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Blue Economy and Innovation

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There is no unique definition for the term Blue Economy. In the narrowest sense, the term Blue Economy refers to the collection of a number of economic sectors connected to the ocean, seas and coasts, as e.g. defined in [Bilsen et al. \(2019\)](#) or [De Backer \(2017\)](#). This description includes sectors directly active in the marine and coastal environment (such as fishing or maritime transport) as well as land-based sectors with a clear link to marine activities (such as shipbuilding or port activities). The Blue Economy is thus a multi-sectoral and constantly, dynamically evolving part of the economy, where newer sectors such as renewable offshore energy and blue biotechnology, are standing side by side with the more traditional sectors like fishing and maritime transport.

Broader than just the economic aspect, it can be argued that the Blue Economy doesn't only include industries, but also the natural resources and ecosystem services provided by the ocean (such as sea food production or CO₂ capture) ([OECD 2016](#)). The origin of this broader interpretation of the Blue Economy can be traced back to the United Nations Conference of 2012 (RIO +20) ([Eikeset et al. 2018](#))¹. Also the United Nations Conference on Trade and Development ([UNCTAD 2014, 2018](#)), the Food and Agriculture Organization of the United Nations ([FAO 2018](#)), the World Bank ([2017](#)) and the High Level Panel for a Sustainable Ocean Economy ([Stuchtey 2020](#)) are examples of organisations that follow this broader interpretation, with two pillars within the Blue Economy: the ecological and the economic aspects. A similar evolution is noticeable at the European level where the Blue Growth strategy, as launched in 2012 (COM (2012) 494), has evolved over the years towards the development of a sustainable Blue Economy as recently confirmed in a new communication (COM (2021) 240). In this last communication, the Blue Economy is put forward as one of the carriers of both the Green Deal (COM (2019) 640) and the European recovery strategy (COM (2020) 442). The ocean and its economy are seen therein as indispensable to achieving the environmental and climate goals. In this context, the Blue Economy is also an essential element in the pursuit of the Sustainable Development Goals (SDGs) defined in the United Nations Agenda 2030. At first, there is a link with SDG 14 'Life below water - Conserve and sustainably use the oceans, seas and marine resources for sustainable development'. There is also a link with other SDGs, such as responsible production and consumption (SDG 12), affordable and clean energy (SDG 7) and zero hunger (SDG 2). A literature review on the link between the Blue Economy and the SDGs was made by [Lee et al. \(2020\)](#).

Innovation is crucial for both the established and emerging marine and maritime sectors in order to grow in a sustainable way (see, among others, [OECD 2019](#)). In this context, the North Sea Vision 2050 ([De Backer 2017](#)) promotes not only technological innovations, but also social and policy innovation.

Sectors within the Blue Economy

The sectors that are part of the Blue Economy are not firmly set, and the classification and naming of these sectors may differ between approaches and reports (e.g. the socio-economic reports in the framework of the Marine Strategy Framework Directive (MSFD, Directive 2008/56/EC) ([Belgian State 2018](#)) or the reports from the European Commission (EC) (e.g. [EC 2018](#), [EC 2019](#)) or the Organisation for Economic Cooperation and Development ([OECD 2016](#))). In the present text, the sectors as named in the EU Blue Economy Report ([EC 2021](#)), will be used as a uniform framework (table 1).

The total collection of sectors that make up the Blue Economy is also subject to change. An illustration of this is the offshore wind energy sector, which has evolved from an 'emerging' to an 'established' sector (figure 1). It should also be noted that the qualification of sectors as 'emerging' in the context of the EU Blue Economy reports may also be a reflection of the lack of qualitative data.

15.1 Policy context and actors

15.1.1 Global and European policy context and policy actors

The United Nations Convention on the law of the sea ([UNCLOS 1982](#)), which also codified previous generally accepted legal practices, constitutes the current global legal framework for marine and maritime activities. This convention regulates a number of important uses of marine areas and the extent to which a coastal state or a port state (of ships) can have control over those activities. One example is the spatial zoning from the coast with the concept of the Exclusive Economic Zone (EEZ), which is connected to the territorial waters (to which the coastal state has all sovereign rights). The EEZ is the zone within which a coastal state also has all exclusive rights to exploit or conserve resources located in the water, on the seabed or beneath the seabed (RD of 22 April 1999).

¹ In a 2010 publication by the [Club of Rome](#), the Blue Economy is defined even more broadly as a collection of nature-based solutions with a positive impact on the global economy (linked also to the definition of the Green Economy, see [Kettunen and Ten Brink 2012](#) and [Silver et al. 2015](#)). Please note that this definition of the term Blue Economy is not linked to the marine and maritime aspect and is not considered further in the present thematic chapter.



Figure 1. Overview of emerging and established sectors (based on the EU Blue Economy Report for the period 2018-2021 (EC 2018, 2019, 2020 and 2021)). *Coastal defense is not included in the reporting as a separate sector after 2018.

UN organisations operate as regulators for certain aspects of the Blue Economy, such as the International Maritime Organization (IMO) for shipping and the International Seabed Authority (ISA) for the use of minerals from the area beyond state control. Affiliated with the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Intergovernmental Oceanographic Commission (IOC) functions as a hub for the promotion of marine scientific research that is indispensable to the “environmental” pillar of sustainable development (see thematic chapter **Integrated maritime policy**).

At the European level, within the EC (with some powers of ‘executive’ within the EU), the Directorate-General for Maritime Affairs and Fisheries (DG MARE) is responsible for policy preparation and implementation on Blue Economy. The Blue Economy has been on the agenda since the Strategic Objectives 2005-2009, published in 2005 (COM (2005) 12), which expressed the need for an all-encompassing maritime policy, with a view to developing the Blue Economy. This was followed by the publication of the Integrated Maritime Policy (COM (2007) 575), which represents a holistic approach to all EU maritime policy matters. The Blue Growth Strategy (COM (2012) 494) is

the long term strategy for sustainable growth in the marine and maritime sector. Through further iterations (figure 2) this evolved towards the 2021 Communication, on a new approach to a sustainable Blue Economy in the EU (COM (2021) 240). This Communication sets out a detailed agenda that supports the green transition, replacing uncontrolled expansion with clean, climate-resilient and sustainable activities. Therein, the Blue Economy is seen as essential to achieving the ambitions of the European *Green Deal* (COM (2019) 640). These include climate

Table 1. Overview (emerging and established) Blue Economy sectors (sectors and description according to the EU Blue Economy Report 2021 (EC 2021)).

