustainability is a key driver of competitiveness, driving businesses to innovate, reduce costs, and increase their economic resilience. Striving for a clean, energy-efficient, sustainable and circular Blue Economy also offers various opportunities for EU businesses, while contributing to the achievement of the European Greed Deal's ambitious targets. As regards the Blue Economy, the EU acts across all marine-based and related industries to foster innovation, improve economic resilience and increase environmental sustainability. This chapter specifically covers the topics of the energy transition in the maritime transport and fisheries sectors and nature-based solutions (NBS) combating coastal floods.

3.1. ENERGY TRANSITION IN THE EU MARITIME TRANSPORT

Maritime transport is fundamental for the transport of cargo and passengers. In 2022, sea and coastal freight water transport represented 31% of the turnover generated by the different cargo transport modes in the EU, while inland freight water transport represented 1%. Turnover for freight transport by road was the largest, at 62% of the overall cargo transport turnover[168]. The importance of maritime transport for passengers is smaller than for cargo, with sea and coastal passenger water transport representing 9% of the total turnover generated by passenger transport in the EU, and inland passenger water transport representing 1%. Passenger air transport generated 50% of the turnover, interurban passenger rail transport 24%, and interurban road transport 16%[169].

Comparing transport sectors in terms of emissions, emissions per tonne transported declined by 29% for rail transport between 2013 and 2022, as well as for sea and coastal freight water transport and road transport to a smaller extent, with a decrease of 10% and 4%, respectively. In the same period, emissions per tonne increased 30% for inland freight water transport. For sea and coastal freight water transport, emissions were rather stable (-1.2%) between 2013 and 2022, with a slight increase in the cargo weight transported (9.2%) (Figure 41). Moreover, there was an increase in the average distance travelled per tonne of cargo, which does not appear in the graph, but is partly captured in the increase in turnover (+168%).

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[165] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions on Stepping up Europe's 2030 climate ambition Investing in a climate-neutral future for the benefit of our people (COM/2020/562). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52020DC0562.

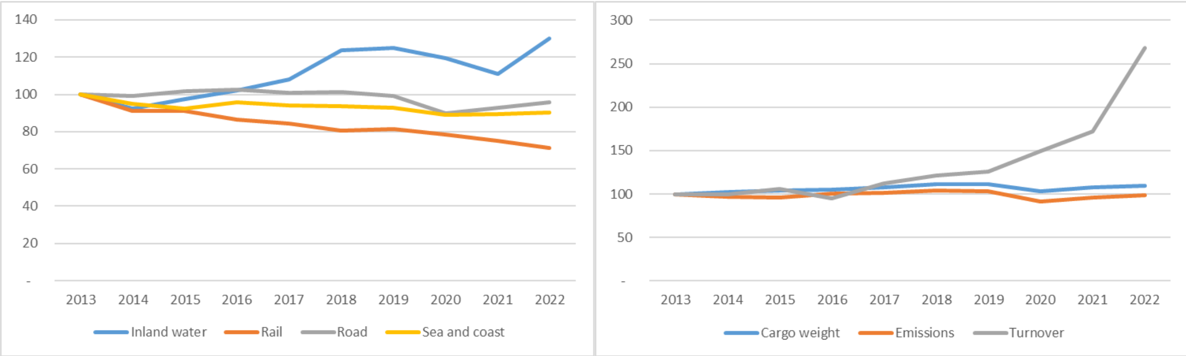
[166] https://ec.europa.eu/clima/policies/eu-climate-action_en

[167] European Commission. A Competitiveness Compass for the EU (COM(2025) 30. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52025DC0030.

[168] Eurostat. https://ec.europa.eu/eurostat/web/structural-business-statistics/database.

[169] Eurostat. https://ec.europa.eu/eurostat/web/structural-business-statistics/database.

Figure 41 - Change in emissions per tonne transported by transport mode (left), and change in sea and coastal freight water transport (weight, emissions and turnover) (right), 2013–2022 (100 = 2013)



Source: Authors' own calculations based on Eurostat data (https://ec.europa.eu/eurostat/web/transport/database) and European Environment Agency (EEA), 'Greenhouse gas emissions from transport in the EU, by transport mode and scenario', EEA website, 4 November 2024, https://www.eea.europa.eu/en/analysis/indicators/greenhouse-gas-emissions-from-transport/greenhouse-gas-emissions-from.

