BLUE INVEST

INVESTOR REPORT:

AN OCEAN OF OPPORTUNITIES

Funded by
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#BlueInvest

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Foreword

Foreword

Virginijus Sinkevičius

Commissioner for Environment,
Oceans and Fisheries, European
Commission

The blue economy will have to be very different by 2030. The EU needs to boost its industrial capacity to meet the objectives of the European Green Deal: decarbonisation, protecting biodiversity and zero-pollution. This is a major transformation and one that needs to happen fast. It requires innovation, and innovation requires finance.

The European Union has what it takes to supercharge this transformation. We have a plan, we have the tools, and we have a lot of talent. We have the researchers, entrepreneurs, innovation ecosystems and industrial capacity. We are on our way.

A whole ecosystem of innovative start-ups and SMEs is emerging, nurtured by business clusters, technology parks, incubators and accelerators, leading the way on transformative and disruptive environmental technologies and solutions.

Clean tech is now the fastest-growing investment sector in Europe – doubling its value between 2020 and 2021 alone. Investors who get in early will surely reap the rewards. And, of course, there is no green tech without blue tech! The EU’s blue sectors are a spawning ground for ground-breaking solutions and technologies that can help fight climate change and support the green transition.

Examples include floating wind platforms and tidal devices, green hydrogen, underwater robots, autonomous ships, clean ships or eco-ships, lightweight materials that resist corrosion and biofouling, underwater internets based on acoustics, processes for creating bioplastics from seaweed, artificial intelligence for image analysis, marine compounds for anti-aging and cosmetics, alternative feed sources, marine-based organic fertilizers and pesticides, and much, much more.

Our BlueInvest initiative has been promoting and accelerating these new ocean-based technologies and the start-ups, SMEs, and scale-ups that drive them. Through its work with the investor scene and dedicated financial instruments such as the InvestEU Blue Economy Fund, it is boosting the finance ecosystem needed to nurture and scale up our blue champions, offering the support they need to be successful and to grow in the European Union and beyond.

This BlueInvest investor report confirms a strong and rising interest in the sustainable blue economy among investors. I hope that its information about investment activities, innovative technologies and investment-ready companies across ten sectors of the sustainable blue economy will help investors move into this space more comfortably and point them towards the companies and ventures that will make a difference both in the market and for our oceans.

1

Introduction

Introduction

The concept of the blue economy, also known as the ocean economy[1], was introduced by the United Nations (UN) in 2012 as a way of acknowledging the vast potential of marine and coastal ecosystems that are kept healthy and managed sustainably.

The UN 2030 Agenda for Sustainable Development in 2015 dedicated one of the 17 Sustainable Development Goals (SDGs) to the conservation and sustainable use of the oceans, seas and marine resources[2].

The EU adopted a Blue Growth Strategy[3] in 2012, and in 2021, declared the Sustainable Blue Economy[4] as a core element toward implementing the European Green Deal.

BlueInvest, the initiative authoring this report, is a flagship of the European Commission to boost investment and innovation in sustainable technologies for the blue economy. The BlueInvest platform supports investment readiness and access to finance for blue start-ups, small and medium-sized enterprises and scale-ups, and promotes opportunities to investors.

Objectives

This first edition of the BlueInvest Investor Report aims to **provide investors with market knowledge on the EU blue economy to support their investment decisions**.

The BlueInvest Investor Report will feature:

- the EU blue economy investment ecosystem for innovation, including its main stakeholders and key initiatives;
- perspectives from a sampling of investors and sentiments on current and future investment prospects*;
- investment opportunities and key innovations and technologies across 10 sectors of the EU Blue Economy.

This report is addressed to investors who are **actively engaged or interested in prospects in the EU Blue Economy**.

Content and structure

Chapter 2 provides a narrative on trends in financing EU innovation in the sustainable blue economy, setting out key players, investments and relevant initiatives.

Chapter 3 offers investor perspectives on prospects in the EU blue economy: how they view the blue economy sectors, make investment decisions, and what drives (and hinders) these.

Chapter 4 highlights investment opportunities in 10 sustainable blue economy sectors in the EU, providing an overview of key innovations and technologies with examples of companies from the BlueInvest pipeline.

The report combines market data with results from an investors survey conducted by BlueInvest. The **annexes** provide complementary data, methodological notes and a complete list of references.

Fig. 1.1: Overview

EU blue economy investment ecosystem

- Financing actors
- Capital flow and deals activity
- Funds as an equity investment
- Blue Economy initiatives

Perspectives from investors

- Interest in the blue economy and preferred sectors
- Sizing current and future financial commitments in the blue economy
- Drivers and barriers
- Investment criteria
- Attractiveness of blue economy sectors

Opportunities for investors

- Investment opportunities in 10 Blue Economy sectors, based on:
  - Sector definition
  - Value chain
  - Innovations and technologies

2900+
Blue deals analysed

87
Investors surveyed

10
Strategic sectors analysed

Note: *Majority of respondents being Venture Capital.

Sources: UNRIC (2022)[1]; The Global Goals Organisation[2]; European Commission (2012)[3]; European Commission (2021)[4]

Scope

This report defines the blue economy along the same lines as the EU Blue Economy Report, encompassing all sectoral and cross-sectoral economic activities based on or related to the oceans, seas and coasts[5].

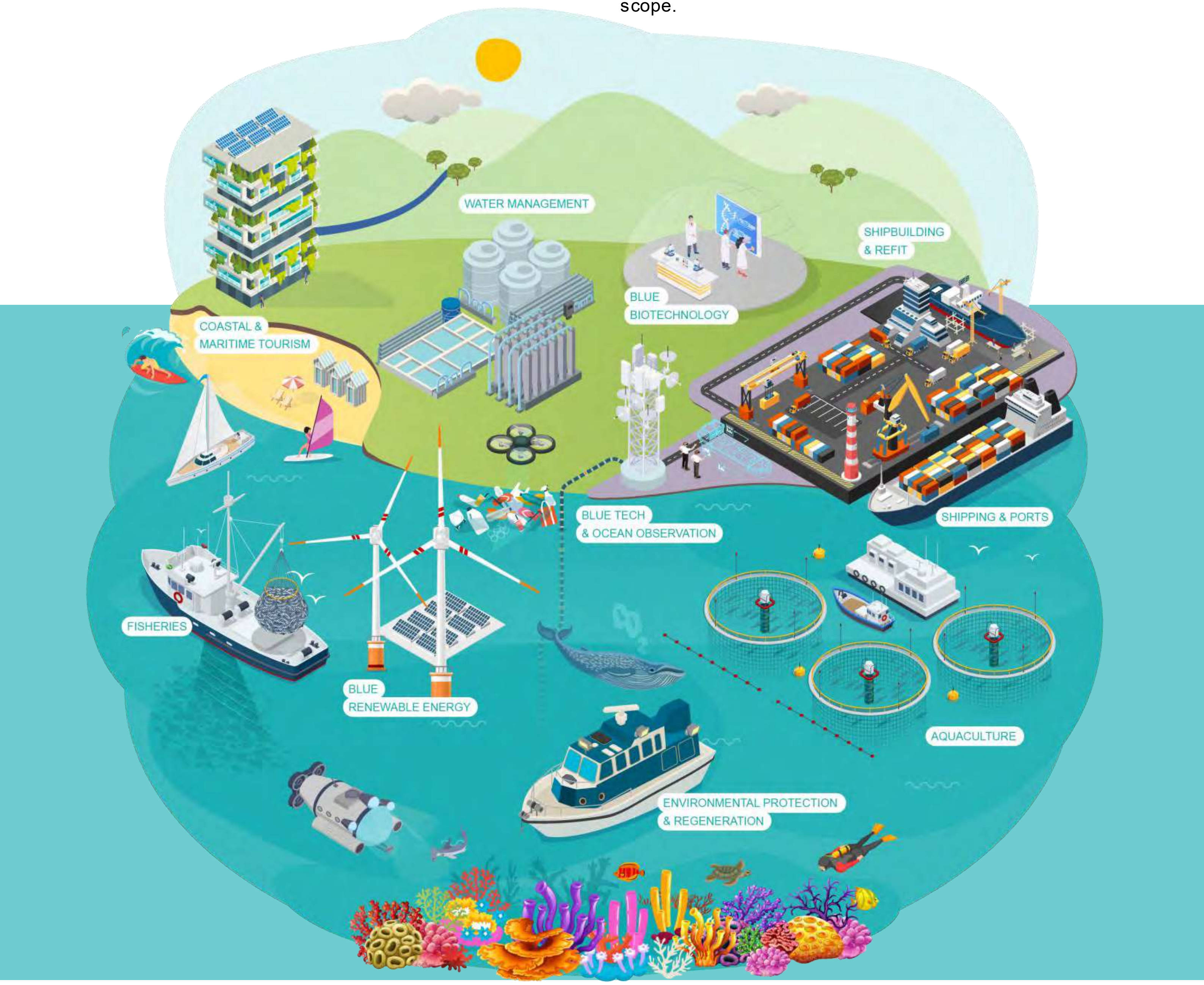
In terms of geographical scope, this report focuses on the **EU territory**, including when and where possible outermost regions. Any international market data used has been signposted for comparison purposes.

This report explores **investment opportunities, prospects and innovation in 10 identified sectors,** depicted in the Figure below.

The methodology used for selecting these sectors was based on **EU and international classifications.** It aims to provide a clear overview of the **EU blue economy** while ensuring consistency and comparability of sectors.

The definition of each sector includes a perspective on **sustainability***, considering this critical to ensuring the long-term viability of the blue economy. The next section sets the context and provides summary descriptions of the sectors in scope.

Fig. 1.2: The blue economy



Note: *Sustainability has been considered as a key factor for responsible investment in the blue economy. This has been factored, where feasible, into the sector definitions, innovations, and companies featured.
Source: European Commission (2022)[5]

Context on sectors

The blue economy includes the **exploration of ocean resources***; innovative **blue tech & ocean observation** is required to better understand and protect aquatic organisms. As a growing population seeks additional sources of food to sustain itself, the **harvesting** and the **farming of aquatic organisms through aquaculture and fisheries** becomes essential. In addition to producing food, marine organisms can meet other essential needs, including healthcare needs, through the **blue biotechnology** sector. Urgent demands on alternative energy sourcing and distribution make **blue renewable energy** production from **wind, ocean and solar** critical.

The ocean offers plenty of opportunities for leisure through **coastal & maritime tourism**. However, our economic activities have an impact on ocean health and its biodiversity, thus creating the need for **environmental protection & regeneration**. One way to preserve the ocean's biodiversity is by starting at the source: these activities require adequate equipment, including **non-polluting vessels**, which is where the **shipbuilding & refit** sector comes in.

Once vessels are constructed, they are also put to the service of society, transporting people and goods through the **shipping & ports sector**. Ultimately, people need safe drinking water to live. This requires effective **water management**.

The BlueInvest definition of key sectors below include the sustainability dimension. These are broadened in Chapter 4 to include the existing market definitions and the green transition of the sector.

The specific investment opportunities featured in this first report take into account **significant interest from investors** based on the investors survey as well as the **technological and industry needs of each sector** towards achieving the goals of the European Green Deal.

In the coming months, the report will be extended to include a deeper market analysis for each sector, on which a consultation will be conducted with the investors and stakeholders on the BlueInvest platform.

Key sectors	Short definition
Aquaculture	The **cultivation and farming of aquatic organisms in a way that has minimal impact** on air, water and soil quality.
Blue Biotechnology	The **application of science and technology to aquatic organisms** in order to produce knowledge, goods and services, in compliance with sustainability practices.
Blue Renewable Energy	The **offshore, inshore and nearshore generation of clean and renewable power** from natural sources, including wind, wave, tidal and solar.
Blue Tech & Ocean Observation	The activities, technologies and infrastructure involved in **ocean data** collection, modelling and prediction, including for maritime security and defence.
Coastal & Maritime Tourism	The **activities** involved in **providing services for tourism** in and around coastal or marine environments that contribute to sustainable development in the local area.
Environmental Protection & Regeneration	The **protection** and **regeneration of marine ecosystems**, including activities to **prevent ocean pollution** and **restore** and **strengthen** biodiversity in coastal areas.
Fisheries	The sustainable **harvesting of naturally occurring living resources** in both marine and freshwater environments.
Shipbuilding & Refit	The **products and services** required for **building, maintenance, repair and refitting** of vessels for environmentally responsible water transport.
Shipping & Ports	The activities associated with ensuring a sustainable **maritime transport ecosystem**, including the transportation of freight and passengers by water and port services.
Water Management	The services and infrastructure required for sustainable **water collection, purification, desalination, decontamination and distribution, as well as for sewage and waste treatment**.

Note: *Activities such as deep sea mining and offshore oil and gas exploration are outside the scope of this report.
Source: See Chapter 4 - Investment Opportunities

Why is it attractive to invest in the blue economy?

The ocean contributes €1.27 trillion **in gross value added to the global economy annually**, and up to **€2.54 trillion by 2030**[6]. The blue economy is extremely important to the EU's economic growth and to achieving the ambitions of the European Green Deal[5].

The EU-27 blue economy is growing fast, is attracting worldwide investment[7] and is set to **generate net positive returns**[8].

In 2019, the EU blue economy employed close to **4.5 million people and generated €184 billion in gross value added*** (an increase of ~20% compared to 2009) and around €667 billion in turnover (up 15% from €578 billion in 2009)[9].

Given the potential it holds for resource wealth, economic growth, employment and innovation, **ocean is rightly considered to be the "next great economic frontier"**[6]. Indeed, the future blue economy will be **marked by growth**, thanks to **contextual factors that act as driving forces, expected positive returns and key innovations**.

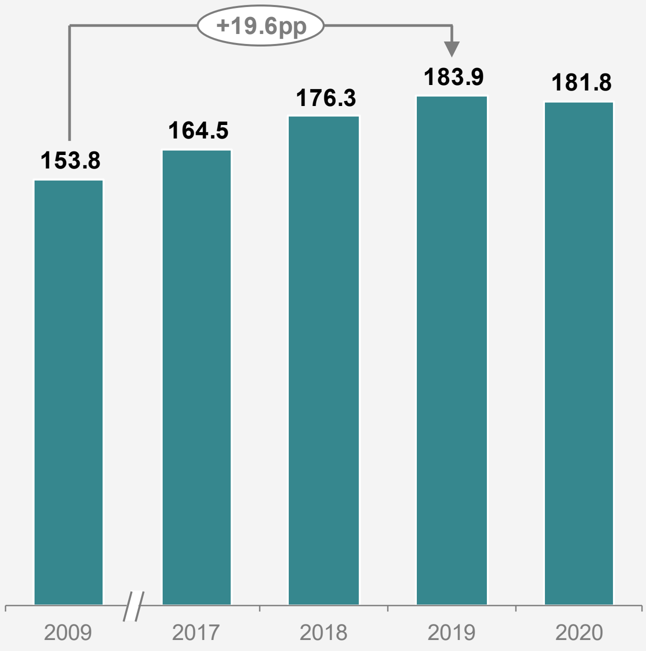
Population growth will inevitably raise pressures on food and feed supply chains worldwide[12], boost energy usage[13] and increase the levels of trade[14, 15], leading to a rise in GDP per capita in the EU[16] and subsequently increased demand overall and increased demand for non-essential goods in particular[17], all of which will generate opportunities in blue economy sectors.