Sector	Short description of the sector	Relevant thematic chapters in the Knowledge Guide Coast and Sea 2022	Link with Blue Cluster domains*	Link with OECD sectors (OECD 2016)**
Marine living resources	Includes the exploitation of biological resources, their conversion into food, feed, bio-based products and bioenergy (processing) and their distribution along the supply chain. Within European reporting, fisheries and aquaculture are counted together here. The other sectors from the overarching blue bioeconomy, in particular biotechnology and bioenergy, are further included as emerging sectors.	Fisheries; Marine aquaculture	Sustainable seafood and marine biotechnology (incl. bioprospecting)/ Ecosystem approach	<i>Capture fisheries; Seafood processing; Marine aquaculture (emerging)</i>
Marine non-living resources	Includes oil and gas exploitation, the extraction of marine aggregates (sand and gravel), clays and salt, as well as support activities for these. Exploitation of other mineral deposits such as manganese or cobalt is included under the emerging sector of marine minerals	Sand- and gravel extraction	Coastal protection and use of mineral resources (excl. oil and gas)	<i>Marine and seabed mining; Offshore oil and gas</i>
Marine renewable energy (offshore wind)	Includes the production and transmission of electricity, based on offshore wind energy. Other forms of ocean energy, such as wave or tidal energy, for example, are considered emerging sectors	Energy (including cables and pipes)	Renewable energy & freshwater production	<i>Offshore wind energy</i>
Port activities	Includes cargo handling and storage as well as hydraulic engineering and service activities related to water transportation	Maritime transport, shipping and ports; Dredging and dumping	Maritime connection (excl. Port logistics)	<i>Ports</i>
Shipbuilding and repair	Includes building, repairing and maintaining ships; as well as manufacturing equipment and machinery	-	Maritime connection (incl. clean and smart shipping; Smart seas)	<i>Shipbuilding and repair</i>
Maritime transport	Includes both passenger and freight transportation, as well as the provision of equipment for water transportation and support activities	Maritime transport, shipping and ports	Maritime connection	<i>Shipping</i>
Coastal tourism	Includes accommodation, transportation and other activities (including sale of goods and catering)	Tourism and recreation	Blue tourism	<i>Maritime and coastal tourism</i>
Ocean energy	Includes technologies for renewable energy production, excluding offshore wind energy (with a foundation on the seabed); ocean energy (tidal and wave energy, thermal energy conversion, salt gradient), floating solar photovoltaic (FPV), floating wind energy and renewable hydrogen production offshore.	Energy (including cables and pipes)	Renewable energy and freshwater production	<i>Ocean renewable energy</i>
Blue bio-economy and biotechnology	Includes all living marine resources that are not traditionally commercially exploited, such as algae or bacteria.	Marine aquaculture	Sustainable seafood and marine biotechnology	<i>Marine biotechnology</i>

Sector (continuation)	Short description of the sector	Relevant thematic chapters in the Knowledge Guide Coast and Sea 2022	Link with Blue Cluster domains*	Link with OECD sectors (OECD 2016)**
Desalination	Includes desalination of brackish and salt water	-	Renewable energy & freshwater production	-
Marine minerals (other than aggregates)	Includes, in addition to the extraction of elements dissolved in seawater (e.g. salt and potassium), the extraction of minerals and metals in or on the seabed such as, for example, manganese, titanium, etc.	-		Marine and seabed mining
Maritime defense, security and surveillance	Includes maritime defense, which refers primarily to the Marines, as well as the sectors of maritime security and surveillance.	Military use	Smart seas	Maritime safety and surveillance
Research and education	Includes the research and innovation, related to the Blue Economy	Indicator report Marine Research and Innovation 2018 (Pirlet et al. 2018)	All domains	Marine R and D and education
Infrastructure	Includes submarine cable and robotics sectors	Energy (including cables and pipes)	Renewable energy & freshwater production (incl. hybrid grids); Smart seas	Marine manufacturing and construction; high tech marine products and services

* For more nuance and details on the thematic links, the Blue Cluster [innovatieroadmaps](#) can be consulted.

** Not all OECD sectors are included in this table.

neutrality and zero pollution, the transition to a circular economy, the preservation of biodiversity and investment in nature, sustainable food production and improved marine spatial management. To drive investments towards the realisation of these goals and a sustainable Blue Economy, the EC released the [BlueInvest report](#) (2023).

At the EU level, there are several further generic legislative and policy instruments that are relevant to the Blue Economy. The most pertinent instruments are listed in the [Legislation reference list](#) and figure 2. Sector-specific regulations are addressed in the relevant thematic chapters of the [Knowledge Guide Coast and Sea 2022](#) (Dauwe et al. 2022).

Europe also identifies Blue Innovation as a key component of the Blue Economy (COM (2014) 254). As such, within the Horizon Programme 2021-2027, new partnerships are being established (including the Sustainable Blue Economy Partnership and the European Partnership on zero-emission waterborne transport). These collaborations between the EU, national authorities and the private sector support a program of research and innovation. These partnerships replace previous forms of financial cooperation between the EU and member states (such as the European Research Area Network (ERA-Net) Cofund scheme). The proposed partnership 'A climate neutral, sustainable and productive Blue Economy', with focus on the Blue Economy, published its draft Strategic Research and Innovation agenda in 2021 ([Horizon Europe Candidate Partnership 2021](#)). In addition, the so-called Missions are introduced for the first time. These missions will provide concrete solutions by 2030 in order to take major steps forward on five specific themes. This new concept tries to ensure focus and cooperation from the research and innovation policy perspective so that the necessary efforts, such as funding programs, policies and regulations, citizen participation etc. are facilitated with specific goals as a result (COM (2021) 609). The mission [Restore our Ocean and Waters by 2030](#) specifically focuses on research and innovation around marine and freshwater environments (see thematic chapter [Integrated maritime policy](#)).

The importance of innovation at European Union level is further underlined by the ambition, stated in the [Strategic innovation agenda 2021-2027](#), to launch a new Knowledge and Innovation Community (KIC) on water, marine and maritime sector and ecosystems in addition to existing KICs such as those on climate, raw materials or food, within the European Institute of Technology (EIT). However, this KIC is currently still a pipe dream.

15.1.2 Belgian, Flemish and local policy contexts and actors

For Belgium, the special Law of 8 August 1980 defines the division of powers between the federal and regional authorities. The management of the Belgian part of the North Sea (BNS) is a federal competence whereby the minister of the North Sea plays a central role in the roll-out and coordination of economic activities at sea. In the North Sea Policy Statement ([Van Quickenborne 2020](#)), the Blue Economy (in general) and specifically Blue Energy are put forward as two of the five pillars for the North Sea policy. It is also stated that these will be based on the