Although maritime transport is one of the most energy-efficient modes of transport, it remains a significant source of GHG emissions. In 2018, international shipping accounted for 1 076 million tonnes of CO_2 emissions, contributing approximately 2.9% to global emissions resulting from human activities. Projections indicate that these emissions could increase by up to 130% by 2050, compared with 2008 levels. Within the EU, maritime transport is responsible for 3-4% of total CO_2 emissions, which translated to over 124 million tonnes of CO_2 in 2021[170].

The European Maritime Transport Environmental Report 2025[171] of the EMSA and the European Environment Agency analyses the maritime transport sector, its environmental impact, the progress it has made so far, and the challenges it faces in terms of decarbonisation, pollution reduction, biodiversity protection, circularity and climate adaptation. On a positive note, the report reveals improvements in specific areas, such as a 70% reduction in SO_x emissions since 2014 thanks to the introduction of the sulphur emission control areas in northern Europe and IMO regulations establishing a maximum sulphur limit globally. However, the report also notes that the sector's overall environmental footprint remains high. The sector's GHG emissions have worsened, with CO_2 emissions increasing steadily since 2015, NO_x emissions rising by 10% across the EU in 2015-2023, and methane (CH_4) emissions doubling between 2018 and 2023. Decarbonising shipping will require a shift in technology and operations and the uptake of alternative fuels[172]. Alternative fuels (nuclear, hydrogen, ammonia, methanol), renewable energy sources (biofuels, wind and solar), the maturation of technologies (fuel cells, internal combustion engines) and technical and operational strategies to reduce fuel consumption for new and existing ships (slow steaming, cleaning and coating, waste heat recovery, hull and propeller design) are needed to decarbonise the shipping sector[173]. These all have implications for the shipbuilding sector in terms of both building new vessels and retrofitting technology in existing vessels.

In 2023, the IMO reached a compromise to achieve net-zero emissions of the global transport fleet by about 2050, and has set a clear timeline. By 2025, mid-term measures must be approved, entering into force by 2027. By 2030, CO_2 emissions must have been reduced by 40%, total GHG emissions by at least 20%, and the uptake of net-zero fuels must have reached at least 5%. By 2040, GHG emissions must have been reduced by 70%[174]. This is in line with the Intergovernmental Panel on Climate Change call to reduce emissions in all sectors, to achieve carbon neutrality in 2050 and to maintain climate change below the target of 1.5ºC.

European technology providers are well positioned to be involved in the future energy transition, although Asian shipyards are also increasing their technological capabilities. There are numerous EU initiatives to support the shipping industry, and in turn the EU's shipbuilding industry along the path to decarbonisation. Through the FuelEU Maritime Regulation, the European Commission – with the EMSA's assistance – aims to increase the use of

[170] https://climate.ec.europa.eu/eu-action/transport/reducing-emissions-shipping-sector_en.

[171] EMSA & EEA. 2025. European Maritime Transport Environmental Report. https://emsa.europa.eu/emter.html.

[172] UNCTAD, 2023. https://unctad.org/system/files/official-document/rmt2023_en.pdf.

[173] https://www.mdpi.com/2077-1312/9/4/415

[174] https://www.imo.org/en/MediaCentre/HotTopics/Pages/Cutting-GHG-emissions.aspx