Despite all the benefits the oceans provide, they are facing several challenges, such as pollution, destruction of habitats, carbon emissions and overexploitation of resources. Ocean health decline prevents future generations from taking full advantage of all the value the oceans have to offer. **To achieve long-term ocean health, it is important to invest in a sustainable blue economy**.

A strong political commitment to implementing the EU Green Deal has resulted in a raft of new regulations promoting green and digital transition and bolstering the need and demand for new clean tech products and services. In 2021, the EU also adopted a new sustainable blue economy strategy, highlighting the fact that the EU's blue sectors are a spawning ground for innovative solutions and technologies that can help fight climate change and take the green transition to the next level.

Fig. 1.3: EU-27 blue economy* gross value added

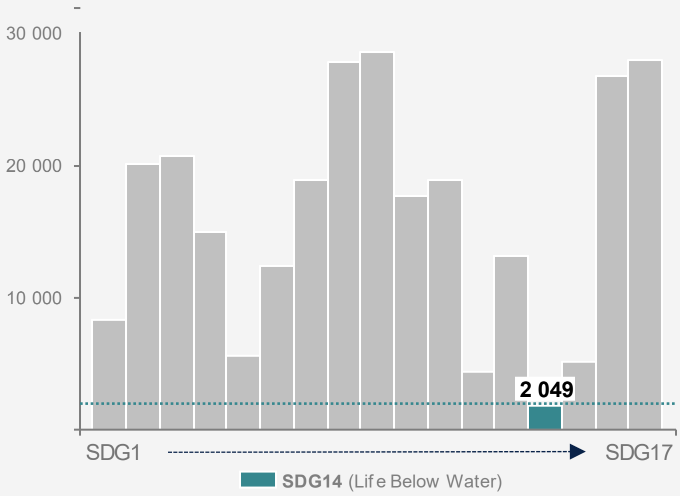
(GVA in billion €, 2009-20)



Source: European Commission (2020)[10]

Fig. 1.4: UN SDGs aid allocation per UN SDG

(aid allocation in million €, 2019)



Source: The SDG Financing Lab, OECD initiative[11]

Note: *Data refers to the most established sectors of the blue economy according to the EC: fisheries, marine non-living resources, marine renewable energy, port activities, shipbuilding and repair, maritime transport and coastal tourism.

Sources: European Commission (2022)[5]; OECD (2016)[6]; European Commission[7, 9]; High Level Panel for a Sustainable Ocean Economy[8]; UN DESA (2021)[12]; OECD & IEA (2011)[13]; World Bank Group (2016)[14]; UNCTAD (2021)[15]; The World Bank (2021)[16]; CFI (2022)[17]

In the coming decades, **emerging innovations and technologies are expected to play a crucial role** in addressing many ocean-related environmental challenges, boosting green transition, economic growth and job creation[5, 6]. This will undoubtedly be associated with attractive investment opportunities, especially for those investors who get on board early on.

According to the High Level Panel for a Sustainable Ocean Economy (Ocean Panel) of the World Resources Institute, **investing into a sustainable ocean economy could bring net positive returns**. Investing €2.54 trillion in 2020 in just four ocean-based solutions – offshore wind production, sustainable ocean-based food production, decarbonisation of international shipping, and conservation and restoration of mangroves – would yield a net benefit of €14.11 trillion by 2050 (a **benefit-cost ratio of 12:1, 10:1, 4:1 and 3:1 for each of the four sectors**, respectively)[8].

As a consequence, investors are more and more interested in the blue economy. In a survey conducted as part of this Report (see Chapter 3 – Perspectives from investors), **87% of the investors asked signalled an interest in blue economy investments**, showcasing the high potential of a sustainable blue economy. And by **making green investments** in ocean technologies and solutions investors can directly contribute to future ocean resilience. Currently, 84% of investors surveyed report having green investments in their portfolios, and 81% consider their blue investments to be sustainable. But **if we are to achieve SDG14 by 2030, more blue finance is needed**[18].

> [The blue economy offers] great potential for sustainable investment in line with positive and growing trends.
>
> - Opinion from an Asset Manager

Fig. 1.5: The global blue economy in numbers

90%

Oceans as a source of economic growth

Around **90%** of international goods are transported by sea[19]

97%

Oceans as a source of climate mitigation

Healthy coral reefs protect us against climate hazards by reducing the intensity of waves by an average of **97%**[20]

350 million

Oceans as a source of employment

350 million jobs worldwide by 2030[21]

97%

Oceans as a source of water

Roughly **97%** of the Earth's water can be found in our oceans[22]

50%

Oceans as a source of nutritious food

Marine fisheries provide the primary source of protein for over **50%** of the population in the least developed countries[23]

50%

Oceans as a source of oxygen

Marine phytoplankton produces **50%** of oxygen on Earth[24]

500+ thousand

Oceans as a source of biodiversity

The world's oceans contain somewhere between **500,000 and 10 million** marine species[25]

Sources: OECD[19]; USGS[20]; Surrey Board of Trade (2021)[21]; National Ocean Service (2021)[22]; UN[23]; NASA - Earth Observatory (2016)[24]; UN (2017)[25]

Sources: European Commission (2022)[5]; OECD (2016)[6]; High Level Panel for a Sustainable Ocean Economy[8]; UNEP FI SBE (2021)[18]

2

EU blue economy investment ecosystem for innovation

Financing innovation in the EU blue economy

This chapter will provide an overview of the key actors in the **EU's sustainable blue economy financial landscape and how capital flows were directed in the past decades**. The report considers mainly capital targeting new sustainable blue technologies and supporting the **development and growth of high-potential start-ups and SMEs**.

The first sub-section outlines the current global **funding gap and investment needs to address the SDG14**, sizing the opportunity for additional investments in the blue economy.

Then, dive into how **private EU investors are directing resources to innovation in the blue economy**, including an overview of selected investment activities in the sector since the year 2000. Our analysis zooms in on equity investment and illustrate how direct and indirect investments are being channeled through various **blue economy impact funds**.

We conclude with a brief look into existing **financial and non-financial EU initiatives supporting the blue investment ecosystem** and describe how policies, impact frameworks and assistance mechanisms are helping to drive investment.

> *In the last 5 years (2018-2022), deals in the blue economy have been on the rise, with a 200% increase in the number of financial transactions. Seed rounds represent 20% of all deals we assessed, followed by acquisitions (16%). With investments concentrated at market launch phase (seed), we see an existing gap of growth capital to supporting those start-ups and SMEs scaling up and expanding. Without capital to ensure an autonomous growth, acquisition remains a save exit, but may result further market concentration*.*

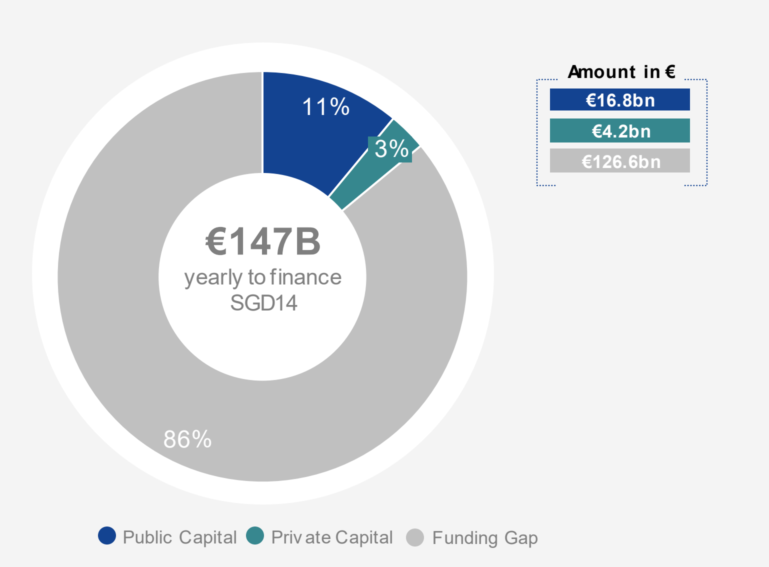
Global funding gap and investment needs in the blue economy

An estimated €147 billion per year globally is needed to achieve Sustainable Development Goal (SDG) 14: Life Below Water by 2030. To date, only €21 billion is available: of this, €16.8 billion comes from domestic and international public sources and €4.2 billion from private investors. **This leaves a funding gap of €126 billion**[26] still to be addressed. Mobilising private capital is critical to closing the gap.

In the EU, the financing gap for SMEs in the blue economy ranges between €60-€70 billion[27].

The following sub-chapters reflect on how European private and public financial institutions **have invested in the blue economy and contributed to reducing this investment gap**.

Fig. 2.1: Unmet financing needs in the Blue Economy



Growth in the investment activity in the EU blue economy

In the EU, investments in the traditional maritime and coastal sectors have an important economic role, in line with the size of the European blue economy. However, **specifically for the sustainable blue economy**, availability of investment data is limited, making it difficult for potential investors to identify opportunities and estimate expected returns. In the past, investment assets targeting ocean & maritime had a generalist approach and were coupled with sectors such as agriculture, supply & logistics, land conservation, energy, infrastructure, food and pharmaceuticals. It was not until 2007 that a venture capital** fund exclusively dedicated to the blue economy was created.

The emergence of new blue sectors and technologies, such as blue biotechnology, offshore renewables and digital ocean surveillance, increased the complexity in mapping the investment landscape. Adding to this, there are difficulties to collect, analyse and compare historical data. To address the lack of consistent information on sustainable blue economy investments, this report developed a pragmatic approach to explore capital flows in pre-listed blue companies over the past two decades.

Our methodology involved mapping and assessing over 2 904 direct and indirect investment deals in blue companies between January 2000 and February 2023. Only businesses founded in EU-27 Member states were considered*.

The analysis detailed the different financial sources and mechanisms deployed through those deals and captured a total of **2 142 investors who made one or more deals in 1 774 companies related to the blue economy**.

Notes: *CB Insights and Pitchbook commercial databases. **Aquacopia Ventures (vintage 2007) was the first aquaculture focused VC fund. Prior to that, VCs such as Seventure Partners (1997) and Smedvig Capital (1996) invested in blue companies as part of their portfolio, but without dedicated focus or specialisation.

Sources: F. Johansen & A. Vestvik (2020)[26]; European Commission (2018)[27]

Fig. 2.2: Deals in the EU Blue Economy

(January 2000 – February 2023)

2 904
Deals in the EU
(Jan 2000 – Feb 2023)

2 142
EU & international investors involved in those deals

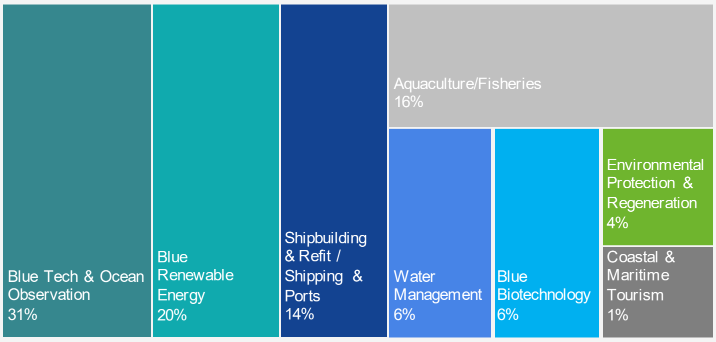
1 774
EU companies benefiting

For our analysis, deals were selected based on a set of specific criteria and the outcomes are presented below:

- **Sectors:** the data* encompass deals from the 10 blue sectors previously defined in this report and its related technologies. Environmentally harmful sub-sectors such as oil & gas extraction and underwater mining have been removed from the sample.

Fig. 2.3: Deals secured by EU firms per blue sector

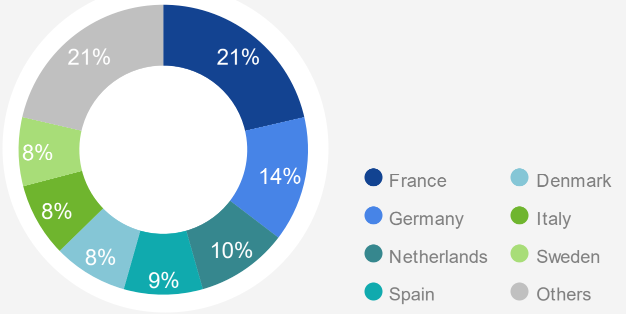
(% of total deals)



- **Geography:** all EU-27 countries were assessed, showing that frequency of investment deals were higher in countries with larger economies and stronger geographic and economic links with the European sea basins.

Fig. 2.4: Countries with most deals

(percentage of deals per country)



- **Investor type:** included private investors (e.g. angel, high net worth individuals, venture capital firms, incubators /accelerators, private equity and growth capital as well as asset managers dealing with relevant blue funds and private corporations and corporate ventures) and non-private financing players (e.g. national promotional banks (NPBs), multilateral development banks (MDBs), sovereign wealth funds, aid agencies, foundations, philanthropic foundations and NGOs***).