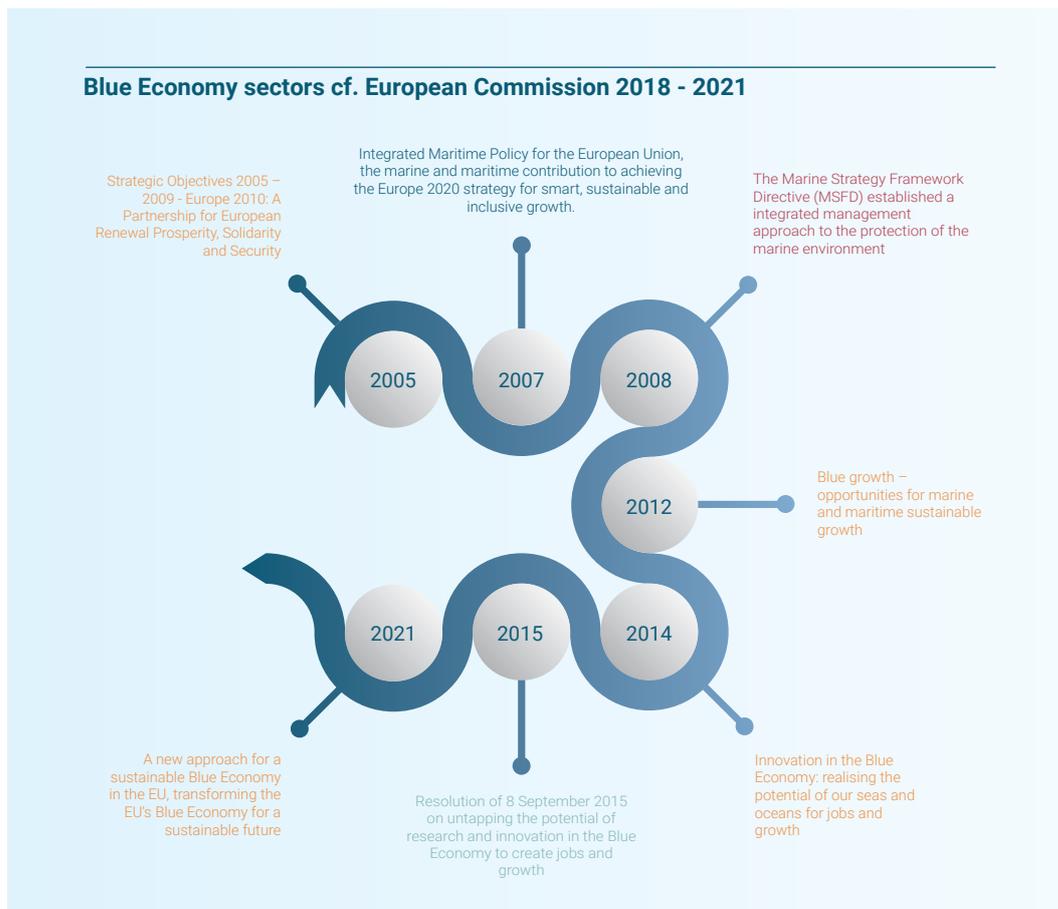


Figure 2. Timeline of EU policies on Blue Economy.

science-based policy principle.

The Flemish Region is competent for a number of the activities within the economic sectors that are exercised on the BNS, namely sea fisheries, (coastal) tourism and the seaports (including the maritime access to these seaports). For an overview of the respective federal and Government of Flanders' services involved in specific aspects of the Blue Economy, we refer to the relevant thematic chapters in the **Knowledge Guide Coast and Sea 2022** (Dauwe et al. 2022).

On the Flemish level, the policy domain of Economy, Science and Innovation (EWI) is increasingly focusing on Blue Economy and Innovation themes. An important instrument in this context is the so-called cluster policy (see the cluster Decision of 4 March 2016) that provides a framework for collaborations between Flemish companies around innovation and development, coordinated by the Flanders Innovation and Entrepreneurship Agency (VLAIO). Currently, two types of clusters are operational: the innovative business networks (IBN) and the spearhead clusters (with seven active clusters). The latter operate on a larger scale than the business networks and are responsible for realising, in a triple helix cooperation, an ambitious long-term strategy and competitiveness programme. In 2018, a spearhead cluster for the Blue Economy was established: The Blue Cluster (DBC). This cluster currently brings together over 180 companies and partners, including the members of the former Flanders Maritime Cluster (FMC) and IBN Offshore Energy (both incorporated in The Blue Cluster) and the members of the Belgian Offshore Cluster (BOC). The Blue Cluster works on six thematic areas, namely: sustainable seafood and marine biotechnology, blue tourism, coastal protection and use of mineral resources, renewable energy and freshwater production, ocean pollution and waste solutions and maritime connection (table 1). In addition to these domains, there are two transversal domains on ecosystem approach and the smart sea concept. Within the policy domain of EWI, there is also an active commitment to marine research and innovation through thematic calls via the Fund for Scientific Research (FWO) and VLAIO (e.g. the thematic call on blue bioeconomy (2020), in the context of the [Flemish policy plan on bioeconomy \(2020\)](#)). An overview of the Flemish Blue Research and Innovation System, linked to the objectives of the UN Decade for Ocean Science, is given in (EWI/VLIZ/DBC 2021).

Furthermore, the Flanders Marine Institute (VLIZ) acts as the marine research platform within Flanders by actively mapping the wider research community of universities and knowledge institutions (Pirlet et al. 2021), supporting them with infrastructure and representing them. In doing so, VLIZ also has a specific mission to conduct research and innovation that can be valorised by actors in the Blue Economy.

In addition to the Flemish and federal level, the Blue Economy is a sector that also has links with policy actors on a provincial and local level. In West Flanders, the Blue Economy is supported by the West Flanders Development Agency (*POM West-Vlaanderen*), which has set up so-called 'Factories for the Future', which are committed to, among other things, [Blue Energy](#). Companies, government and research institutions work together in the development of test platforms at the international level (for example the [Blue Accelerator](#) test platform). Furthermore, the Technical University Alliance for Economic Transformation in West Flanders (*TUA West*) is an external agency of the province of West Flanders that brings companies, knowledge institutions and governments together in a triple helix configuration and where [Blue Energy](#) is one of the focal points.

The local and (sub-)regional initiatives and actors in Blue Economy and Innovation are geographically linked to the Flemish seaports (see also thematic chapter **Maritime transport, shipping and ports**). For example, in Antwerp there is the [Maritime Campus Antwerp](#), which connects sustainable and water-related companies and houses companies and research institutions (incl. laboratories, workshops and R&D halls). The [Port of Antwerp](#) has opened up the port area as a testing ground for new ideas and projects and has a collaboration agreement with the University of Antwerp where research projects are set up on subjects such as autonomous sailing or water quality in the docks.

[Port Oostende](#) is actively engaged in the sector of renewable offshore energy, with, among others, the development of the REBO heavy lift terminal. [Ostend Science Park](#), a collaboration between Ghent University, the West Flanders Development Agency, and Port Oostende, is developing a science park where companies linked to the Blue Economy can make use of test facilities and know-how, including the [Flanders Maritime Laboratory](#). The headquarters of Ostend Science Park, [Bluebridge](#), functions as an incubator for innovative companies from the Blue Economy. Near port Oostende, the InnovOcean Campus is located, the joint home of VLIZ and the Ostend branch of the Research Institute for Agricultural, Fisheries and Food (ILVO), which will be inaugurated in 2022. The Eguermin site also hosts the Naval Mine Warfare Centre of Excellence (NMWCO) and the Ostend branch of the Operational Directorate Natural Environment of the Royal Belgian Institute of Natural Sciences (RBINS-OD Nature).