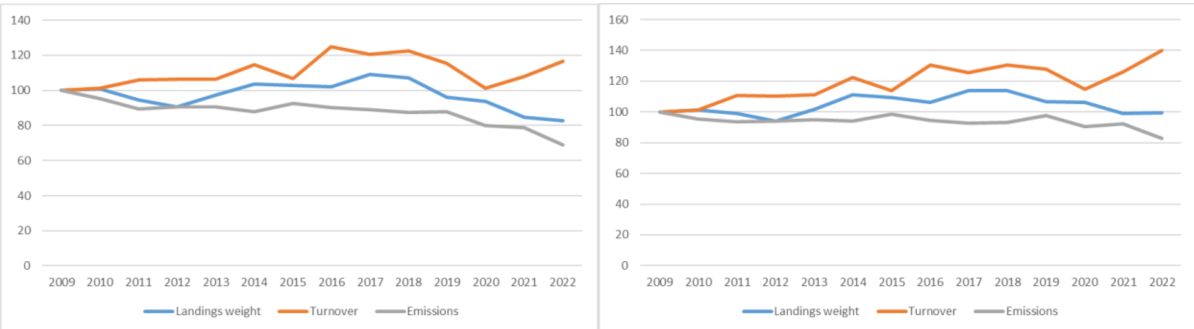
sustainable alternative fuels in European shipping and ports by addressing market barriers and uncertainty over which technical options are market ready. The Net-Zero Industry Act, as part of the Green Deal industrial plan, could enhance the competitiveness of the EU shipping sector by directing essential investments toward clean technologies and the production capacity of shipping fuels[175]. The EMSA provides industry with research on the safety aspects of alternative propulsion technologies[176]. The European Community Shipowners Association is also helping the sector coordinate actions and share information on the development of alternative fuel[177]. Finally, the EU is consolidating its global technical leadership, particularly in LNG infrastructure, which includes a diversity of services from large- to small-scale operations, including LNG terminals, refuelling stations, and refuelling and transhipment processes. Adapting existing infrastructure to carbon-neutral gases with minimal or no modification can help reduce costs and enable efficient decarbonisation[178].

3.2. ENERGY TRANSITION IN THE EU FISHING FLEET

In terms of the energy transition and emission reduction targets, the fishing sector is covered by the Effort Sharing Regulation. The regulation establishes for each Member State a national target for the reduction of GHG emissions by 2030 in a group of sectors that includes fisheries, along with domestic transport (excluding aviation), buildings, agriculture, small industry and waste. In total, the emissions covered by the Effort Sharing Regulation account for almost 60% of total domestic EU emissions. The regulation was amended in 2023, to include new national targets that should collectively contribute to a 40% reduction in emissions compared with 2005 levels in the effort sharing sectors[179].

The EU fishing fleet consumed 1.60 billion litres of fuel to land 3.5 million tonnes of fish valued at 6.6 billion at the first sale in 2022. This fuel consumption led to the emission of roughly 4.2 million tonnes of CO_2. Between 2009 and 2022, fuel consumption and therefore CO_2 emissions decreased by 31%, while fish landings in weight decreased by 17%, despite increasing by 17% in value (Figure 42).

Figure 42 - Change in landings weight, turnover and emissions, in total (left) and per vessel (right), 2009–2022 (100 = 2009)



Source: Authors' own calculations based on Scientific, Technical and Economic Committee for Fisheries (STECF), The 2024 annual economic report on the EU fishing fleet, Publications Office of the European Union, Luxembourg, 2024.

The EU fleet has become more efficient over the years, as emissions have decreased faster than the weight of landings, and the value of landings has even increased.

Fuel use and efficiency indicators for the fisheries sector can be defined as follows:

- **Fuel use intensity** or **fuel use per kg of fish** is defined as the ratio between the quantity of fuel

[175] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan/net-zero-industry-act_en

[176] https://emsa.europa.eu/publications/reports.html

[177] https://www.ecsa.eu/index.php/resources/race-zero-emission

[178] https://www.ngva.eu/wp-content/uploads/2022/05/Fuelling-clean-mobility-with-bio-LNG_EBA-GIE-NGVAEurope-SEA-LNG_May2022.pdf.

[179] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32023R0857, https://climate.ec.europa.eu/eu-action/effort-sharing-member-states-emission-targets/effort-sharing-2021-2030-targets-and-flexibilities_en.