Fig. 2.5: Investors taking part in the mapped deals

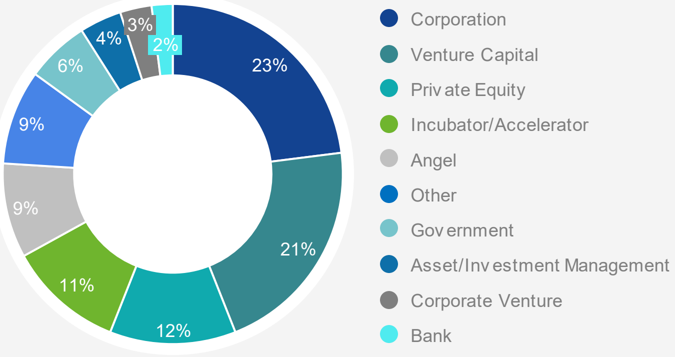
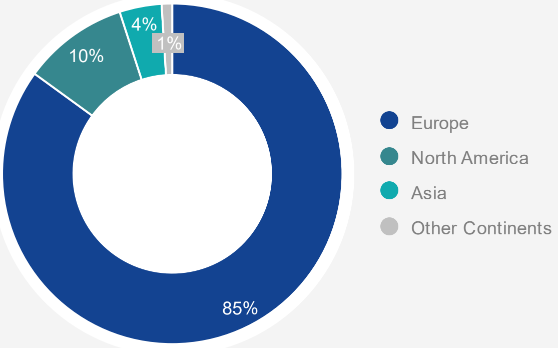


Fig. 2.6: Investors country of origin

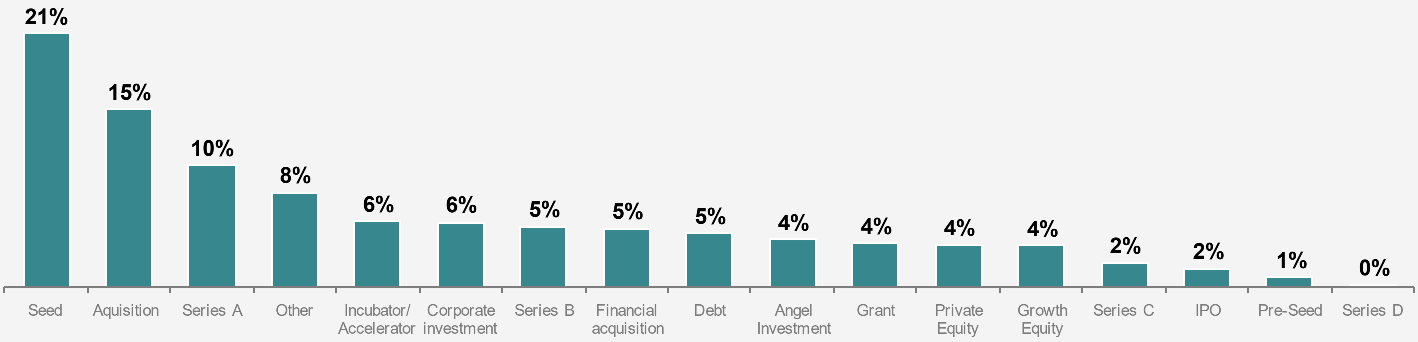


- Investors taking part in the mapped deals were mainly Corporates (23%) and Venture Capital (21%). Venture Capital is behind most of the equity-fundraising rounds (568 deals). Corporates are mostly backing acquisitions (474 mapped) but have also an important role as an equity provider co-investing in seed rounds as well as in Series A to D (101 deals)****. As per the investors country of origin, European investors represent 85% of the capital flow in EU-based deals, followed by the USA (10% of deals). In Asia, spread is diversified and led by Japan and Singapore.

- **Types of deals:** These include pre-seed, seed, series A to D, growth equity, IPO, financial and corporate acquisitions, and various forms of debts (e.g. convertible notes, mezzanine, subordinated loans, etc.).

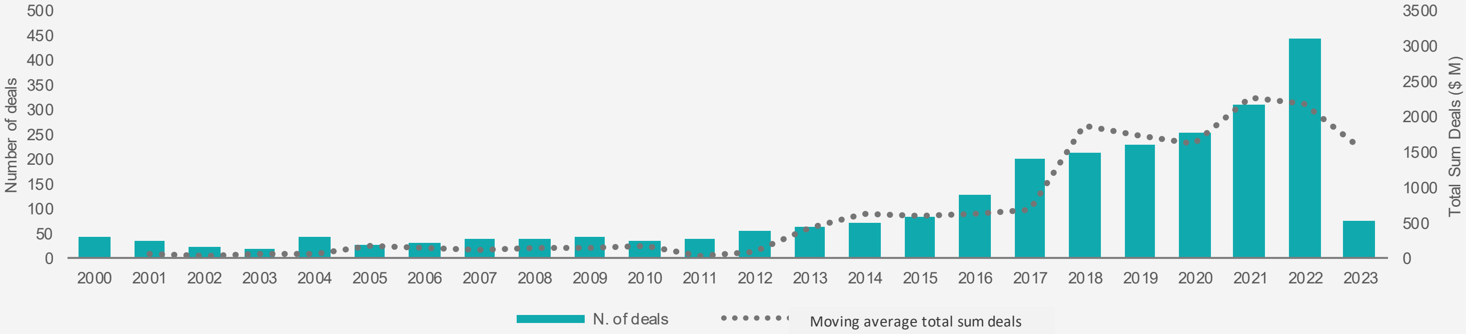
Notes: *To identify and filter relevant deals, a set of key words was defined to ensure that the data encompassed the 10 sectors of this study and its technologies. **CB Insights is specialised in technology market monitoring. Although deals are mapped in all sectors and activities, the database may be biased and favour new innovative solutions over traditional products and services. ***NGOs and foundations were only mapped when involved in for-profit co-investments. Impact-only money, although important to preserve and sustain the ocean and its biodiversity, will not be detailed in this report. ****8% of the deal mapped had undisclosed investors and were therefore excluded from this analysis. "Other investors" includes Crowdfunding, Family Offices, Public-Private Partnerships, Growth Equity and other financial services. Please note that Hedge Funds, Pension Funds and Sovereign Wealth Funds are usually indirect investors and therefore disburse through financial intermediaries and fund of funds above represented.

Fig. 2.7: Investments per round and deal type*



- **Volume and spread of investments:** amount invested and number of deals (sample from January 2000 to February 2023).

Fig. 2.8: Number of deals and total funding amount per year

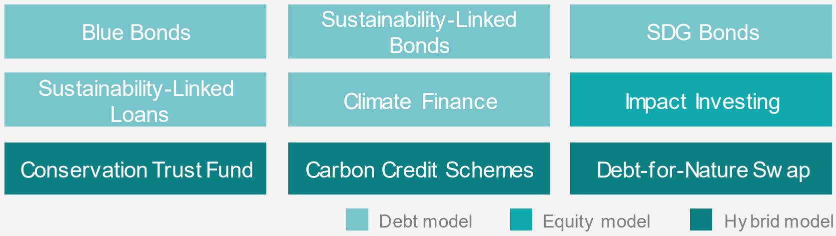


Data on financial transactions over time shows the start of a steeper growth between 2013-14, when investments in the EU Blue Economy crossing the $2 billion** mark in value in 2018. In 2019-2020, a deacceleration in the amount invested may reflect the impact of the COVID-19 pandemic, which reduced investors' risk appetite. As for the number of deals, the growth was steady in the past 10 years, even during the pandemic, when a **high number of transactions** was observed. This increase in transactions is due to a large "acquisition spree" phenomenon observed in these years (101 in total), leading to larger market concentration.

The deals activity in the blue economy **proved resilient through the most recent global developments**. In 2022, funding recovered to pre-pandemic levels in value and number of deals was at its peak (over 440). The increasing concerns around energy security, environmental protection, defence and EU autonomy are among the driving forces behind this. An indicator of these is the increased deal activity in sectors such as blue renewable energy and blue tech & ocean observation: from an average of 51 and 80 deals / year in the past 5 years, those sectors saw a rise to 101 and 120 deals respectively in 2022. This means a 2x and 1.5x times increase.

Fig. 2.9: Alternative investment strategies

Beyond the traditional direct and indirect equity investments, financial institutions and intermediaries may also opt for **alternative indirect investment strategies**. Despite not being the focus of this report, this box provides a short summary of those innovative financing instruments, that can follow debt, equity, or hybrid models and do not fall into one of the conventional investment categories:



Debt model: includes **bond instruments** designed to (re)finance projects that seek to solve certain challenges – **blue bonds**, **sustainability bonds** (**green** and **social bonds**) and **SDG bonds** (bonds that contribute to Agenda 2030). Other debt instruments include **sustainability-linked loans**, which incentivise companies to improve their sustainability performance and **climate finance**, which seeks to support mitigation and adaptation to climate change.

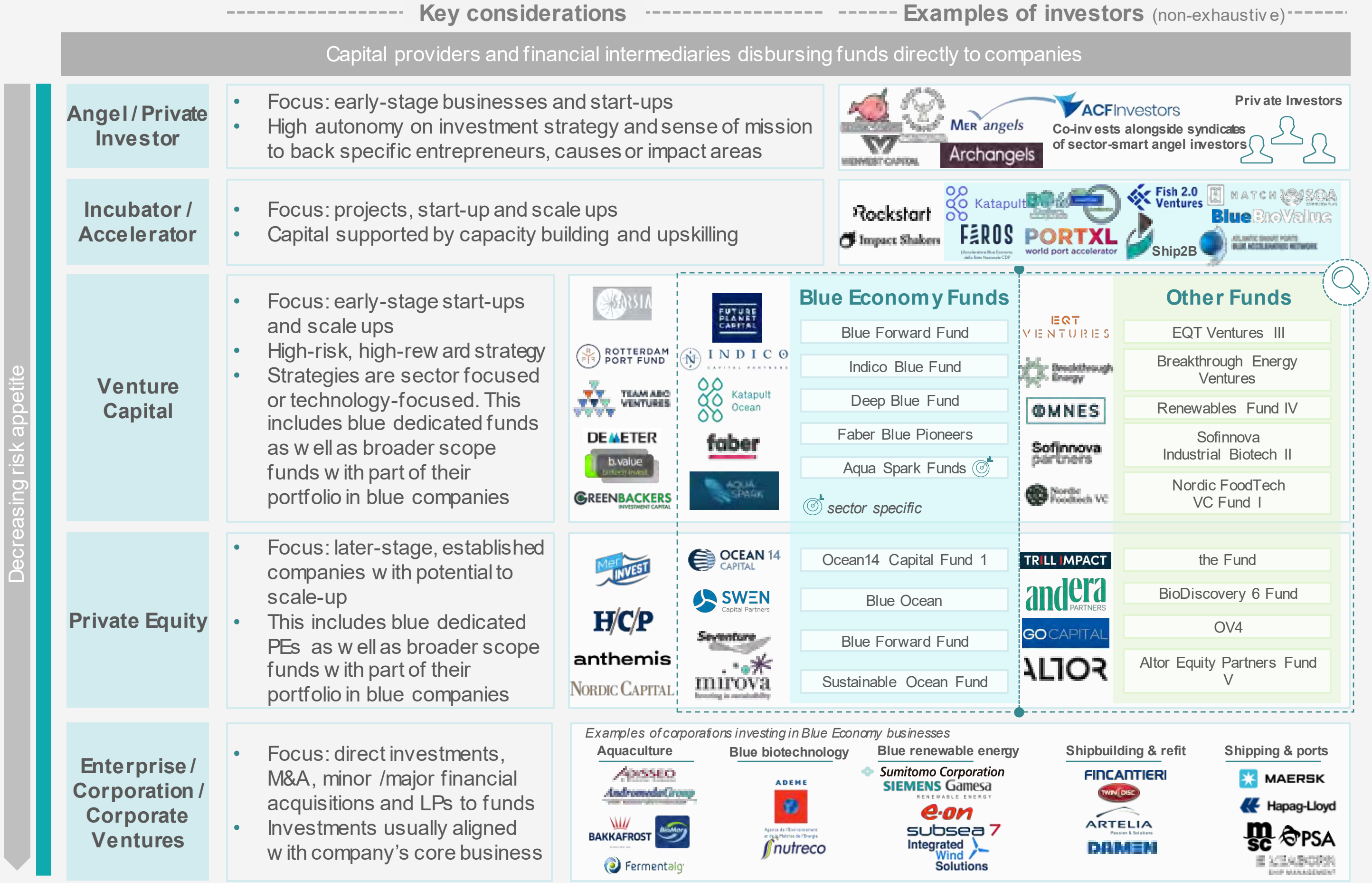
Equity model: includes impact investing, which refers to investments aiming to generate both financial returns and a positive, measurable social and environmental impact.

Hybrid models: include **carbon credit schemes**, **debt-for-nature swaps** and **conservation trust funds**.

Notes: *Unattributed and undisclosed deals were excluded from the analysis. "Other" includes Asset Sale, Business Plan Competition, Bridge, Crowdfunding, Leveraged and Management Buyout, Merger and Reverse, Mezzanine, PIPE, Secondary Market, Shareholder Liquidity, Spinoff / Spinout and Take Private. "Debt" also includes convertible notes, lines of credit and loans in the context of financing innovation. Debts to support day-to-day business operations are not taken into consideration.**Values presented in USD due to sources utilised.

- **Concrete examples of active investors and investment strategies**: based on the data analysed, the following images provide a visual representation of some of the key players investing in the blue economy.

Fig. 2.10: Direct investors[28]



Key considerations — Examples of investors (non-exhaustive)

Capital providers and financial intermediaries disbursing funds directly to companies

Decreasing risk appetite

	Key considerations	Examples of investors (non-exhaustive)
Angel / Private Investor	Focus: early-stage businesses and start-ups High autonomy on investment strategy and sense of mission to back specific entrepreneurs, causes or impact areas	Private Investors Co-invests alongside syndicates of sector-smart angel investors
Incubator / Accelerator	Focus: projects, start-up and scale ups Capital supported by capacity building and upskilling	
Venture Capital	Focus: early-stage start-ups and scale ups High-risk, high-reward strategy Strategies are sector focused or technology-focused. This includes blue dedicated funds as well as broader scope funds with part of their portfolio in blue companies	**Blue Economy Funds:** Blue Forward Fund Indico Blue Fund Deep Blue Fund Faber Blue Pioneers Aqua Spark Funds ◎ ◎ *sector specific* **Other Funds:** EQT Ventures III Breakthrough Energy Ventures Renewables Fund IV Sofinnova Industrial Biotech II Nordic FoodTech VC Fund I
Private Equity	Focus: later-stage, established companies with potential to scale-up This includes blue dedicated PEs as well as broader scope funds with part of their portfolio in blue companies	**Blue Economy Funds:** Ocean14 Capital Fund 1 Blue Ocean Blue Forward Fund Sustainable Ocean Fund **Other Funds:** the Fund BioDiscovery 6 Fund OV4 Altor Equity Partners Fund V
Enterprise / Corporation / Corporate Ventures	Focus: direct investments, M&A, minor /major financial acquisitions and LPs to funds Investments usually aligned with company's core business	*Examples of corporations investing in Blue Economy businesses* Aquaculture Blue biotechnology Blue renewable energy Shipbuilding & refit Shipping & ports

Fig. 2.11: Indirect investors[28]

Traditional providers of capital and potential targets for fund raising

	Strategy	Examples
Asset Manager	Strategy: defined by asset management mandates based on specific investment opportunities and expected performance of investment	
Banks (Commercial banks, NPBs)	Strategy commercial bank: well-established financial service offering for traditional markets & increasing appetite for new products and services supporting emerging technologies, new business opportunities & impact-driven markets Strategy NPBs: driven by policies linked to socioeconomic objectives	*Examples of banks with clear sustainability missions* First Blue Economy ETF (BNPP AM) National Promotional Banks
Asset Owners	Sovereign wealth funds and pension funds: operate on large scale, low risk and preference for higher tickets. Increasing number of impact window openings Family offices: autonomous and agile strategies. Often opportunistic, able to deploy small investments Foundations: impact-focused with links to different themes and areas of development	Monaco Sovereign Wealth Fund New Zealand Superannuation Fund Family philanthropy working on sustainable marine projects Cooperative non-profit pension fund administrator Evergreen investment company Global network for impact investing for private asset owners

Source: Friends of Ocean Action (2020)[28]

The following sub-chapters zoom in on EU private investments (equity only), EU public investments and initiatives supporting the Blue Economy.