North Sea Port Flanders (port area of Ghent) is committed to sustainability, with investments in circular energy projects, climate and energy ([North Sea Port 2021](#)), among others. In Zeebrugge, the private sector within the port has united in the Association Port of Zeebrugge Interests (APZI). Furthermore, the [Port of Zeebrugge](#) is also committed to innovation, working on the rollout of a 5G network in the port and there is a link with innovations from the naval component of Belgian Defense, which has its home base there.

15.2 Spatial use

In the preparation process for the current marine spatial plan (MSP 2020-2026, RD of May 22, 2019, see also [Verhalle and Van de Velde 2020](#)) for the BNS, which was outlined in the document [North Sea Vision 2050](#), Blue Economy and Innovation were already put forward as one of the three supporting themes, the other two being naturalness and multi-use of space. Marine spatial planning can help countries grow their maritime economies sustainably ([MSP Platform 2018](#)) and is an essential component of the Integrated Maritime Policy ([Scholaert et al. 2020](#)). Furthermore, a MSP can also play a role as a catalyst for innovative, high-tech solutions by establishing test zones ([Martens et al. 2019](#)). In the BNS, an evaluation of the first MSP 2014-2020 indicated a net positive economic impact ([COGEA et al. 2020](#)).

The MSP 2020-2026 regulates the spatial use for the existing sectors of the Blue Economy with the demarcation of specific zones for the relevant user functions. The principle of multiple use of space is hereby put forward as the standard concerning spatial use within the BNS in 2050. Industrial research, trials under realistic conditions and demonstration projects are permitted everywhere, providing certain conditions are fulfilled. In addition, earmarked zones for research and testing are also provided. These zones are more specifically the Ostend zone (for industrial trials), a reference zone for the calibration and evaluation of measuring devices (where bottom-disturbing activities are prohibited) and a zone as a reference area for the study of the impact of wind farms and sand and gravel extraction. In addition, a specific area is foreseen near De Panne to carry out tests on coastal protection. The MSP also identifies specific zones for generic commercial and industrial activities (CIA). There are five zones in total, from zone A to zone E. As of early 2022, zone C has gone through the entire permit process for

the operation of the [Westdiep²](#) marine farm (see thematic chapter **Marine aquaculture**).

Based on the economic sectors of the Blue Economy, as defined in the Blue Economy Report (EC 2021) (see the section **Sectors within the Blue Economy**), the potential space requirement per sector can be calculated (table 2). This space requirement is based on the zones defined in the MSP (2020-2026), whereby only the zones where economic sectors were active and/or authorised in 2021 have been taken into account and whereby for newly defined zones with a clear main function (such as the Princess Elisabeth zone), only its main function (i.e. energy supply) has been taken into account. It should be noted that not every sector from the Blue Economy has been assigned specific zones in the BNS (figure 3). This is partly because not every economic sector is active in BNS (such as desalination, which only takes place in the coastal region), but partly also because for some sectors, such as tourism or research and development, the entire BNS is made available. Taking the above into account, one obtains an area four times larger than the BNS when adding up the total area available to all economic sectors. The GAUFRE project (BELSPO), although using a different calculation method, calculated a user rate of 264% in 2005 (Van den Abeele et al. 2005).

The density of the current economic activities on the BNS (figure 4) illustrates how several economic sectors can be accommodated at each point of the BNS. This figure is not a measure of the intensity of economic activity, but it does illustrate the extensive degree of multiple use of space that is in place at the BNS. This analysis is

Table 2. Overview of the spatial use of the established and emerging (*italics*) sectors of the Blue Economy (based on the MSP (2020-2026) and the Blue Economy Report 2021 (EC 2021)). The area for the Princess Elisabeth zone is - to avoid double counting - fully included under marine renewable energy (offshore wind).

Sector	Surface area (km ²)	% of BNS
Marine living resources	2,936	84.9
Marine non-living resources	566	16.4
Marine renewable energy (offshore wind)	522	15.1
Port activities	75	2.2
Ship building and repair		
Maritime transport	1,234	35.7
Coastal tourism	3,458	100
Ocean Energy		
Blue Bio-economy and biotechnology		
Desalination		
Marine minerals other than aggregates		
Maritime Defence, Security and Surveillance	1,174	34.0
Research and Education	3,458	100
Infrastructure	920	26.6

independent of other (non-economic) functions such as nature conservation.

15.3 Societal relevance

15.3.1 Mapping the economic importance of the Blue Economy

Mapping the economic importance of the Blue Economy, whether at the regional level or not, poses a number of challenges. After all, the Blue Economy is not a clearly delineated economic sector, but rather a transversal aggregate of different sectors, which in turn may consist entirely or partially of marine and maritime components. This means that in many cases a traditional determination based on the NACE codes³, cannot be applied arbitrarily. In general, the ocean economy is still not sufficiently understood and information on changes in its condition is often less visible than in other economic areas, hence figures can vary between sources. The OECD is attempting

² Some parties, including the town of Nieuwpoort, appealed the user and environmental permit. At the end of 2021 there was no ruling yet.

³ NACE is the abbreviation for General Nomenclature of Economic Activities in the European Communities ("*Nomenclature générale des Activités économiques dans les Communautés Européennes*") and is an official list of activity descriptions, at the European level.