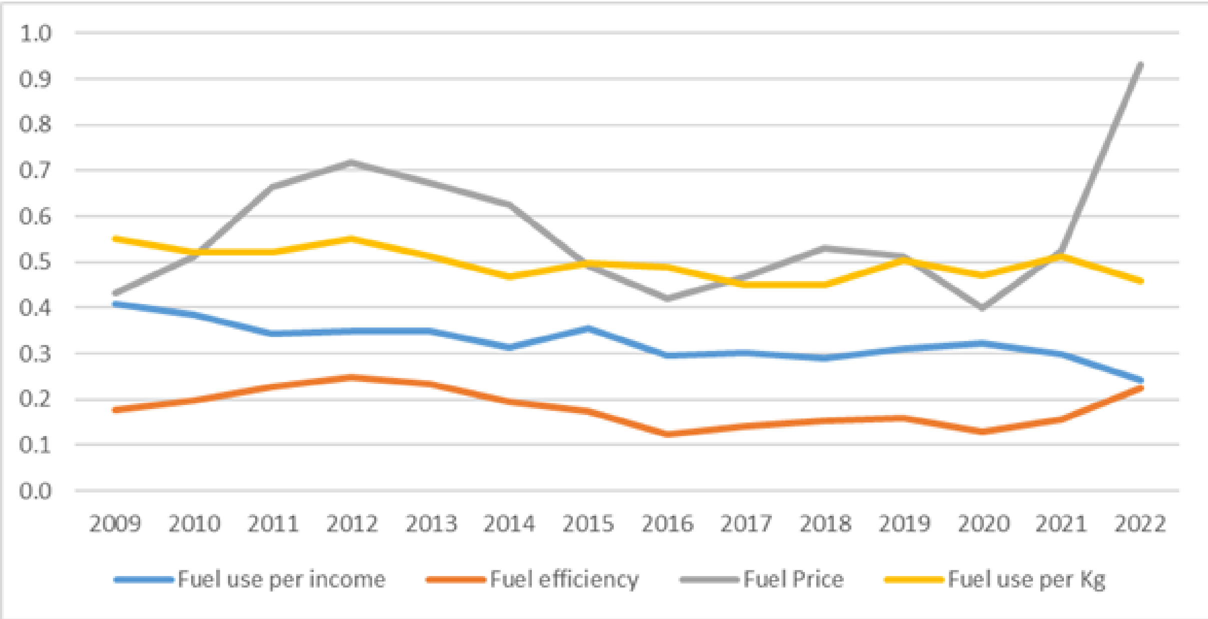
consumed and the quantity of fish landed, expressed in litres per kg;

- **Fuel efficiency** is defined as the ratio between fuel costs and income from landings, expressed as a percentage;
- **Fuel use per income generated** is defined as the ratio between the quantity of fuel consumed and the value of landings, expressed in litres per euro.

The fuel efficiency indicator that compares fuel costs with the income from landings has increased in recent years because of rising fuel prices. Fuel price increases lead to higher fuel costs, worsening economic efficiency. The lower the percentage, the more fuel efficient the vessel (i.e., less income is used to cover fuel costs). Fuel costs as a proportion of income were estimated at 22% in 2022, the highest historical value since 2013.

On the other hand, Fuel use per kg of fish shows how much fuel is needed to land a kg of fish. This indicator confirms a decreasing trend, so 17% less fuel was needed to land a kg of fish in 2022 (0.46 litres/kg), than in 2009 (0.55 litres/kg).

Figure 43 - Change in fuel intensity (l/kg), fuel efficiency (%), fuel use per income generated (l/EUR) and fuel price, 2009–2022



Source: Authors' own elaboration based on STECF, The 2024 annual economic report on the EU fishing fleet, Publications Office of the European Union, Luxembourg, 2024.

On average, seafood has a lower carbon footprint than animal production on land; however, emissions vary significantly by fishing method and species targeted[180]. Depending on the fishery, fuel use intensity can vary from less than 1 l/kg to up to 10 l/kg[181]. According to studies at the global level, fish species associated with the highest fuel use intensity are high-value crustaceans captured with traps and lift nets (2-5 l/kg). Flatfish fishing and the use of bottom trawls are also related to higher fuel use intensities (1-3 l/kg), while cheaper small pelagic fishing and the use of surrounding nets and pelagic trawling are related to low fuel intensity (below 0.2 l/kg)[182]. Fishery management can also affect emissions, since overfished stocks require more fuel than sustainably managed resources to catch the same amount of fish[183].

[180] Bianchi, M., Hallström, E., Parker, R. W., Mifflin, K., Tyedmers, P., & Ziegler, F. (2022). Assessing seafood nutritional diversity together with climate impacts informs more comprehensive dietary advice. Communications Earth & Environment, 3(1), 188. https://www.nature.com/articles/s43247-022-00516-4.