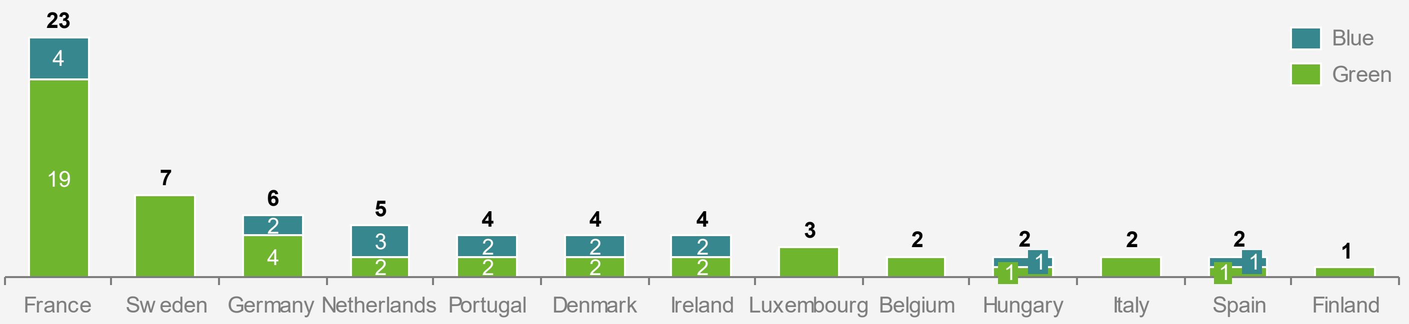
Private impact investments in the EU blue economy

Private investments, as presented above, are composed of a vast and heterogeneous group of investors and capital holders. To ensure we have sufficient focus and capture investments in start-ups and SMEs, we will narrow this assessment to **equity investments funds**, managed usually by direct investors such as VCs and LPs (profiles mentioned in Figure 2.10*).

65 funds created with the intention to generate positive environmental and social impact** were identified in the EU during this initial mapping. Out of those, 17 are blue dedicated and 48 are green funds with one or more blue technologies in their portfolio. Their spread across the EU is presented below.

France and Sweden lead in number of impact funds while Netherlands is the only to have 4 blue dedicated funds.

Fig. 2.12: Number of VC funds in Green and Blue in the EU***



Notes: ***France has investors in the green space that have multiple funds launches (such as Mirova, Omnes and Soffinova). Same happens in the Netherlands, where Aqua-Spark has multiple blue dedicated funds.

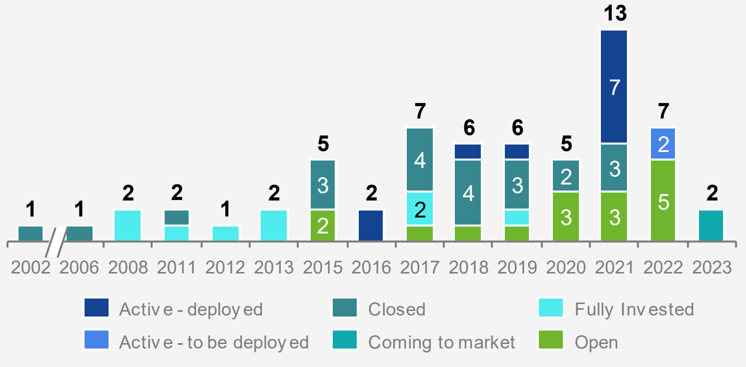
75% of those funds were launched from 2017 onwards, showing impact-oriented investments are gaining traction.

Looking at the funds life cycle****, 35% of the funds mapped are already closed for new investors and may be in different stages of divestment and exits. The remaining 65% are distributed as follows:

- 21% are actively deployed or to be deployed,
- 15% are fully invested
- 24% of them still open
- 3% is expected to come to market in 2023
- 2% is evergreen

The spread of this across the years is visually detailed below:

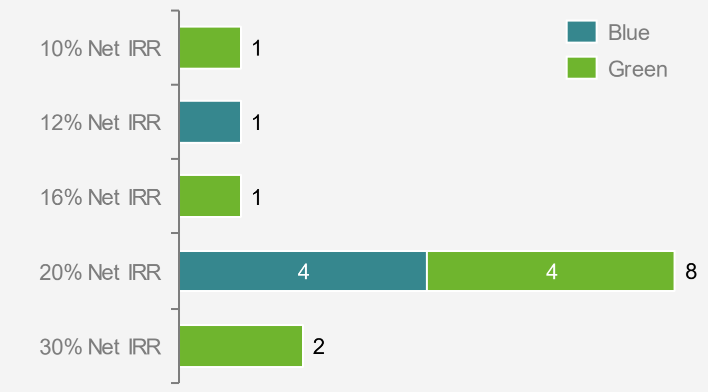
Fig. 2.13: Vintage years of green & blue funds sample



2021 was the busiest year in our sample, with 13 funds launched, all of them now Open for investments or Active.

Information on target returns is not always made public. For this analysis, we considered data made available by 13 of the funds sampled. This analysis is nonetheless very relevant showing that **10 of them are targeting Net Internal Rate of Return (IRR) equal or above 20%**.

Fig. 2.14: Expected Net IRR

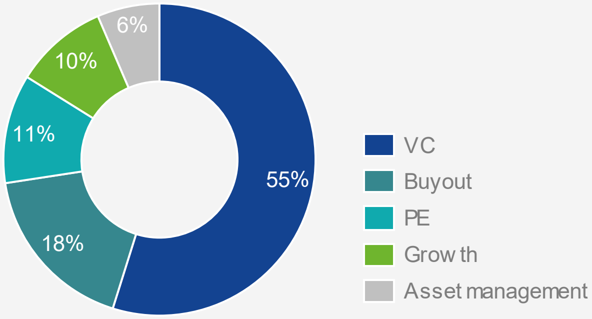


In the following page, Figure 2.15 shows that looking exclusively to dedicated blue funds, the majority are VC owned (55%).

Under the VCs we find investors like Aqua-Spark, Devonian Capital, Faber, HATCH, Indico Capital, Innoport, Swen Capital and Susterra Capital. Under PE, Mirova and Seventures are the key investors. Finally, Navigare Capital Partners and Aqua-Spark have buyouts funds deployed.

Notes: *Indirect investors , such as asset owners and banks are important sources of institutional capital and potential LPs, but their direct investments in equity is usually dedicated a larger deal and rarely concern start-ups and SMEs. Their contribution to funding innovation, nonetheless, will likely be captured through our funds analysis. **Impact funds are those created with the intention to generate positive, measurable social and environmental impact alongside a financial return. ****Definitions of fund cycles and investment stages were aligned with the ones from Pitchbook, where data was sourced.

Fig. 2.15: Investor type



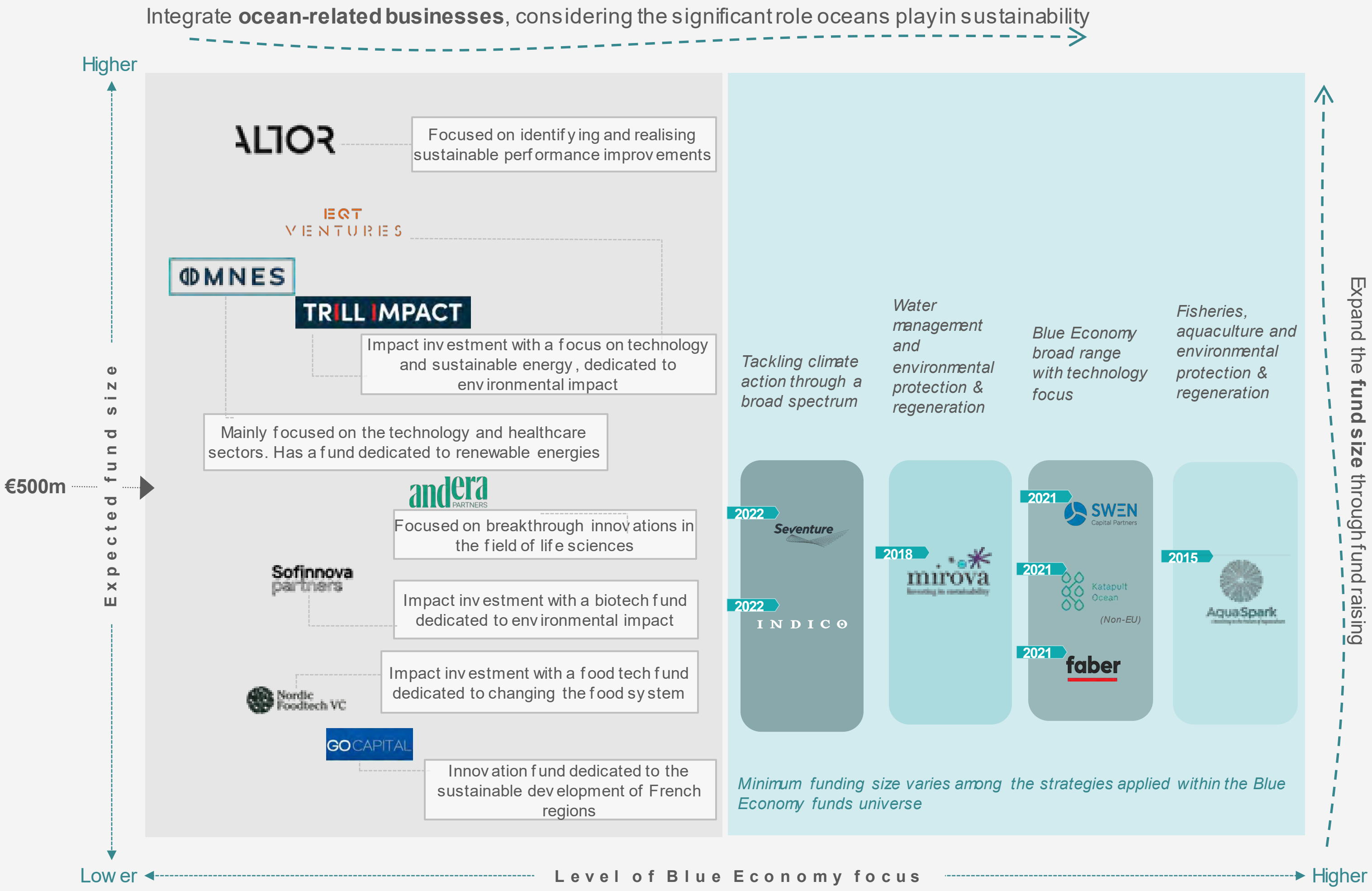
The matrix below was developed to help readers navigate through the funds and their different strategies and portfolios, considering the level of specialisation in the blue economy and the size of the funds.

On the right-hand side of the matrix, we see blue-dedicated funds with different levels of specialisation strategy. Some have a broad portfolio range, covering innovations across multiple sectors contributing to SDG14 and regenerating ocean health, such as **Swen Capital Partners** and **Seventure Partners**. Others, like **Aqua-Spark and Faber,** are sector-focused, and they target, respectively, the aquaculture value chain and tech companies across the spectrum of the blue economy.

On the left-hand side of the figure are funds that focus on different strategic areas that happen to include blue economy-related industries. For instance, the larger funds raised by **EQT Ventures** and **Trill Impact** invest in technology and sustainable energy that have an positive environmental impact; the smaller funds raised by **Sofinnova Partners**, and **Nordic Food Tech** focus on (blue) biotechnology and sustainable food system & food tech, respectively.

Fig. 2.16: Select funds with interest in the Blue Economy*

ILLUSTRATIVE



Focused on identifying and realising sustainable performance improvements

Impact investment with a focus on technology and sustainable energy, dedicated to environmental impact

Mainly focused on the technology and healthcare sectors. Has a fund dedicated to renewable energies

Focused on breakthrough innovations in the field of life sciences

Impact investment with a biotech fund dedicated to environmental impact

Impact investment with a food tech fund dedicated to changing the food system

Innovation fund dedicated to the sustainable development of French regions

Minimum funding size varies among the strategies applied within the Blue Economy funds universe

Note: *Active funds investing in Europe that either solely focus on ocean-related businesses (**Blue Economy Funds** on the **right-hand side** of the Figure) or have a **broader focus** on **sustainability** themes (**Other funds** on the **left-hand side** of the Figure). Both larger and smaller funds are represented.

Source: PwC Analysis

Showcase of Blue Economy Funds (1/2)

Examples of active Blue Economy funds investing in Europe that solely focus on ocean-related businesses. Both larger and smaller funds are represented. All the evidence showcased dates to January 2023.

NON-EXHAUSTIVE

Blue Economy Fund	Strategic intent	Financial considerations	Fund evolution
Blue Ocean SWEN Capital Partners	Achieve both systemic impact and top-tier financial performance through investments in developing innovations that help regenerate ocean health and contribute to SDG14 **Start-ups**	**€150 million** – *target* *Current commitment of **€120M*** Already invested in OptoScale, Nature Metrics, Spinergies, Noray, Avant and 900.Care	**September 2021** Grow its portfolio to between 20 to 25 innovative start-ups
Althelia Sustainable Ocean Fund mirova Investing in sustainability	Marine and coastal projects and enterprises that can deliver sustainable economic returns in fisheries, aquaculture, associated seafood supply chains, ocean waste & recycling and marine conservation **Start-ups / post revenue** 40% Latin America & Caribbean, 30% Africa & 30% Asia and Pacific	**€132 million** – *target* Already invested in Martec Industries, nextProtein; Clean Marine Group, Biomega, SafetyNet Technologies, Plastics for Change, TASA	**June 2018** Build resilience in coastal ecosystems and create sustainable economic growth and livelihoods in the Blue Economy through a minimum investment period of 8 years
Blue Forward Fund Seventure	Back the transition to a more sustainable lifestyle, including health and the natural environment aspects by investing in the blue economy **Seed- to late-stage venture, growth** and **pre-IPO stage** Businesses based in France, Europe, Israel, North America and Asia	**€130 million** – *target* *Current commitment of **at least €30M*** Ticket size of **€500k-€5m per round**; up to **€10m** per company	**February 2022** Grow its portfolio to 20 innovative companies
Aqua Spark Funds AquaSpark	Industry challenges within the aquaculture sector: feed, waste, pollution and disease; seeking entrepreneurs working towards a more sustainable aquaculture food system **Global**	**€89 million** - *raised* **Invested in 24** complementary aquaculture companies between **2015 and 2021**	**2015** Enable aquaculture to reach its potential as the healthiest, most resource efficient, lowest footprint animal protein to produce

● *Fund already deployed* ● *Fund to be deployed* ● *Unclear fund status* *Fund strategy; sectors of focus* *Type and size of firms*

Geographical scope *Fund amount* *Ticket size* *Fund portfolio companies* *Launch date* *Future expectations*

Showcase of Blue Economy Funds (2/2)

NON-EXHAUSTIVE

Blue Economy Fund	Strategic intent	Financial considerations	Fund evolution
Indico Blue Fund ● INDICO	Tackle climate action by focusing on ocean-related companies in all Blue Economy sectors (except extractives) that have a positive impact on ocean ecosystems **Early- to growth-stage** businesses; **start-ups and SMEs** Businesses based out of Portugal to **scale globally**	**€50 million** – *target* *Current commitment of **€38.7M*** Ticket size of **up to €5M** for SMEs Already invested in **BioMimetx, Bitcliq, Inclita Seaweed Solutions and Ittinsect**	**January 2022** **First ocean-**related fund launched by Indico
Faber Blue Pioneers ● faber	Deep-tech solutions with global ambitions in areas such as blue biotech, food and feed from the ocean, ocean health, ocean intelligence and decarbonisation for multiple industries **Pre-seed to series A** Businesses based in **Europe** (south), with a focus on **Portugal**	**€30 million** – *target* Already invested in **Microharvest, Fuelsave and 1s1 Energy**	**October 2021** Grow its portfolio to **20-25 early-stage companies**

● *Fund already deployed* ● *Fund to be deployed* ● *Unclear fund status* *Fund strategy; sectors of focus* *Type and size of firms*

Geographical scope *Fund amount* *Ticket size* *Fund portfolio companies* *Launch date* *Future expectations*

Showcase of other Funds with an interest in ocean-related themes (1/2)

Examples of active impact investment funds investing in Europe that have a broader focus on sustainability themes. Both larger and smaller funds are represented. All the evidence showcased dates to January 2023.