Spatial use of the individual sectors of the Blue Economy

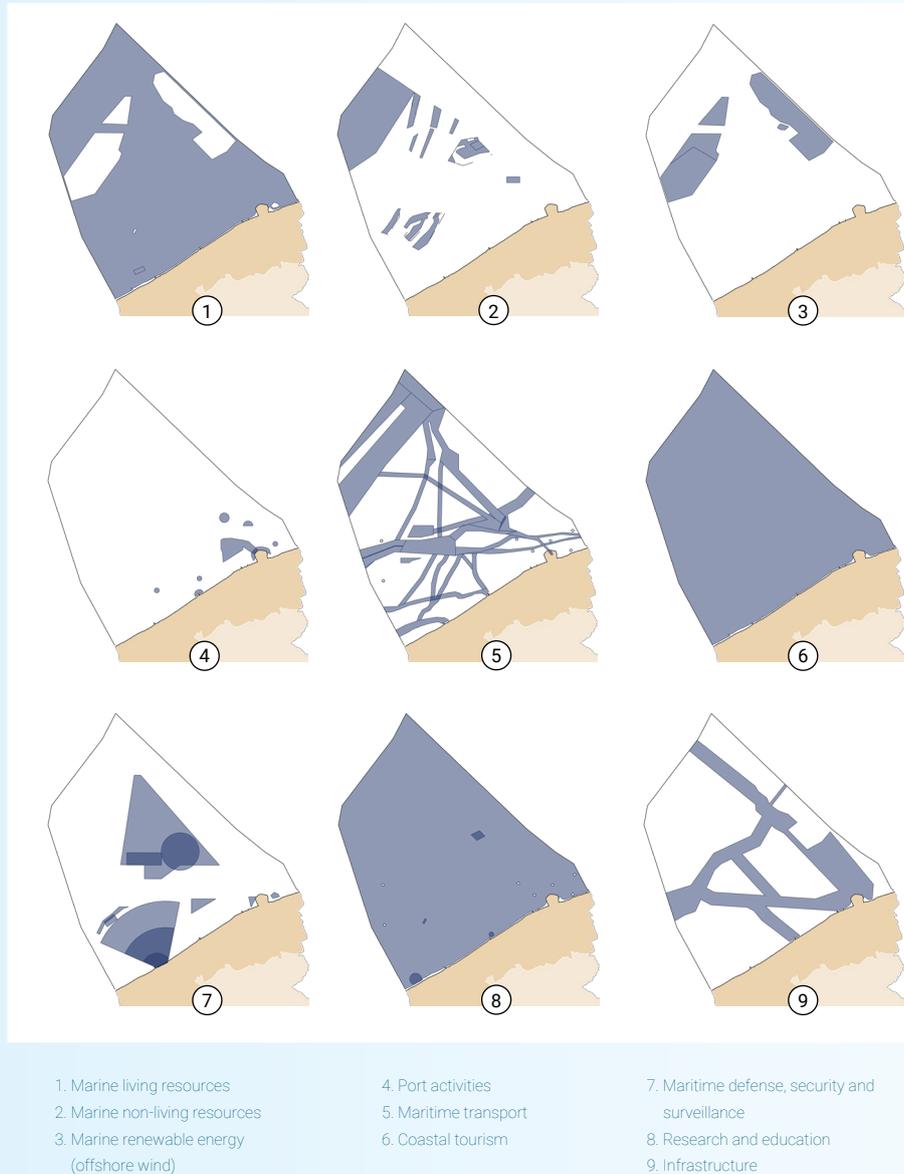


Figure 3. Space use by economic sector on the BNS (sectors based on the EU Blue Economy report 2021 (EC 2021). Zones based on RBINS, [MarineAtlas.be](#) (based on RD of 22 May 2019 (MSP 2020-2026)), [Coastal Portal](#).

to remedy this by developing ocean economy satellite accounts for countries that wish to obtain a more detailed understanding of the importance of the Blue Economy (Joliffe et al. 2021).

Specifically for the Flemish level, a mapping of the Blue Economy was carried out in 2019 on behalf of The Blue Cluster (Bilsen et al. 2019), based on the one hand on a top-down approach via the NACE codes and on the other hand on a bottom-up survey of selected companies. From this, a turnover of 30.8 billion euro, with an added value of 7.2 billion euro and an employment of over 75,000 full-time equivalents (FTEs) was calculated. If the direct, indirect and derived impact is taken into account, the turnover is estimated at 48.4 billion euro, with an added value of 13.5 billion euro, which is 5.2% of the Flemish Gross Domestic Product (GDP).

Recently, there has been a growing awareness that the mapping of the Blue Economy should not only take into account the purely economic activities, but that a statistical information system should be created that measures the many ways in which the ocean contributes to the common good on the one hand, and includes the effects of economic activities on the marine environment on the other.(Joliffe et al. 2021). In this way, the focus is on both

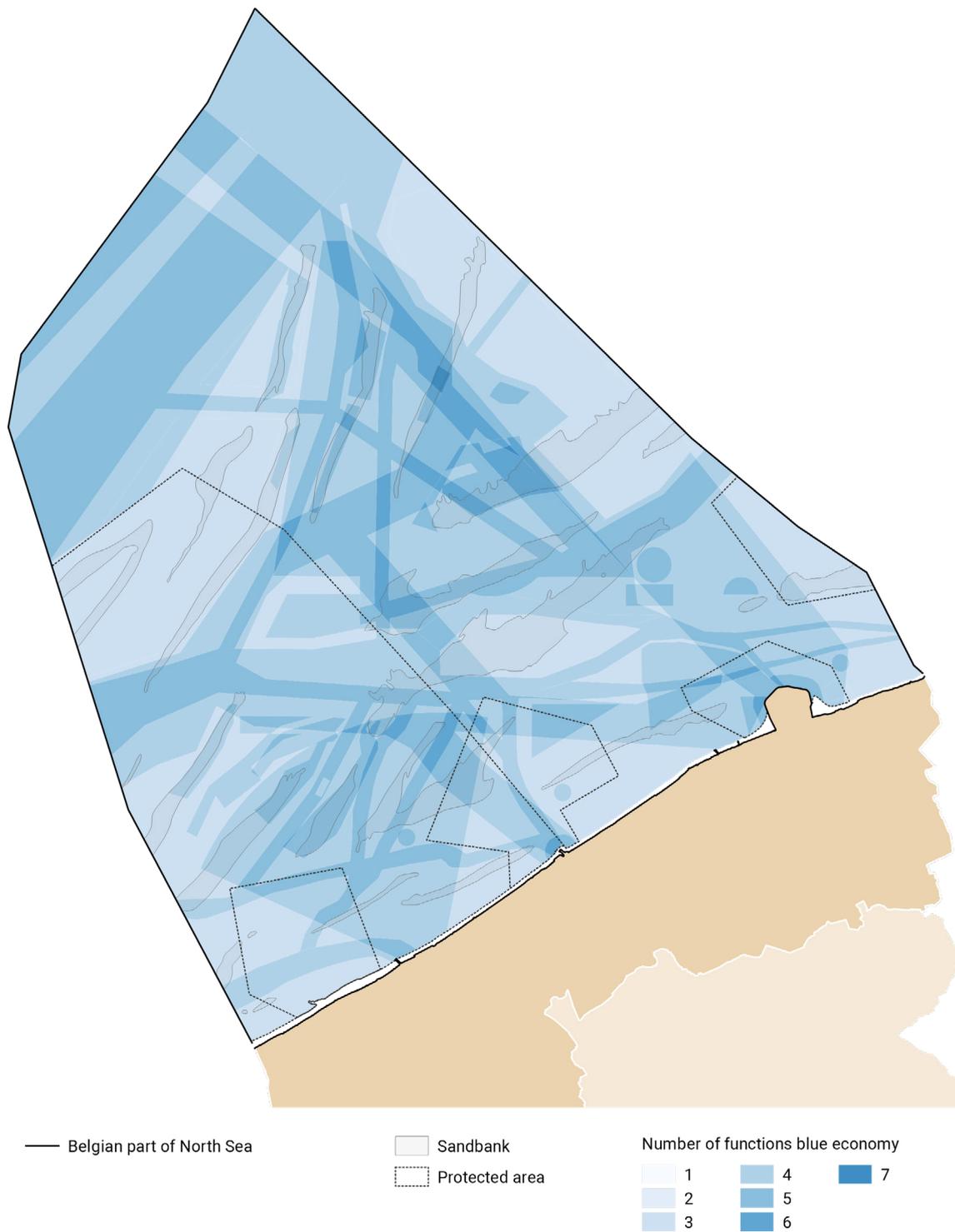


Figure 4. Density of the economic sectors in the BNS (Source: sectors based on the *EU Blue Economy report 2021* (European Commission 2021), Coastal Portal).

pillars of the ocean economy: the contribution of economic activities in the ocean and the assets and ecosystem services provided by the marine environment (OECD 2019, Fenichel et al. 2020, Stuchtey 2020).