[181] https://www.europarl.europa.eu/RegData/etudes/STUD/2023/740225/EPRS_STU(2023)740225_EN.pdf.

[182] https://www.europarl.europa.eu/RegData/etudes/STUD/2023/740225/EPRS_STU(2023)740225_EN.pdf.

[183] https://www.europarl.europa.eu/RegData/etudes/STUD/2023/740225/EPRS_STU(2023)740225_EN.pdf.

3.3. ENERGY TRANSITION PARTNERSHIP IN FISHERIES AND AQUACULTURE: TOWARDS A ROADMAP FOR THE ENERGY TRANSITION

The high fossil fuel dependency of the EU's fisheries and aquaculture sector, makes the sector economically vulnerable to increases in fuel prices and reduces the sustainability of fisheries and aquaculture products. To ensure the long-term resilience and sustainability of the EU's fisheries and aquaculture sector, there is a need to improve the energy efficiency of the sector in the short to medium term and to prepare the sector for the transition to alternative and low-carbon energy sources to achieve a resilient and climate-neutral sector by 2050.

The energy transition in the EU fisheries and aquaculture sector serves the dual objective of (i) increasing the socio-economic resilience of the sector by reducing its high dependency on fossil fuels and thereby the impact of its fluctuating prices and (ii) assuring the appropriate contribution of the sector to the EU's green ambitions by eliminating its net GHG emissions, including indirect emissions related to operations. The objectives follow from those set out in the communication on the energy transition in EU fisheries[184], published in February 2023 as part of the fisheries and ocean package[185].

The challenge of the energy transition in the EU fisheries and aquaculture sector cannot be faced by one player alone; it requires the involvement, willingness, coordination, and collaboration of a wide range of stakeholders. The Energy Transition Partnership is a multi-stakeholder platform that aims to improve this necessary stakeholder collaboration, with the objective of facilitating and promoting cooperation, knowledge sharing and dialogue between all private and public stakeholders, who need to act together to accelerate the energy transition in the sector.

By the first quarter of 2026, the European Commission will develop, in close cooperation with the Energy Transition Partnership, a roadmap for the energy transition of the EU fisheries and aquaculture sector towards climate neutrality by 2050. This roadmap will be one of the main deliverables of the partnership and will outline investments needs, discuss sector initiatives and inform policy decisions to help achieve the energy transition.

Box 3 -Nature-based solutions

Oceans are a great carbon sink, absorbing excess heat and energy released from rising GHG emissions. Seaweed cultivation can be an effective NBS, as in addition to being a source of food and energy, and having other uses, its production contributes to carbon sequestration and ecosystem restoration. Macias et al. have assessed the environmental suitability of EU marine regions for seaweed cultivation, showing that Atlantic regions are the most suitable areas for seaweed cultivation, particularly for cold-water and intermediate-water species. Moreover, taking a precautionary approach by using only 1% of the suitable area and considering logistical constraints (water depth and distance to coast), seaweed production in Member States' waters could reach about 5.5 million tonnes, assimilating about 1.9 million tonnes of carbon, 225 000 tonnes of nitrogen and 24 000 tonnes of phosphorous per year over an area of about 1 900 km^2.

In implementing the **strategic guidelines for a more sustainable and competitive EU aquaculture**, the European Commission published a staff working document[186] on the energy transition of EU aquaculture in December 2024. The aim of the document is to provide information on energy efficiency and on the use of renewable sources of energy in aquaculture production. It provides an overview of the energy used in different production systems, the technologies that can be applied, and good practices. The document also aims to provide relevant information for the purposes of developing the roadmap for the energy transition initiative.

For more information, please visit the section on ***Energy Transition*** within the EU Blue Economy Observatory.

[184] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS On the Energy Transition of the EU Fisheries and Aquaculture sector. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52023DC0100.

[185] https://ec.europa.eu/commission/presscorner/detail/en/IP_23_828.

[186] https://aquaculture.ec.europa.eu/key-documents/energy-transition-eu.