NON-EXHAUSTIVE

Fund	Strategic intent	Financial considerations	Fund evolution
🇸🇪 Altor Equity Partners Fund V ● ALTOR	**Innovative and high-performing** companies that can **accelerate the green transition** and redefine the industry landscape Invest in and develop **mid-market companies** **Nordics and DACH** regions	**€2.5 billion** – *raised* Already invested in **H2 Green Steel, Svea Solar, Trioworld, Nova Austral** and **Nordic Climate Group**	**February 2019** Engaged in partnerships built on **curiosity, creativity and achieving a lasting impact**
🇸🇪 EQT VENTURES III EQT VENTURES ●	**Climate tech, food tech, the creator economy, energy,** fintech, software, deep tech and more **Early-stage** businesses **Europe and North America**	**€1.1 billion** – *raised* Ticket size of **€2m-€50m** per company Already invested in **Candela, Einride, Single.earth** and **Heart Aerospace**	**November 2022** **A multi-stage** ventures investment **strategy**
🇫🇷 Renewables Fund IV ● OMNES	**The technology and healthcare sectors** **All business stages** Businesses based in **Europe, with a focus on France**	**€1 billion** – *raised* Ticket size of **€3m-€5m per round**; up to **€15m** per company Already invested in **TagEnergy, ILOS New Energy, Repower Renewable, Ilmatar Energy** and **Gourmey**	**January 2020** Finance companies which **create disruptive innovations as well as strong commercial traction**
🇸🇪 the Fund ● TRILL IMPACT	**Attractive businesses** with the potential to **accelerate their contribution to the SDGs** through products and services, or to become impact leaders in their respective industry from sustainable value chains Majority **ownership** in **mid-sized businesses** **Nordics, DACH** and **Benelux** regions	**€900 million** – *raised* Already invested in **Cinclus Pharma** and **Nordomatic**	**July 2021** **Deliver real returns and lasting impact for** the benefit of investors, businesses and society at large

__DACH__ – Germany, Austria and Switzerland; __Benelux__ – Belgium, the Netherlands and Luxembourg

● *Fund already deployed* ● *Fund to be deployed* ○ *Unclear fund status* *Fund strategy; sectors of focus* *Type and size of firms*

Geographical scope *Fund amount* *Ticket size* *Fund portfolio companies* *Launch date* *Future expectations*

Showcase of other Funds with an interest in ocean-related themes (2/2)

NON-EXHAUSTIVE

Fund	Strategic intent	Financial considerations	Fund evolution
BioDiscovery 6 Fund ●	Companies developing **breakthrough therapeutic products and medical technologies** from pre-clinical stages to commercialisation From **start-up/early-stage to growth/late-stage** businesses **Europe** and the **US**	**€456 million** – *raised* Ticket size of **€5m-€35m per company** Already invested in **Qovoltis, Kyotherm, Terr.A, Lhyfe, Watt & Co Ingénierie** and **Klubb Group**	**October 2022** **Fund the development of innovative medical solutions** based on strong scientific hypotheses, supported by robust pre-clinical or clinical data, and protected by **strong intellectual property**
Sofinnova Industrial Biotech II ●	Investments that will have a **positive impact on sustainability in the chemicals, agriculture, food and materials sectors** **Seed- to later-stage** businesses Main focus on **Europe and North America**	**€175 million** – *raised* Already invested in **Afyren, Microphyt, Biosyntia, Pyrowave, Meiogenix**	**November 2021** Bring **sustainable solutions to our everyday lives**
Nordic Food Tech VC Fund I ●	Solving the hard underlying problems in **food and farming with new technology built on scientific discovery** and solid engineering – the deep food-tech **Early-stage** businesses Main focus in **Europe (Nordics and Baltics)**	**€42 million** – *raised* Already invested in **Hailia Nordic, Nordic Umami Company**	**October 2021** Transform the global food system for the **climate and for life on the planet**
OV4 ●	**High-potential companies** that aim to accelerate through **innovation or international deployment** Focus on **start-up/early-stage** businesses Businesses based in **France**	**€40 million** – *raised* Ticket size of **€1m-€5m per round** Already invested in **Mascara Renewable Water, Sabella, ERGOSUP** and **Sweetch Energy**	**December 2021** Provide **equity to some 20 companies** aiming for strong growth, particularly in international markets

● *Fund already deployed*
● *Fund to be deployed*
● *Unclear fund status*
Fund strategy; sectors of focus
Type and size of firms
Geographical scope
Fund amount
Ticket size
Fund portfolio companies
Launch date
Future expectations

Public investments in the EU Blue Economy

The European Union helps drive investment flows not only through enabling policies and initiatives, but also by allocating public funding to foster green and blue innovation. This capital is channeled through either the initiatives and programmes under the Multiannual Financial Framework or its financial intermediaries, the European Investment Bank (EIB) and the European Investment Fund (EIF).

Together, they launch initiatives to increase access to financing by pooling the necessary resources and providing risk-reduction facilities to attract private investment. Both the EIB and the EIF use a range of financial instruments such as bonds, guarantees and quasi-equity to help de-risk specific investments and technologies linked to many sectors including the blue economy.

The box below lists the main public funds currently dedicated to advancing new sustainable ocean technologies. Some of them are focusing more broadly on the green and digital transition, while others are dedicated to blue economy instruments. Some noteworthy examples are:

- NextGenerationEU, including the Recovery and Resilience Facility, an instrument aimed at driving Europe's green and digital recovery from the Covid pandemic (€806.9 billion[29]);
- European Maritime, Fisheries and Aquaculture Fund (EMFAF), with a budget of €6.11 billion and the goals of facilitating the sustainable use and management of marine resources and developing a resilient blue economy[29];
- ETS Innovation fund, with a budget of €38 billion (2020-2030) is already funding large-scale demonstration projects in innovative low-carbon technologies, including blue solutions;
- European Innovation Council (EIC) established under the EU Horizon Europe programme, has a budget of €10 billion to support innovation in areas that can be transversal to the blue economy, such as renewable energy and biotech.
- InvestEU which aims to mobilise more than €372 billion of public and private investment through an EU budget guarantee of €26.2 billion that backs the investment of implementing partners such as the European Investment Bank (EIB) Group and other financial institutions, providing guarantees to de-risk investments, including in the Blue economy.

To further illustrate how financial intermediaries and companies can benefit from EU public funding, we present below the two dedicated blue funds of funds deployed by the European Commission in partnership with the European Investment Fund:

I. In 2020 the **BlueInvest Fund** was announced and launched: this was the first ever dedicated equity funding programme for the EU Blue Economy sector. The fund successfully deployed €75 million EFSI contribution plus €15 million from InnovFin Equity to several Venture Capital Funds, who are now using these guarantees to invest up €300 million in the Blue Economy in the next 5 years, most of it in the EU.

II. In 2022, the **InvestEU Blue Economy Fund** was announced: this is the scaled-up equity initiative building on the BlueInvest Fund pilot under EFSI, bringing together the European Maritime, Fisheries and Aquaculture Fund, the EIB Group and InvestEU finance. The aim of this equity initiative is to mobilise an ***additional* €500 million** of EU funds for financial intermediaries investing in the Blue Economy sector. This is expected to **result in €1.5 billion of risk-financing** available to innovative and sustainable Blue Economy SMEs and start-ups, via financial intermediaries. The call for expressions of interest is open via the EIF website.

Finally, as the **Green Transition** is a cross-cutting priority area, several other EU funds support Blue Economy projects[29] with a view to tackling challenges related to decarbonisation, sustainable development, climate action, environmental protection and food security. Some examples are the **Cohesion Fund (CF), Horizon Europe, the LIFE programme, the Connecting Europe Facility**.

Fig. 2.17: EU funding, financing and support to financing*

NON-EXHAUSTIVE

European Commission:

Multiannual Financial Framework 2021-27 (long-term budget):

- Horizon Europe
    - European Circular Bioeconomy Fund
    - Copernicus
    - European Innovation Council
- 💧 European Maritime, Fisheries and Aquaculture Fund (EMFAF)
- Program for Environment and Climate Action (LIFE)
- Connecting Europe Facility (CEF)
- InvestEU
    - 💧 Climate and Environmental Solutions includes **InvestEU Blue Economy**
    - Blue economy sectors targeted under several windows
- Cohesion Fund (CF)
- Just Transition Fund
    - Sustainable Europe Investment Plan
- European Regional Development Fund
- European Defence Fund

NextGenerationEU (temporary instrument)

- Recovery and Resilience Facility

Other sources of EC funding

- Emission Trading System
    - Innovation Fund
    - Modernisation Fund
- Renewable Energy Financing Mechanism

European Investment Bank

- 💧 Blue Sustainable Ocean Strategy (Blue SOS)
- 💧 Clean Ocean Initiative

💧 Mechanism exclusively dedicated to the Blue Economy

Note: *Given the number of initiatives that exist, this section is not comprehensive; rather, it focuses on some of the more prominent initiatives.

Source: European Commission - public investments in the EU blue economy[29]

Enabling initiatives supporting the EU blue ecosystem

To enable and bring to market innovation and scale-up companies, it is necessary to provide assistance beyond financial support. Numerous initiatives (see Figure 2.18) are already being implemented and promoted by public actors with support from the private sector, academia, clusters and society, with a view to developing an entrepreneurial ecosystem well-suited to support the EU blue economy.

At **policy level**, the overarching driver is the commitment undertaken by the European Commission (EC) and many national governments to implement the UN 2030 Agenda for Sustainable Development[30, 31]. Among specific EU policies is the European Green Deal, which seeks to advance climate action and set standards for sustainable growth[32]. Under the Deal, the EU is implementing a wide range of policies, principles and standards, including initiatives aimed at promoting the sustainable management of maritime activities and coping with different environmental pressures. The EU's Restore our Ocean and Waters by 2030 Mission under Horizon Europe research and innovation programme is one prominent example of such policy initiatives[33].

In terms of **sustainability principles and impact standard-setting**, EU initiatives and investment programmes are already underway to support the transition to a sustainable blue economy, as announced by the **European Commission's** communication **titled** "A new approach for a sustainable blue economy in the EU - Transforming the EU's Blue Economy for a Sustainable Future"[4].

The **EU's Sustainable Finance Strategy**, including the **EU Taxonomy** for sustainable activities, is important to help investors determine which economic activities are environmentally sustainable and encourage them to redirect capital flows towards these activities[5].

Also, the EC is involved in many international initiatives to align metrics and practices. Among these is the Sustainable Blue Economy Finance initiative, a platform currently hosted by the United Nations Environment Programme Finance Initiative (UNEP FI), which brings together international stakeholders to adopt and implement the Sustainable Blue Economy Finance Principles[34] (launched in 2018). These Principles constitute the first global guiding framework for investors and are the keystone of sustainable ocean economy investments. Alongside promoting the implementation of SDG14, they set out ocean-specific standards that help the financial industry to mainstream the sustainability of ocean-based sectors[34, 35].

At a **capacity and community building level**, the BlueInvest Platform[5] is an EC flagship initiative supporting entrepreneurs and investors navigate through the sustainable blue transition and growth.

Fig. 2.18: Key Blue Economy initiatives*

NON-EXHAUSTIVE

Policy framework
Guidance, procedures and goals for all ocean stakeholders

European initiatives
- European Green Deal - Sustainable Blue Economy
- European Mission Restore Our Ocean and Waters by 2030

Global initiatives
- United Nations Sustainable Development Goals (SDGs)

14 LIFE BELOW WATER

Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Principles and standards
Tools to analyse, set criteria and evaluate sustainable and environmental disclosures

European initiatives
- EU Taxonomy
- European Green Bond Standard

Global initiatives
- Sustainable Blue Economy Finance Initiative
- Task Force on Climate-related Financial Disclosures
- Task Force on Nature-related Financial Disclosures
- Coalition for Private Investment in Conservation
- Poseidon Principles
- International Union for the Conservation of Nature - Blue Natural Capital Financing Facility

Programmes and platforms
Boosting innovation and investment in Blue Economy sectors

European initiatives
- BlueInvest
- European Network of Maritime Clusters

Global initiatives
- Financing Sustainable Maritime Transport Roundtable
- High-Level Panel for a Sustainable Ocean Economy

HIGH LEVEL PANEL for A SUSTAINABLE OCEAN ECONOMY

Note: *The European Circular Bioeconomy Fund was established with a commitment from the EIB and backed by a guarantee from Horizon 2020; the InvestEU Blue Economy is funded by EMFAF, EIB Group and InvestEU Finance; the Sustainable Europe Investment Plan will also be funded by other public and private entities; the Clean Oceans Initiative is funded by the German development bank KfW Group, the Agence Française de Développement, Cassa Depositi e Prestiti (CDP), the Spanish promotional bank ICO and the European Bank for Reconstruction and Development.

Sources: European Commission (2021)[4]; European Commission (2022)[5]; European Commission[30, 31, 32]; European Commission (2021)[33]; UN Environment Programme[34]; UNEP FI SBE (2021)[35]

Fig. 2.19: BlueInvest platform

The BlueInvest impact

Launched by the European Commission in April 2019 and funded by the European Maritime, Fisheries and Aquaculture Fund (EMFAF), BlueInvest established the first investment platform for the sustainable blue economy, providing support to high potential businesses in the sustainable blue economy to build capacity for growth and attract investment.