15.3.2 The socio-economic importance of Blue Economy sectors

In the majority of the Blue Economy sectors, strong growth rates can be seen between 2009-2018 (EC 2021) (table 3). Due to the different ways in which the Blue Economy can be mapped (cf. supra), these figures may differ from other sources. Table 3 should therefore mainly be seen as a tool for tracing its evolution in Belgium, compared to the period since 2009 and compared to the figures for the European Union as a whole. For the emerging sectors no figures were made available in the EU reporting. They are hence not discussed in the table, but briefly explained in the paragraphs below. For further detailed information on the socio-economic and innovation aspects for both emerging and established sectors, please consult the relevant thematic chapters of the **Knowledge Guide Coast and Sea 2022** (Dauwe et al. 2022).

- **Ocean Energy.** Includes technologies for the production of renewable energy, excluding offshore wind energy (with a foundation on the seabed): ocean energy (tidal and wave energy thermal energy conversion, salt gradient), floating solar photovoltaic (FPV), floating wind energy and renewable hydrogen production offshore. Both in the [Long-Term Vision for MSP 2014-2020](#), as well as the [Long-Term Vision for MSP 2020-2026](#), the ambition is expressed to focus on alternative forms of renewable energy. For several of these designs, innovation and demonstration projects have already been started at the BNS. For further explanation, see the thematic chapter **Energy (including cables and pipes)**;
- **Blue bioeconomy and biotechnology.** This sector includes all living marine resources that cannot be traditionally commercially exploited, such as algae or bacteria. The [Flemish policy plan bio-economy \(2020\)](#) creates the policy framework for supporting the Flemish bio-economy. The BNS has a number of research and innovation projects in this area, which could possibly be incorporated into commercial (aquaculture) projects. For further explanation see the thematic chapter **Marine aquaculture**;
- **Desalination.** Covers the desalination of salt and brackish water. In the [water policy note 2020-2025](#), issued by the Coordinating Committee for Integrated Water Policy (CIW), the desalination of brackish water is put forward as one of the possible avenues for water problems in the coastal zone. In 2020, an installation was built in Ostend, along the Bruges-Ostend canal, which is responsible for the desalination of brackish water for the supply of drinking water with a capacity of up to 24,000 m³ per day (VMM 2021). In 2021, a pilot project for the desalination of brackish and salt water into drinking water was started in Nieuwpoort. In Knokke, the Autonomous Municipal Urban Development Company (AGSO) is conducting a feasibility study on desalinating seawater into drinking water in cooperation with private companies (De Tijd, 16/07/2020). Also in the framework of the [Blue Deal](#) of the Government of Flanders and The Blue Cluster, innovation and implementation projects are started by VLAIO and the [Department of Environment and Spatial Development \(OMG\)](#).
- **Marine minerals.** This sector, in addition to the extraction of elements dissolved in seawater (e.g. salt and potassium), also includes the extraction of minerals and metals in or on the seabed such as, e.g., manganese, titanium, etc. These activities do not apply to the BNS, however, Belgium acts as a sponsoring state for the exploration contract of the GSR company for deep sea mining in the Clarion-Clipperton Zone in the Pacific Ocean. Deep-sea mining is regulated in Belgium by the Law of 7 August 2013 and the RD of 13 October 2013;
- **Maritime defense, security and surveillance.** The reason this category is classified as 'emerging' rather than 'established' in the Blue Economy reports is mainly due to the lack of publicly available data on employment and turnover. The European Naval Shipbuilding industry generated a turnover of 26 billion euro in 2019, representing 23% of total European defense revenues (EC 2021). The EU Maritime Security Strategy EUMMS defines strategic maritime interests for the European Union and combines the objectives of the European Security Union strategy with Blue Economy topics. At the Belgian level, reference can be made to the recent investments carried out jointly by the Belgian and Dutch Navies in the context of replacing the mine sweepers and frigates, with an explicit focus on innovation, including the deployment of sailing drones in the context of mine counter measures. The MAiDEN project was set up to ensure a smoother flow of information in the [Coast Guard Centre](#). For further information, see the thematic chapter **Military use**;
- **Research and education.** The Indicator Report - Marine Research and Innovation 2018 (Pirlet et al. 2018) provides an overview of the investments at the European, federal and Flemish level in research and innovation serving the Blue Economy. Therefore, for the detailed overview of investments in marine research and innovation, please refer to this report;
- **Infrastructure (including cables and robotics).** In the EU Blue Economy report from 2021 (EC 2021), both the deployment of robotics and submarine cables (for data, telecommunications and energy) are

discussed under this denominator. As far as cables and pipes are concerned, reference is made to the thematic chapter **Energy (including cables and pipes)**. Robotics and drones refer to (semi-)automated vehicles both on land, in or on the water or in the air. A study from 2021 (OECD 2021) indicates that new technologies such as artificial intelligence (AI), cloud computing, the Internet of Things (IoT), process automation, robotics and powerful sensors, have rapidly spread in a wide range of old and new applications within the mainstream economy. An overview of the robotics that can be deployed in marine environments is given in Langedock (2021). In the BNS, robotics are not only used for research, but also for inspection and maintenance work in the offshore industry, in hydrographic surveys and also in military applications are proving their usefulness. An increased use of robotics also requires an adapted legislative framework (see e.g. Deketelaere 2017). The federal Directorate-General for Maritime Affairs is working, under the umbrella of IMO, on the drafting of an international regulatory framework for autonomous and semi-autonomous ships. The RD of 16 June 2021, which regulates unmanned shipping in the BNS, makes Belgium one of the first countries with legislation on the subject. The importance of robotics for the Blue Economy is also further illustrated by the cooperation and research initiatives that have been set up in this field, such as the partnership *Drone Port West-Vlaanderen* coordinated by the West Flanders Development Agency, (with projects such as *Drone Innovations*) and *Ostend Drone Hub*. The *VLIZ Marine Robotics Centre* was established in 2019 to give Flemish scientists and their (inter)national partners, as well as other Flemish stakeholders, access to the most advanced technologies in marine research.