Box 4 - Impacts of climate change over water scarcity

The impacts of climate change are expected to exacerbate water scarcity in the EU, particularly in southern and south-western European regions, where river discharge could decrease by up to 40% by 2050. Recently, Macias et al. estimated that such a reduction in river flow may result in a 10%-decline in marine primary productivity and a 6%-decrease in the biomass of commercial marine species in the Mediterranean Sea; however, local and regional reductions could be much higher, disrupting coastal and marine ecosystems together with their related socio-economic sectors.

3.4. CLIMATE CHANGE AND NATURE-BASED SOLUTIONS TO COASTAL FLOODING IN EUROPE

According to the 2023 Blue Economy Report, coastal flooding currently causes economic damages of **EUR 1.2 billion per year in the EU**. To put this into perspective, this amount is roughly one sixth of the total budget allocated to the EMFAF. Additionally, approximately **72 000 people in the EU are affected by coastal flooding each year**. If coastal protection measures remain unchanged, the economic impact of coastal flooding is expected to increase significantly due to global warming, affecting all Member States with a coastline. **By 2100,** annual damages could reach EUR 1 trillion, with 3.9 million people exposed to coastal flooding every year in Europe. Between **EUR 137 billion** (moderate-emission scenario) **to EUR 814 billion** (high-emission scenario) of these **annual damages could take place in the EU**, depending on the severity of climate change[187].

Regarding investments and climate financing, the average annual cost of adaptation for the EU-27 is estimated at EUR 1.8 billion per year under a high emissions scenario and EUR 1.1 billion per year under a moderate mitigation scenario for 2020-2100. Notably, the cost of enhancing coastal protection is considerably lower than the potential reduction in annual flood losses by the end of the century. This highlights the substantial and increasing long-term benefits of investing in coastal protection now, demonstrating that spending on adaptation and coastal defence in the EU is highly cost-effective.

As climate change accelerates the rise in sea levels and intensifies coastal hazards, societies will actively adapt to protect assets and livelihoods from flooding and erosion. NBSs have been gaining increasing attention as a resilient and adaptable strategy for safeguarding coastlines. Compared with traditional engineering approaches, they can be more sustainable and cost-effective, leveraging natural processes and ecosystems such as wetlands, mangroves, dunes, and reefs, to reduce the impacts of coastal flooding and erosion while simultaneously enhancing biodiversity and supporting local communities. By integrating ecological restoration with human infrastructure needs, these approaches not only provide physical protection but also contribute to carbon sequestration, water quality improvement, and recreational opportunities, making them a holistic solution for coastal resilience.

Current state of Nature-based solutions practice

Evidence from Europe shows that most NBS projects were implemented from 2002 onwards, with a significant increase between 2005 and 2015. The Netherlands and the United Kingdom have the most documented case studies, with public funding being the most common source. Although 81% of case studies reported monitoring efforts, more than half did not provide information on flood or erosion effectiveness. Nonetheless, many NBS projects report multiple co-benefits, including biodiversity conservation, recreation, flood reduction, and tourism.

Bioinspired design also plays a role in developing NBSs, utilising problem-based and solution-based approaches. While many studies report positive outcomes, some findings indicate negative, neutral, or mixed results, particularly in terms of sediment and morphology. This highlights that NBSs may not always fully achieve coastal protection goals, highlighting the need for ongoing research and adaptive management[188].

Nature-based solutions in view of rising seas from a European perspective

Coastal adaptation pathways typically include three main strategies: protect, accommodate, and retreat. Protection involves constructing physical barriers to defend against coastal flooding and erosion, thus safeguarding human

[187] European Commission: Joint Research Centre, Feyen, L., Ciscar, J., Gosling, S., Ibarreta, D. et al., Climate change impacts and adaptation in Europe – JRC PESETA IV final report. Publications Office, 2020, https://data.europa.eu/doi/10.2760/171121; Managing climate risks - protecting people and prosperity. COM/2024/91 final. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52024DC0091; EEA. 2024. European Climate Risk Assessment. https://www.eea.europa.eu/en/analysis/publications/european-climate-risk-assessment.