Since 2019, 226 high-potential businesses have benefited from the Investment Readiness Assistance, with a 96.5% satisfaction rate. More than 80 beneficiaries had qualified introductions to investors and 32 of them secured investment.

Following the EU BlueInvest Readiness Assistance programme, a number of companies successfully secured investments and their success stories are available at the BlueInvest community*. Some examples include the Italian start-up Ittinsect producing aquaculture feed with novel raw ingredients successfully raised €750 000 of which €625 000 in equity from investors end of 2022. The BlueInvest coach has played a key role in the success of the start-up by equipping it with the right skills to participate in fundraising rounds and by facilitating quality introductions to investors. The completion of the EU BlueInvest Readiness Assistance programme has also been key for KandaAps developing digital training solutions using virtual reality in the maritime and energy sectors. The start-up successfully raised $2 million from strategic investors from Singapore, namely the shipping company Eastern Pacific Shipping, joined by existing shareholders from Techstars. 'Our BlueInvest Coach has been excellent in helping us improving our pitch skills and introducing us to a number of relevant investors in the sector' says Kristian Emil Andreasen,CEO of Kanda. Today, BlueInvest continues to support the building up of a blue investment ecosystem in the EU that will power the Road to Net Zero. It provides investors access to a range of services to get in early and reap the rewards of the growing EU blue economy:

- the **BlueInvest Community**, a networking platform bringing together more than 1 550 blue economy entrepreneurs, investors, corporate firms and innovation stakeholders;
- the **Investor Capacity Building sessions**, providing investors with market intelligence and the sector knowledge that they need to set-up or finetune your portfolio strategy;
- The **BlueInvest Investor Report** offering intelligence based on market trends and concrete investment opportunities in the sustainable blue economy;
- The **BlueInvest Academy** providing capacity-building courses, training events and exclusive webinars;
- The **BlueInvest Project Pipeline** helping investors looking for new ventures in the sustainable blue economy by showcasing high potential businesses with innovative and sustainable technologies and solutions in the field;
- Access to **funding opportunities**, by providing investors information or matching them to funding opportunities, including through InvestEU;
- The **BlueInvest events and matchmaking sessions** generating new leads and expanding investors and companies' network.

Note: *Access more success stories at https://blueinvest-community.converve.io/newsroom_successstories.html

3

Investor perspectives

Investor perspectives

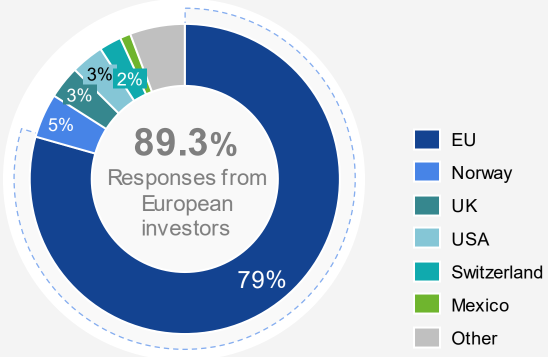
The investor survey

This chapter is based on the results of a survey completed by 87 investors between late September and early October 2022. The respondents come from an original pool of 300 investors that had been contacted based on their previous engagement with BlueInvest and stated interest in investing in the blue economy. Several types of investors were surveyed, the majority of respondents coming from **venture capital and private equity (58%),** most of whom were based in the EU (79%).

The survey results provide a view on the current investment activity in the sustainable blue economy, reflecting on the attractiveness of each sector from an investor's standpoint. It also reveals perceptions on where market opportunities are, how capital is allocated, what drives (and hinders) investment, and which criteria are relevant when deciding to invest.

Fig. 3.1: Respondent demographics*

Question: Are you currently based in Europe? Please enter the country in which your office is located.



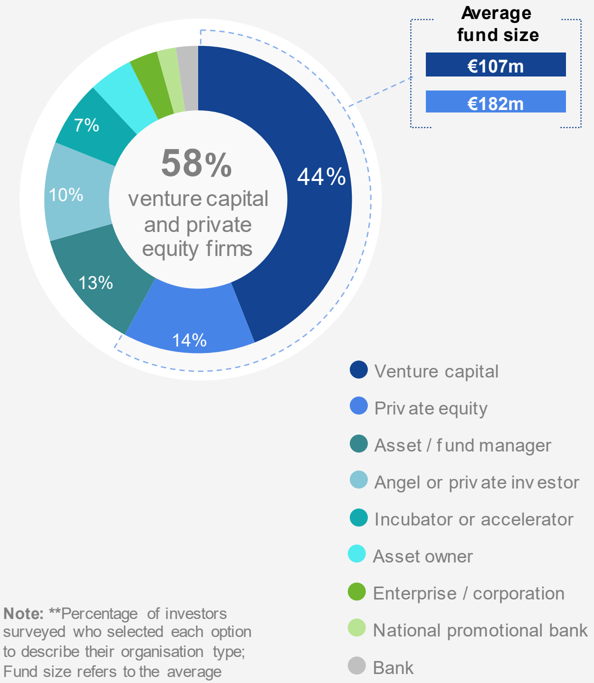
List of EU countries represented in the sample:

Austria
Belgium
Bulgaria
Croatia
Denmark
Finland
France
Germany
Greece
Ireland
Italy
Latvia
Lithuania
Luxembourg
Netherlands
Poland
Portugal
Romania
Slovakia
Spain
Sweden

Note: *n=87.

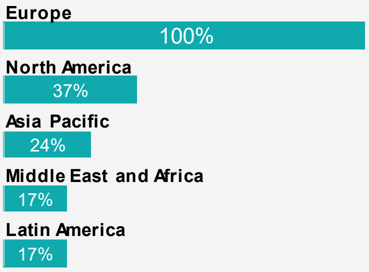
Fig. 3.2: Investor profile

Question: What investor type best describes your organisation?**

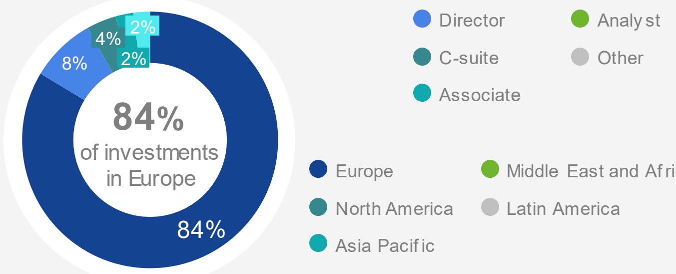


Note: **Percentage of investors surveyed who selected each option to describe their organisation type; Fund size refers to the average amount of capital each organisation has; n=87.

Question: Which regions do you invest in?***

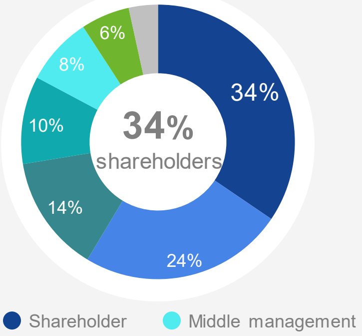


Question: What is the percentage of investment allocated to this region (average)?****



Note: ***Percentage of investors surveyed who invest in each region, n=87; ****(2) Share of investments allocated to each region, on average, n=87.

Question: What is your role within the organisation?*****



Note: *****Percentage of investors surveyed who selected each option to describe their role. Where more than one option was selected, only the highest position was considered; n=87.

Interest in investing in the sustainable blue economy

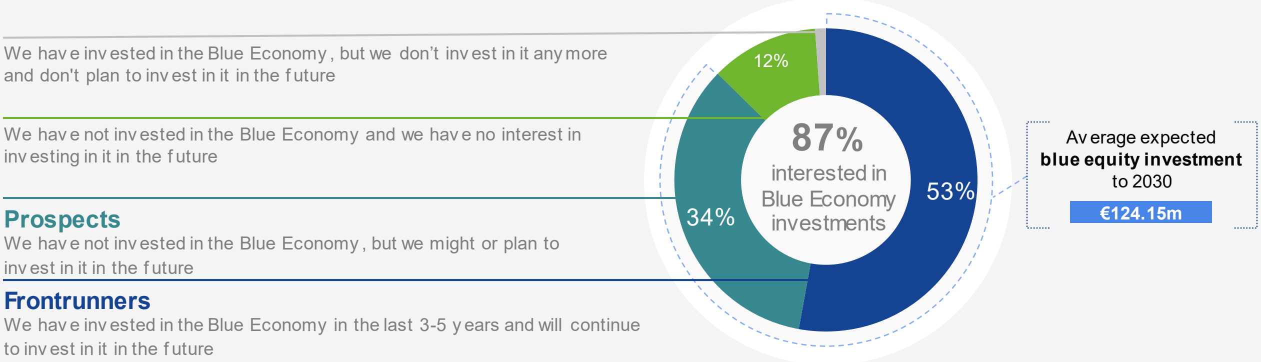
Among the investors surveyed, 87% either currently invest or plan to invest in the sustainable blue economy. 53% are current investors ("Frontrunners“), and 34% are future investors ("Prospects“).

Europe is at the heart of their strategy. On average, respondents plan to allocate 83% of their investments to Europe.

The majority of Prospects plan to invest within 1-3 years, with 23% planning to do so within a year. Only 20% of respondents plan to invest long term. Respondents reported the blue economy in general as a main focus (55%), but also information technology (47%) and energy (45%).

Fig. 3.3: Interest in the Sustainable Blue Economy*

Question: (1) What best describes your interest in investing in the Sustainable Blue Economy? (2) What is the total amount of equity investment you expect to make in the Blue Economy in EU-27 between now and 2030?



Note: *(1) All investors surveyed indicated their level of interest in the Sustainable Blue Economy, n=87; (2) Only those planning to invest in the Blue Economy in the future indicated the amount of blue equity investments they expect to make; n=76.

Prospects and frontrunners expect to invest €124.15 million on average in the sustainable blue economy between now and 2030. Venture capital firms plan to invest an average of €62.7 million and private equity firms €33.1 million. Notably, asset managers and fund managers plan to invest more, at €81.0 million on average.

That said, the **EU’s Green Deal objectives are increasingly prominent** in their current allocation of equity investments. For the frontrunners, **43% is allocated to green investments and 28% of their portfolio on average is allocated to blue investments**.

Fig. 3.4: Planning of investment in the Blue Economy

Question: When will you start investing in the Blue Economy?

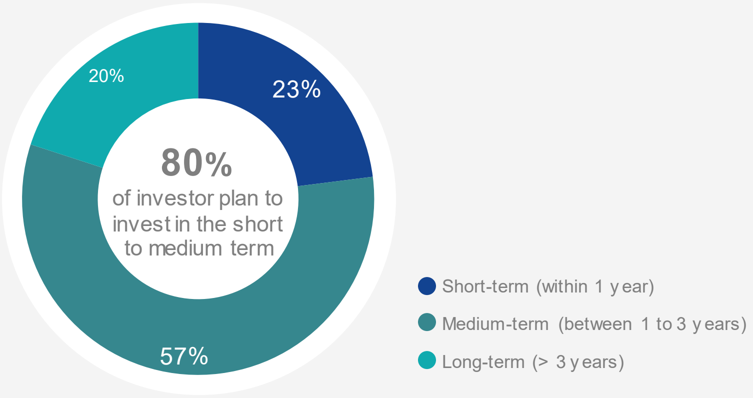


Fig. 3.5: Blue and Green equity investment allocation*

43% of blue economy investor portfolios are **green investments**

28% of portfolios are **blue investments**

45% of investors have **energy** as a main focus

47% of investors have **information technology** as a main focus

55% of investors have **blue economy** as a main focus

Note: *Share of green / blue investments in the portfolios of investors who have green / blue investments; n=73 and 60, respectively. Respondents were asked to select up to 5 industries; n=87.

Prospecting for blue investments

In terms of location, the countries perceived to be the **most attractive for blue economy investment** are:

- **Within the EU:** France, Spain, the Netherlands, Portugal, Italy, Sweden, Denmark, Germany;
- **Outside the EU:** UK and Norway.

Majority of countries selected are **coastal nations**, where marine-based economic opportunities are higher. However, most respondents were primarily based in the EU, which may generate some bias towards European countries.

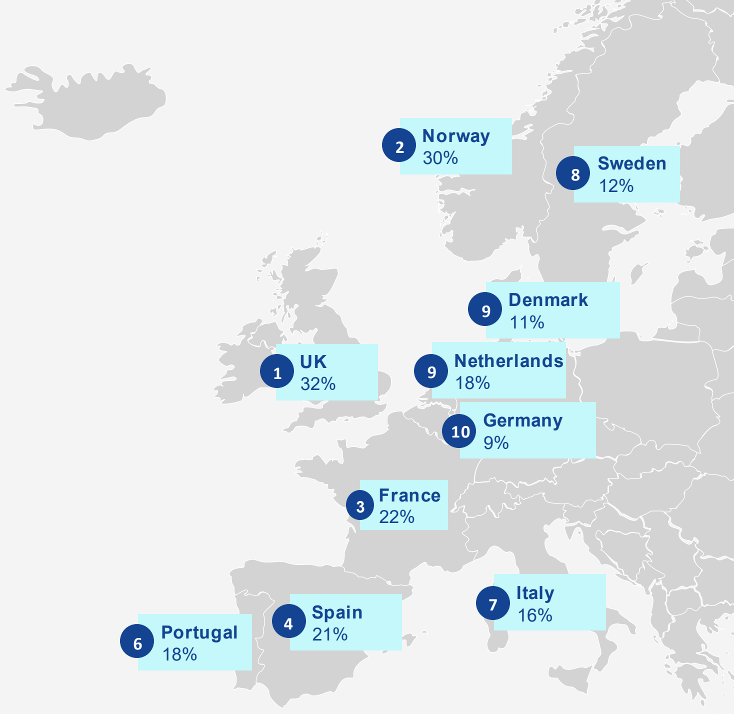
When considering perceptions on historical interest per sector, responses indicate that **interest will grow in varying degrees across all the sectors** of the sustainable blue economy, reinforcing their high potential for investment prospects.

Blue renewable energy, water management and **blue biotechnology were among the sectors that generated the most interest today, and for which interest will grow.** These sectors register a rise in future investment interest of 46, 42 and 41 percentage points, respectively.

Frontrunners indicated higher future interest than Prospects in the **fisheries**, **aquaculture** and **blue biotechnology** sectors. **Coastal and maritime tourism** attracted less attention for both Frontrunners and Prospects: less than 15% of respondents showed interest in this sector. Moreover, the likely evolution is fairly modest, with 30% of investors indicating a future interest in this sector.

Fig. 3.6: Country attractiveness*

Question: Please select the 3 countries in Europe that you find most attractive for Blue Economy investments.