15.3.3 Investment platforms for the Blue Economy and Innovation

The European Climate, Infrastructure and Environment Executive Agency (CINEA), established in April 2021, coordinates support for the European Green Deal. The European Maritime, Fisheries and Aquaculture Fund (EMFAF) has a budget of 6.1 billion euro in the period 2021-2027 to support innovative projects that contribute to the sustainable exploitation and management of aquatic and maritime resources. Specifically for the Blue Bioeconomy, the *BlueBio Cofund* provides a coordinated R&D funding scheme. For further detail on the specific funding of research and innovation, please refer to Piret et al. (2018).

When looking at the financing instruments available to innovative Blue Economy companies, a 2018 study reveals that at the European level, the financing sector relevant to the Blue Economy is still emerging and lacks the maturity of more established sectors (Van Aalst et al. 2018). A 2020 report (Sumaila et al. 2020) by the High Level Panel for sustainable Ocean Economy highlights the specific challenges around setting up and financing marine projects and provides an assessment of how economic instruments and financing mechanisms can be deployed to achieve a sustainable ocean economy. Launched in 2020, the *BlueInvest Fund* is a collaboration between the European Investment Bank (EIB) and the EC, and provides financing for companies with innovative products and services, linked to the Green Deal. This financing is not done directly. The *BlueInvest Fund* provides funding to funds that focus entirely or partially on the Blue Economy. In addition, the *BlueInvest Platform*, managed by the EU and running in parallel, supports SMEs and start-ups in accessing funding. In addition to these generic financial instruments there are also more sector-oriented financings, such as e.g. the support from the European Investment Bank (EIB) for the construction of the offshore wind farms in the BNS, whereby the EIB until 2019 has contributed more than 2.5 billion to the sector through the European Fund for Strategic Investments (EFSI) (EC 2019).

The EIB itself, through the *Clean and Sustainable Ocean Programme*, manages the Blue Sustainable Ocean Strategy (Blue SOS) on the one hand, and the Clean Oceans Initiative on the other, both of which also operate outside Europe. Blue SOS provides long-term loans for (local) governments and private parties, allowing for a doubling of the lending capacity to 2.5 billion euro in the period 2019-2023 on themes such as sustainable coastal defense, green shipping technology, blue biotechnology, and sustainable marine nutrition. Rather, the Clean Oceans Initiative focuses on reducing the input of (plastic) waste to the ocean. The World Bank's *ProBlue* fund supports the development of integrated, sustainable and healthy marine and coastal resources.

At the Flemish level, VLAIO's *grants database* collects all basic information on funding, advice and grants. The FIVA (*Financieringsinstrument voor de Vlaamse Visserij- en Aquacultuursector*) and EMFAF (European Maritime Fisheries and Aquaculture Fund) are the instruments used at the Flemish level to support the fisheries and aquaculture sector. It concerns start-up and investment support as well as support for research, auctions, processing and commercialisation.

15.4 Impact and Sustainable use

Each of the Blue Economy sectors has a certain impact on the marine environment. A general overview can be

Table 3. Overview for established sectors of employment and value added in 2018, and evolution relative to 2009. Figures based on EC (2021)*.

Sectors (established)	Employment 2018 (% to 2009) - Belgium	Added value at factor cost in million euro (% to 2009) - Belgium	Employment 2018 in 1,000 (% to 2009) - Europe	Added value at factor cost in million euro (% to 2009) - Europe	Breakdown of the Belgian numbers
Marine living resources	7,712 (+41%)	509 (+48%)	538.4 (-3%)	19,100 (+29%)	The figures for both employment and added value show a strong increase over the 2009 figures, an increase that is also more pronounced in Belgium than on the general European level. This increase is mainly due to a significant increase in processing (into ready meals, for example) and the distribution of seafood.
Marine non-living resources	52 (+132%)	7 (+117%)	11.1 (-68%)	4,243 (-62%)	Employment and turnover figures in Belgium increased between 2009 and 2018, going against the European trend. However, the downward trend at the European level is driven by sharp declines in both employment and turnover in the oil and gas exploitation sector (a sector that does not feature in the BNS).
Marine offshore renewable energy (incl. wind energy)	872 (+10,889%)	114 (+3,788%)	9.0 (+2,246%)	1,495 (+3,582%)	The trends for employment and turnover in this sector in Belgium even exceeded the explosive growth recorded at the European level, with an increase by a factor of 100 over the period 2009-2018.
Port activities	14,272 (+44%)	1,780 (+16%)	384.0 (+1%)	26,481 (+15%)	The increase in both employment and added value is mainly due to a strong increase in terms of hydraulic engineering projects and storage and warehousing of goods in the ports.
Shipbuilding and repairs	1,444 (-51%)	130 (-41%)	292.0 (-5%)	14,654 (+30%)	The Belgian figures do not follow the European trend here. Across all subsectors (the construction of ships and pleasure craft and the repair and maintenance of ships), employment and added value are declining.
Maritime transport	4,105 (-35%)	1,237 (+90%)	397.6 (+11%)	30,047 (+12%)	Although there is a strong increase (300+) in terms of employment in marine transportation subsector, there is a strong decrease in employment in support activities subsectors (brokerage, agents, etc.).
Coastal tourism	9,057 (+57%)	446 (+79%)	2,843.1 (+1%)	80,049 (+21%)	The growth noted compared to 2009 is evenly distributed among accommodation, transportation and other activities (including merchandise sales and hospitality).

* The figures, and trends derived from them, in the 2021 Blue Economy Report may differ - due to the way in which the calculations were done - from figures and trends presented in other reports.

found in the strategic environmental assessment of the draft marine spatial plan (MSP 2020-2026) (Volckaert and Durinck 2018) or in the North Sea Vision 2050 (De Backer 2017). The socio-economic analysis made in the framework of the MSFD in turn provides an estimate of the cost of measures to avoid the degradation of the BNS (Belgian State 2018). For the specific permit processes, monitoring efforts and sectoral impact, see the relevant thematic chapters of the **Knowledge Guide Coast and Sea 2022** (Dauwe et al. 2022).

The Blue Economy and ecology cannot, however, be regarded as two separate entities that are only connected by cause-impact relationships. Where in the past, economic activities were strictly separated from ecological aspects, the realisation has grown that a sustainable Blue Economy can be a pillar of the Green Deal at the European level. More specifically for the BNS, during the preparation of the MSP (2020-2026) in the North Sea Vision 2050 (De Backer 2017), it was said that human activities at sea should be arranged in such a way that they have zero impact or even a positive impact. The latter was a.o. further elaborated in Degraer et al. (2020). The *Think Thank North Sea* will reflect on *Environmentally Sustainable Blue Growth* in 2021-2022.