[188] European Commission: Joint Research Centre, Feyen, L., Ciscar, J., Gosling, S., Ibarreta, D. et al., Climate change impacts and adaptation in Europe – JRC PESETA IV final report. Publications Office, 2020, https://data.europa.eu/doi/10.2760/171121.

settlements and infrastructure. Accommodating means adjusting human activities and infrastructure to adapt to changing coastal conditions, for example elevating buildings and enhancing drainage systems to manage flood risks. Retreating involves the strategic relocation of people, assets, and infrastructure away from vulnerable coastal areas to safer inland locations, allowing natural coastal processes to occur without human interference.

NBSs often involve a loose combination of the three strategies. Some level of retreating is necessary to generate space so that natural elements can offer their protective services. Further, when NBSs are applied, the capacity of a given area to accommodate flooding increases, and in many cases NBSs offer protection, absorbing the energy of storms and even acting as a natural block to floods. The methodology for assessing the costs and benefits of NBS projects has recently become better formalised, and several cases studies even **report benefits exceeding the costs by more than five times**[189].

Europe's coastline is remarkably diverse, characterised by significant variations in wave energy, tidal range, and storm exposure. Along the Atlantic coast, powerful waves generated by the North Atlantic Ocean influence regions such as the west coasts of France, Ireland and Portugal, creating high-energy environments ideal for dynamic coastal landforms like cliffs and sandy beaches. In contrast, the Mediterranean coastline experiences relatively lower wave energy due to its enclosed basin, resulting in calmer waters and more sheltered coastal features. Tidal ranges also vary widely across Europe, from extreme tidal fluctuations exceeding 10 metres in the United Kingdom (e.g. the Severn Estuary) to minimal tidal changes in the Mediterranean Sea. In addition, Europe's coastlines face diverse storm patterns, with frequent and intense winter storms affecting the Atlantic and North Sea coasts, whereas the Mediterranean is more prone to shorter, more intense rainstorms and occasional 'medicanes' (Mediterranean hurricanes). This complex interplay of waves, tides, and storms shapes Europe's coastal landscapes and influences its ecosystems, and as a result defines the nature of adequate NBS approaches at each region[190].

Wave-dominated coastlines require structures strong enough to sustain the impact of waves, and therefore soft vegetation cannot offer any substantial protection. This implies that salt marshes and sea grass meadows could mainly serve as a complementary, 'second line of defense', behind beaches and other protective structures, or in estuaries. Coral reefs can dissipate waves but their species cannot survive in Europe's conditions. The same can be said for mangroves, and as a result both could be possible avenues to explore in the outermost regions of continental Europe or overseas territories.

Data shows that, worldwide, only a small part of the coastline is protected by vegetation and coral reefs, and there is a clear tendency for natural sandy beaches to be replaced by managed ones. Europe's coastline is densely populated and has already undergone several interventions, losing its natural protective capacity. The discussion above indicates that well-planned interventions are needed, rather than 'leaving nature alone to act'.

In previous Blue Economy Reports we reported clear economic motivations for investing in coastal adaptation, as the benefits of immediate action outweighed the costs, even when high discount rates were considered. The previous analyses were based on unit cost values for traditional interventions providing coastal protection, which are expected to be slightly lower than those for NBSs. However, our previous estimates entail a high range of uncertainty, so the previous conclusion of undisputed economic motivation for adaptation also applies to the case of NBSs, especially in the parts of the European coastline that hosts built-up areas. This conclusion is justified by existing studies, which report that **the benefits of NBSs outweigh the costs by at least three times**[191].

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[189] Boris van Zanten, Gonzalo Gutierrez Goizueta, Luke Brander, Borja Gonzalez Reguero, Robert Griffin, Kavita Kapur Macleod, Alida Alves, Amelia Midgley, Luis Diego Herrera, and Brenden Jongman. 2023. Assessing the Benefits and Costs of Nature-Based Solutions for Climate Resilience: A Guideline for Project Developers. World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO

[190] European Commission: Joint Research Centre, Feyen, L., Ciscar, J., Gosling, S., Ibarreta, D. et al., Climate change impacts and adaptation in Europe – JRC PESETA IV final report. Publications Office, 2020, https://data.europa.eu/doi/10.2760/171121.

EEA. 2024. European Climate Risk Assessment. https://www.eea.europa.eu/en/analysis/publications/european-climate-risk-assessment.

[191] https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0192132

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