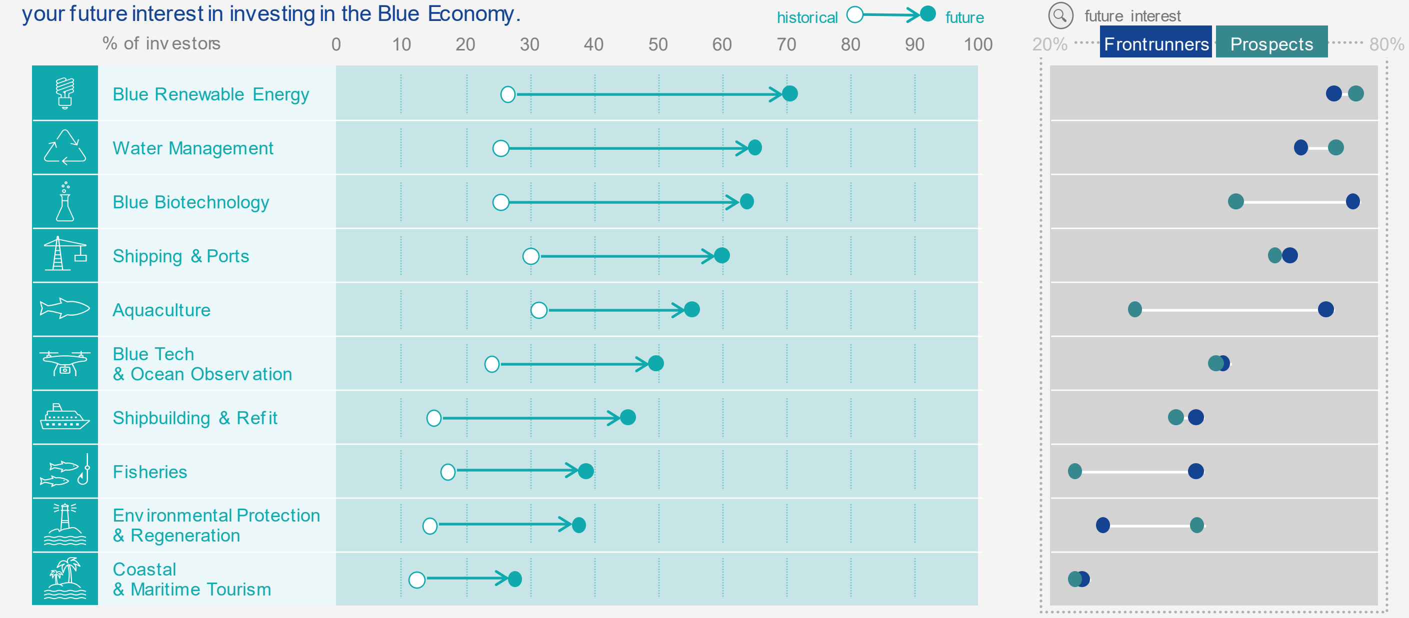


Note: *Percentage of investors surveyed who selected each country as one of their 3 most attractive for Blue Economy investments, excluding the country in which their office is located; n=76.

> The climate emergency, energy crisis and increasing interest in sustainable and impact investing are likely to drive increased investment in the Blue Economy over the next 5 years.
>
> - Opinion on the Blue Economy investment landscape from a c-suite executive at a venture capital investor

Fig. 3.7: Historical and future interest in each sector**

Question: (1) Please select the option that best describes your current interest in each sector; (2) Select the option that best describes your future interest in investing in the Blue Economy.



Note: **n=77 for historical and future interest; n=46 for Frontrunners; n=30 for Prospects.

Preferences on stage, size and method

On average, survey respondents **expected to see a return on investment in approximately 7 years and 2 months**.

There was no indication of a “one-size-fits-all” approach to the funding stage and firm size that respondents invested in, or how portfolios were weighted. However, two common threads emerged from the survey results: (1) a proclivity to **invest in earlier funding stages** and (2) a preference for **smaller firms**.

Funding stage. 71% of respondents reported investing in the seed round, 67% in Series A. Only 7% of respondents invested in the public stage. Those that do invest in the later stages seem to allocate a larger share of their portfolio to later stage firms (e.g. those investing at the public stage allocate around 52% of their portfolio to public firms).

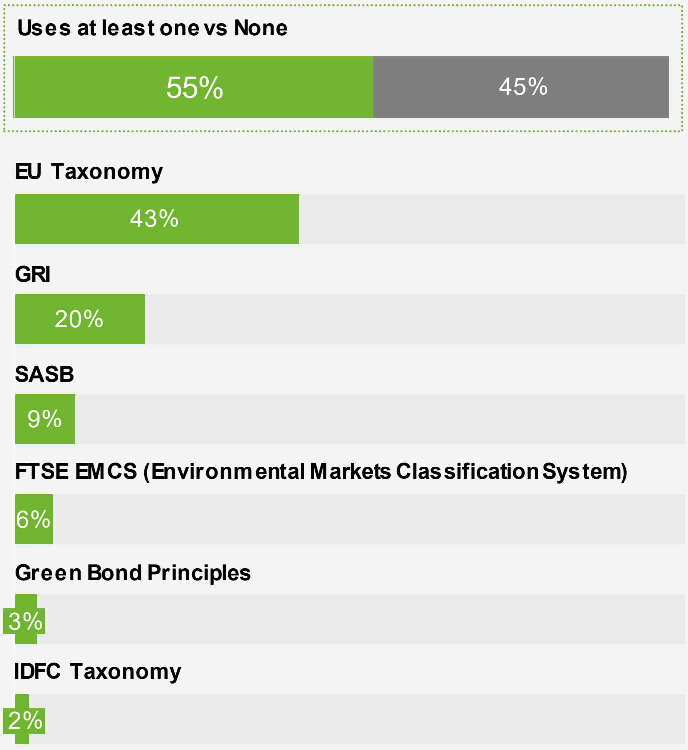
Firm size. 84% of respondents invest in small firms, 62% in micro firms. Moreover, those investing in small firms tend to allocate majority of their portfolio to this segment (56% of their portfolio on average).

Method. When it comes to methods used for prospecting green investments, **less than half of respondents are currently not using a specific methodology** to define which investments are green or estimate their share in their portfolios. Among the more than half that do, three methodologies stand out: the EU taxonomy (43%), Global Reporting Initiative (GRI) Standards (20%) and Sustainability Accounting Standards Board (SASB) (9%).

It should be noted that while definitions for environmentally sustainable activities for the blue economy sectors continue to be developed, the **EU taxonomy** has been cited as providing a view towards creating more regulatory certainty for investors to avoid market fragmentation while helping to shift investments where they are most needed[36].

Fig. 3.8: Top methodologies used by investors**

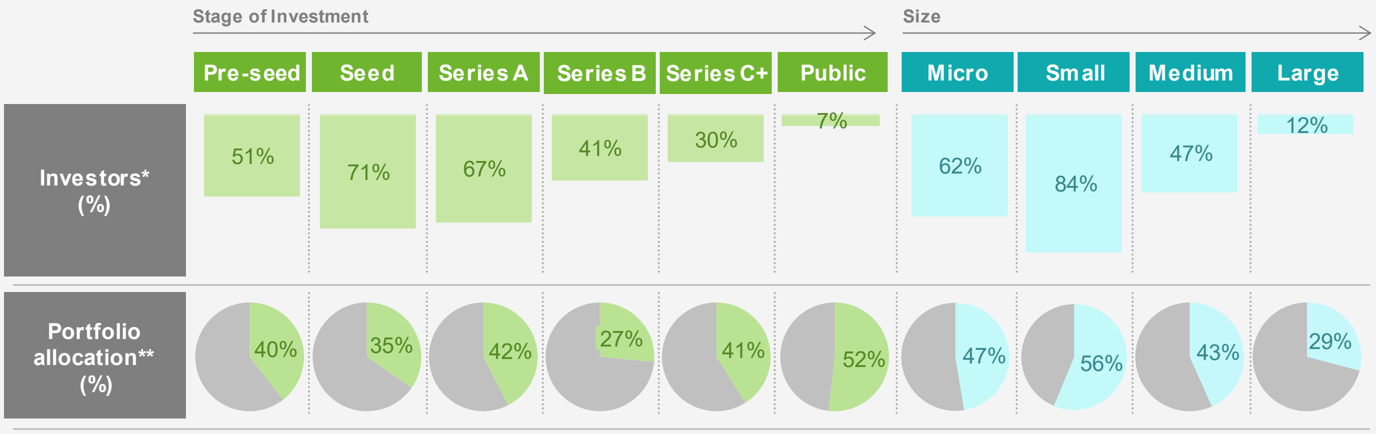
Question: Which methodologies do you use to define and/or estimate green investments?



Note: **Percentage of investors surveyed who use each methodology; n=87.

Fig. 3.9: Preferred stage and size for blue investments

Question: Please indicate the percentage of your portfolio that you allocate or plan to allocate to blue investments for each funding stage and size of firm, with the total adding up to 100% in both cases [best estimate].



Note: *Percentage of respondents investing in each stage of investment and firm size, n=73. **Average share of portfolio allocated to each funding stage and size of firm.

Source: European Commission (2022)[36]

Blue economy investment drivers

Respondents identified three top drivers for their blue investments: (1) environmental, social and governance (ESG) impact, (2) opportunities for innovation and new technologies and **(3) appealing growth prospects**. For majority of respondents, these factors most attracted them toward their blue investments.

While there is general agreement on the top three factors across the board, two distinct trends emerged for Frontrunner and Prospect investors. For **Frontrunners**, the principal driver of investment is **ESG Impact**, while for **Prospects**, the leading drivers are **opportunities for innovation and new technologies** and **appealing growth prospects**. This suggests that investors who have shown historical interest in the blue economy have been mostly driven by impact investing, whereas those who are looking at future investments **place greater importance on the sector's potential for growth and returns.**

With regard to other drivers of investment, 38% of respondents are driven by the idea of contributing to the UN SDGs. This figure tallies with reporting that only 8% of contributions to SDG14 come from private investors[26], as majority of survey respondents represent venture capital and private equity.

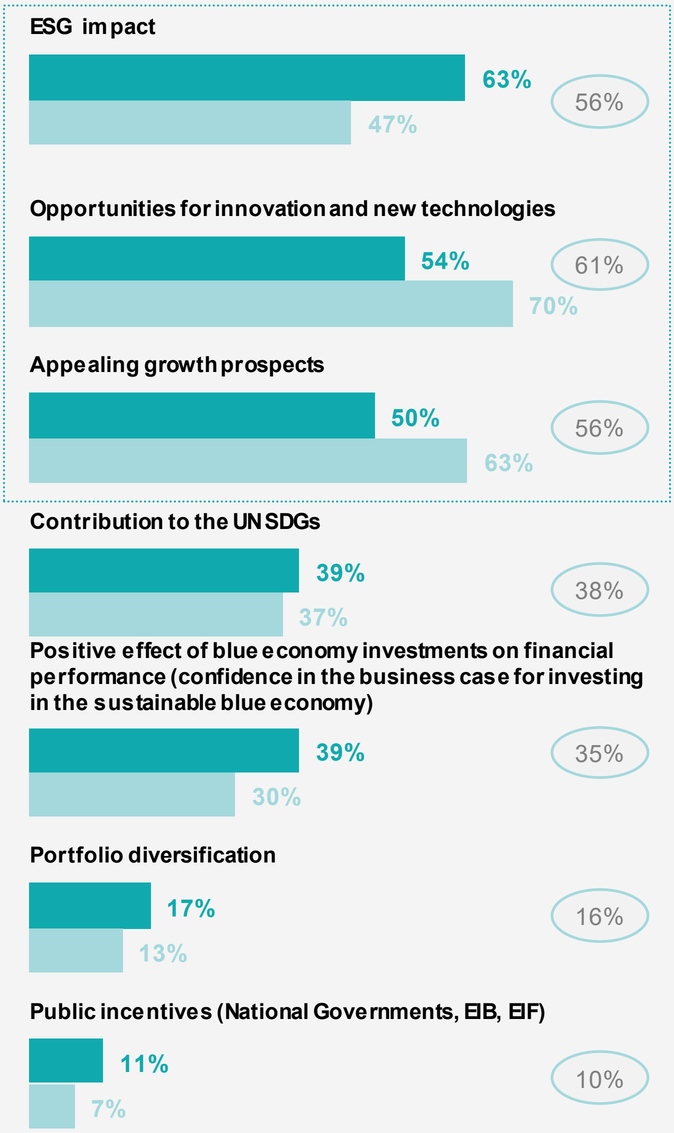
Although more than 30% of survey respondents stated the positive effect of blue economy investment on financial performance as a driving factor, the majority continues to cite the need for a stronger business case for investing in the sustainable blue economy.

Lastly, a tenth of respondents indicated portfolio diversification and public incentives from national governments and European institutions as having played a part in driving their blue investments.

The survey responses were generally consistent with reporting on this topic, notably Credit Suisse's report on "Investors and the Blue Economy" and the more recent Impact Investor's "Guide 2023: Impact Investing: a vital cog in the SDG wheel" [37]. Investors have been reported to identify the positive effect on financial performance, contributions to the UN SDGs, appealing growth prospects and ESG impact as drivers of investment. The focus on growth is also not misplaced. The OECD[6], estimates that the blue economy will grow at twice the rate of the land-based economy between now and 2030.

Fig. 3.10: Drivers of investment in the Blue Economy*

Question: Please select the top three factors that most attracted or attract you to blue investments.



Note: *Percentage of investors driven per factor; Frontrunners are those who invest and will continue to invest in the blue economy and Prospects are those who do not invest in the blue economy but plan to in future; n=46, n=30 and n=77 (Frontrunners, Prospects and total, respectively).

● Frontrunners
● Prospects
% Total

> At the highest level, we focus on climate tech opportunities that are attractive in terms of both financial performance and environmental and social sustainability.
>
> Opinion from a Venture Capital Investor

Sources: OECD (2016)[6]; F.Johansen & A.Vestvik (2020)[26]; Credit Suisse (2020) & Impact Investor (2023)[37]

Criteria for investing in the blue economy

Respondents declared a range of criteria for determining their investments in blue economy, with varying levels of relevance.

The most relevant criterion among those surveyed was the **"direct economic value generated and distributed"** by a project or firm, which 57% deemed as highly relevant. In second and third place, respectively, were **"growth of key financials compared to growth of sector"** and **"years of investment or years to break even"**.