The concept of ecosystem services has already been used to enable the translation and connection between ecology and economic activities (Reker et al. 2019). The European Marine Board's (EMB) publication *Valuing Ecosystem Services* (Coopman et al. 2019) highlights the current thinking on valuing ecosystem services for the marine environment. The practical application of the ecosystem services concept to a number of marine infrastructure projects was a.o. elaborated in Boerema et al. (2016), Van der Biest et al. (2017a), Van der Biest et al. (2017b) and Boerema et al. (2021). The SUMES project provides for the construction of a model that assesses the extent to which the marine ecosystem is capable of providing certain goods and services and the extent to which activities (from the Blue Economy) have an impact on ecosystem goods and services. A recent PIP project (Program Innovative Public Procurement) looks at combining elements of ecosystem services within the existing Environmental Impact Assessment (EIA) framework (Dugernier et al. 2021). A clear example of the link between innovation and sustainability in the Blue Economy, is the growing use of Nature-based Solutions in coastal defense, see also the thematic chapter **Safety against flooding**.

In addition to investment platforms (see **15.3.3 Investment platforms for the Blue Economy and Innovation**), there is also a focus on the sustainability of investments. The *Action Plan for Sustainable Growth* issued by the EC in 2018 called for the introduction of a general classification system for sustainable economic activities, which led to the Taxonomy Regulation (Regulation (EU) 2020/852). This Regulation defines the four conditions an activity must meet to be considered ecologically sustainable, and does so for six ecological objectives, including the sustainable use and protection of water and marine resources. In order to facilitate the dialogue between the various stakeholders involved in the sustainable realisation of the Green Deal, the *Sustainable Finance Platform* was established. These initiatives from the EU are part of a broader trend to strive for more sustainable financing. An overview of further initiatives worldwide is given in UNEPFI (2021). Because the pursuit of sustainability also extends beyond EU funding, work is currently underway to develop a Blue Economy sustainability framework (CINEA 2021).

Good quality data on the marine environment is indispensable for sustainable use and management of this environment (Larkin et al. 2022). More and more, this involves collaborations between government, researchers and industry (McMeel et al. 2017, Guidi et al. 2020). The European Marine Observation and Data Network (EMODnet) is therefore also developing specific initiatives towards the private sector.

Legislation reference list

Overview of the relevant legislation on international ('Year A': adoption; 'Year EIF': entry into force), European, federal and Flemish level. For the consolidated European policy context see [Eurlex](#). The national legislation can be consulted on the [Belgian official journal](#) and the [Justel-database](#), the Flemish legislation is available on the [Flemish Codex](#).

International conventions and agreements			
Acronyms	Title	Year A	Year EIF
UNCLOS	United Nations Convention on the law of the sea	1982	1994

European legislation and policy context			
Document number	Title	Year	Number
Communications			
COM (2005) 12	Strategic objectives 2005-2009 - Europe 2010: A partnership for European renewal prosperity, solidarity and security	2005	12
COM (2007) 575	Communication from the Commission - An integrated maritime policy for the European Union	2007	575
COM (2008) 534	Communication from the Commission - A European strategy for marine and maritime research: a coherent European research area framework in support of a sustainable use of oceans and seas	2008	534
COM (2009) 536	Communication from the Commission - Developing the international dimension of the Integrated Maritime Policy of the European Union	2009	536
COM (2010) 461	Communication from the Commission: Marine Knowledge 2020 marine data and observation for smart and sustainable growth	2010	461
COM (2010) 2020	Europe 2020 - A strategy for smart, sustainable and inclusive growth	2010	2020
COM (2012) 494	Communication from the Commission: Blue Growth opportunities for marine and maritime sustainable growth	2012	494
COM (2014) 254	Communication from the Commission: Innovation in the Blue Economy: realising the potential of our seas and oceans for jobs and growth	2014	254
COM (2019) 640	Communication from the Commission: The European Green Deal	2019	640
COM (2020) 442	Communication from the Commission: The EU budget powering the recovery plan for Europe	2020	442
COM (2021) 240	Communication from the Commission on a new approach for a sustainable blue economy in the EU - Transforming the EU's Blue Economy for a sustainable future	2021	240
COM (2021) 609	Communication from the Commission on European missions	2021	609
Resolutions			
2014/2240(INI)	European Parliament resolution on untapping the potential of research and innovation in the blue economy to create jobs and growth	2014	2240
Directives			
Directive 2008/56/EC	Directive establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)	2008	56
Directive 2014/89/EU	Directive establishing a framework for maritime spatial planning (MSP Directive)	2014	89
Regulations			
Regulation (EU) 2020/852	Regulation on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088	2020	852

Belgian and Flemish legislation		
Dates	Title	File number
Decisions of the Govt. of Flanders		
Decision of the Government of Flanders of 4 May 2016	Besluit van de Vlaamse Regering tot regeling van de steun aan de innovatieclusters in Vlaanderen	
Royal Decrees		
RD of 7 September 2003	Koninklijk besluit houdende de procedure tot vergunning en machtiging van bepaalde activiteiten in de zeegebieden onder de rechtsbevoegdheid van België	2003-09-07/32
RD of 9 September 2003	Koninklijk besluit houdende de regels betreffende de milieu-effectenbeoordeling in toepassing van de wet van 20 januari 1999 ter bescherming van het mariene milieu in de zeegebieden onder de rechtsbevoegdheid van België	2003-09-09/30
RD of 23 June 2010	Koninklijk besluit betreffende de vaststelling van een kader voor het bereiken van een goede oppervlaktewatertoestand	2010-06-23/04
RD of 23 June 2010	Koninklijk besluit betreffende de mariene strategie voor de Belgische zeegebieden	2010-06-23/05
RD of 13 November 2012	Koninklijk besluit betreffende de instelling van een raadgevende commissie en de procedure tot aanneming van een marien ruimtelijk plan in de Belgische zeegebieden	2012-11-13/07
RD of 22 May 2019	Koninklijk besluit tot vaststelling van het marien ruimtelijk plan voor de periode van 2020 tot 2026 in de Belgische zeegebieden	2019-05-22/23
Laws		
Law of 13 June 1969	Wet inzake de exploratie en exploitatie van niet-levende rijkdommen van de territoriale zee en het continentaal plat	1969-06-13/30
Special Law of 8 August 1980	Bijzondere wet tot hervorming der instellingen	1980-08-08/02
Law of 20 January 1999	Wet ter bescherming van het mariene milieu en ter organisatie van de mariene ruimtelijke planning in de zeegebieden onder de rechtsbevoegdheid van België	1999-01-20/33
Law of 22 April 1999	Wet betreffende de exclusieve economische zone van België in de Noordzee	1999-04-22/47
Law of 20 July 2012	Wet tot wijziging van de wet van 20 januari 1999 ter bescherming van het mariene milieu in de zeegebieden onder de rechtsbevoegdheid van België, wat de organisatie van de mariene ruimtelijke planning betreft	2012-07-20/39