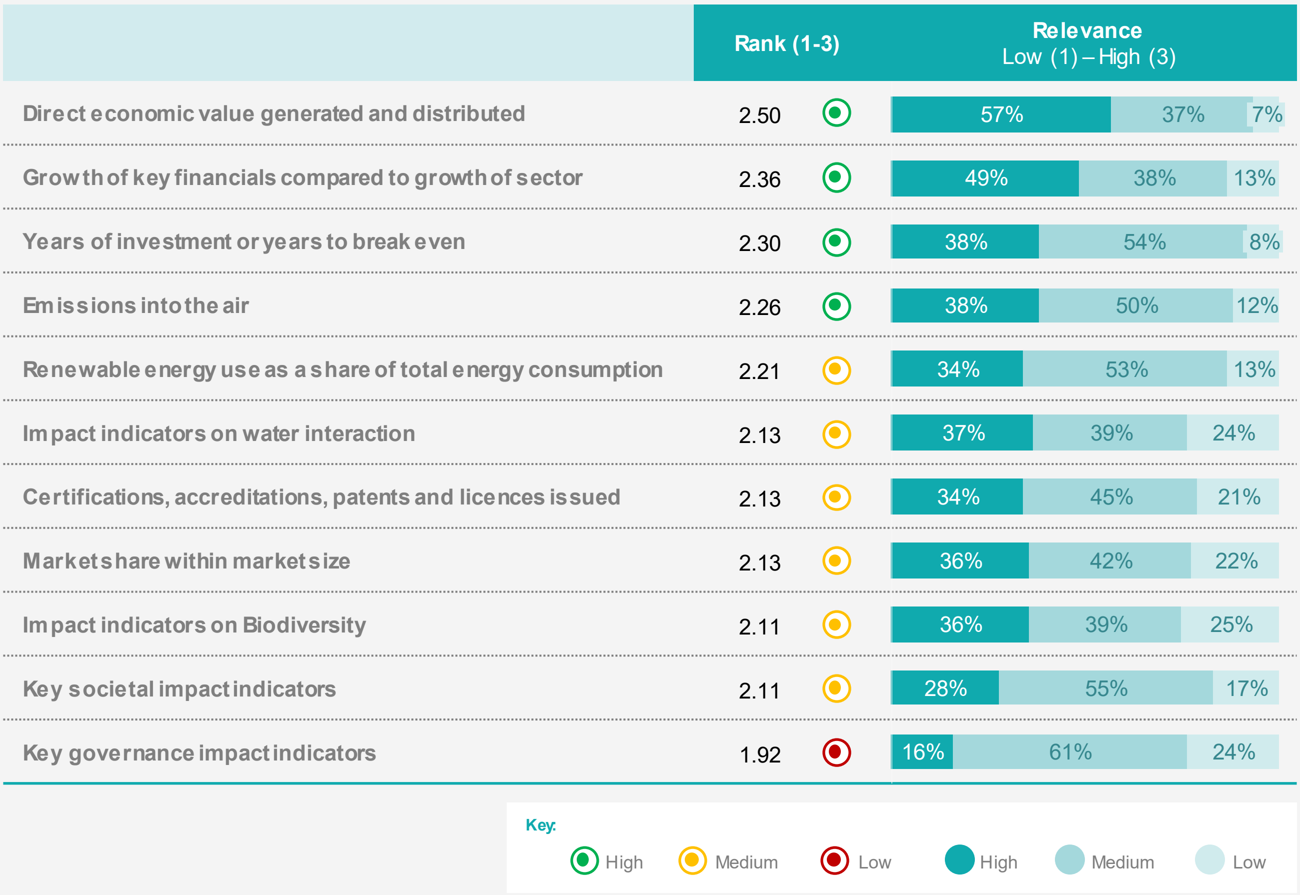
While the three top criteria all relate to the financial viability and potential of blue economy investments, environmental considerations are close behind. The fourth and fifth ranked criteria in terms of relevance are **"emissions into the air"** (38%) and **"renewable energy use as a share of total energy consumption"** (34%).

21% of respondents attached low relevance to **"certifications, accreditations, patents and licences issued"**. This could be linked to currently low standards and certifications for the most innovative sectors in the blue economy (e.g. emerging technologies for offshore renewable energy generation); lack of reliability (e.g. it takes a long time after submitting an application for fishery and aquaculture certifications to be issued and their approval criteria is still in doubt); or simply because other factors take precedence.

One additional factor worth highlighting is that, when asked to indicate any other criteria they use, several investors noted that they also factor in **the team in charge of the project:** their experience, sector-specific knowledge and internal dynamics.

Fig. 3.11: Blue economy investment criteria*

Question: Please indicate the relevance the following criteria have for you when deciding which blue economy assets or companies to invest in.



	Rank (1-3)		Relevance Low (1) – High (3)		
Direct economic value generated and distributed	2.50	🟢	57%	37%	7%
Growth of key financials compared to growth of sector	2.36	🟢	49%	38%	13%
Years of investment or years to break even	2.30	🟢	38%	54%	8%
Emissions into the air	2.26	🟢	38%	50%	12%
Renewable energy use as a share of total energy consumption	2.21	🟡	34%	53%	13%
Impact indicators on water interaction	2.13	🟡	37%	39%	24%
Certifications, accreditations, patents and licences issued	2.13	🟡	34%	45%	21%
Market share within market size	2.13	🟡	36%	42%	22%
Impact indicators on Biodiversity	2.11	🟡	36%	39%	25%
Key societal impact indicators	2.11	🟡	28%	55%	17%
Key governance impact indicators	1.92	🔴	16%	61%	24%

Note: *Rankings: Low (< 1.7), Medium (1.7 < x > 2.3), High (> 2.3), n=77 - Investors who have or plan to invest in the blue economy.

Barriers to blue economy investment

Three main barriers to blue economy investment were cited by the survey respondents:

- **79% ranked the need for large upfront investment** as having high to medium impact.
- **78% ranked the lack of investment-grade projects or scale** as having high to medium impact.
- **75% ranked their own lack of expertise or knowledge** as having high to medium impact.

While the declared lack of expertise or knowledge of the blue economy was third in ranking, it is notable that this barrier received the most high impact ratings.

Altogether, the three top-ranked barriers reflect the main obstacles to investment as being market-related (limitations on market size and maturity) and investor-related (knowledge and capacity to invest). 54 out of 87 respondents considered training on emerging technologies with high market potential would help to overcome barriers to investment.

Another barrier worth mentioning is the **"lack of available data"**. This is a challenge particularly for sectors of the sustainable blue economy that do not fit neatly into one industry or market because the data available cannot readily be split into "blue" versus "non-blue".

While respondents were divided on the importance of a **"lack of quantifiable environment benefits or uncertainty about environmental impacts"**, this still represented a high-impact barrier for 55% of responses.

For the 12% of investors surveyed that had not invested and had no interest in investing in the blue economy, the blue economy was found to be less appealing than other industries more aligned with their investment scope and geographically closer to their investment experience.

> We believe the key barriers are the significant investment [needs], the small scale of many blue economy investments and the higher funding needs for companies that are starting to scale. Investment also requires a joint commitment from the private and public sector.
>
> - Venture Capital Investor

> The lack of regulatory framework between countries, including within the EU, creates barriers to upscaling companies.
>
> - Venture Capital Investor

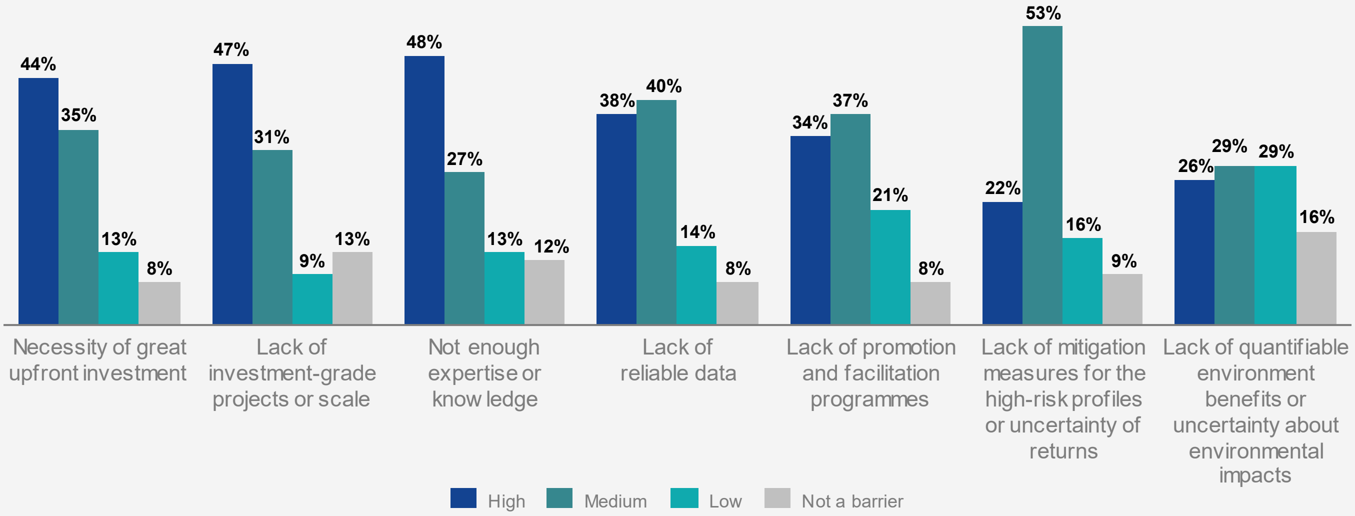
> The co-investor network/ecosystem is less developed than in other industries; the lack of mega success stories/unicorns makes it more difficult to convince other investors.
>
> - Venture Capital Shareholder

> [The Blue Economy] is a niche market that does not yet receive much attention. Knowledge is still too scarce among the population and the financial sector in particular.
>
> - Asset Fund Manager

Notably, decisions not to invest in blue seems to mostly be attributed to vision and strategy as defined by board members and higher management. Some respondents have cited improvements to the regulatory landscape as a pre-requisite for investing in the blue economy.

Fig. 3.12: Barriers to investment in the Blue Economy*

Question: Please select the level of impact the following barriers have on Blue Economy investments.



Note: *n=77 - Investors who have invested or will invest in the Blue Economy. Barriers are ordered (from left to right) from highest to lowest in a score calculated as: ∑ (3 × # high + 2 × # medium + 1 × # low + 0 × # not a barrier).

Conclusions from the investor survey

The survey confirms a **strong interest in the sustainable blue economy among investors.** 87% of respondents currently invest in blue economy sectors or plan to do so in the near future. Respondents expect to invest an average of **€124.15 million between now and 2030**. Blue economy sectors are forecasted to become ever more appealing to investors, with **blue renewable energy, water management** and **blue biotechnology** standing out as associated with highly attractive investment opportunities.

Blue economy investments made up 28% of total investments of the survey respondents, among them 81% considered sustainable blue investments. Moreover, survey respondents **expected to see a return on investment in approximately 7 years and 2 months.** Most investors preferred to invest in **seed or series A stages**, and **small and micro firms took up the majority of their portfolios**. Green investments were prominent: 84% of respondents had green investments in their portfolios and had 43% of their total portfolio on average allocated to these.

Two notable trends emerged from the survey: **ESG impact** was the main driver for investors with a historical interest in the blue economy, while new and potential investors tended to favour **opportunities for innovation and new technologies,** as well as **growth prospects**.

Investors used a range of criteria to decide on blue economy investments, with **financial viability and potential** being the most relevant. The top three criteria determining decision-making were **direct economic value generated**, **growth of key financials compared to sector growth**, and **years of investment or years to break even**. Environmental considerations such as **emissions and renewable energy use** were also important for a significant number of investors.

The main barriers to blue economy investment continue to be the **need for a large upfront investment**, **lack of investment-grade projects, and the (investor's own) lack of expertise or knowledge**.

These results indicate a **growing recognition of the potential of the blue economy as a source of sustainable and impactful investment opportunities**. Moving on to the next chapter, we will explore the investment opportunities across ten sectors of the sustainable blue economy.

4

Sector opportunities

4.1

Aquaculture

Definition

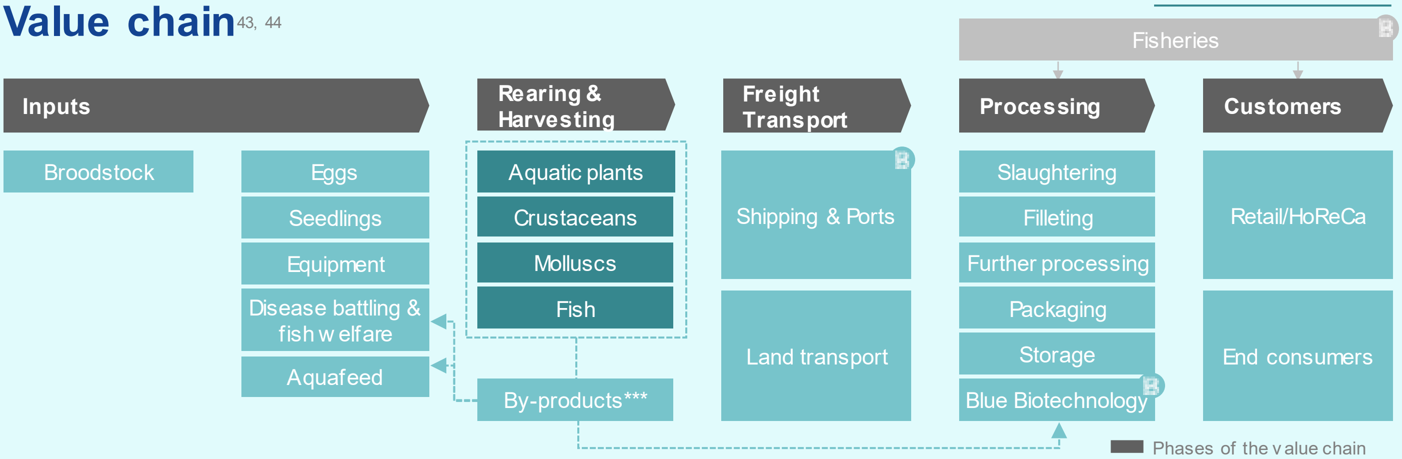
Aquaculture is the cultivation and farming of aquatic organisms, specifically the **rearing**, **breeding** and **harvesting** of freshwater, brackish water and saltwater populations under controlled or semi-controlled conditions[38]. This can be done either through **water-based systems**, **land-based systems** or **integrated farming***[39]. Various marine and freshwater species are farmed, including **fish, molluscs, crustaceans and aquatic plants** (mostly macroalgae).

For fish, molluscs and crustaceans, the aquaculture process is: (i) generating/producing the aquaculture species (**breeding**), (ii) keeping, feeding and providing medical care for them (**rearing**), and (iii) catching and killing them for consumption (**harvesting**). For aquatic plants, the process is: (i) selecting and spawning seedlings (**breeding**), (ii) growing and tending the plants (**rearing**), and (iii) **harvesting**.

Green transition

In general terms, sustainable aquaculture is used to produce food, but it can also serve to **replenish wild stocks and rebuild populations of endangered species**[40]. In more specific terms, **sustainable aquaculture** is the farming of aquatic species in a way that reduces emissions, mitigates pollution, uses less plastic and more renewable energies, is more energy and water efficient, puts less strain on supply chains (particularly those of wild fish stocks), uses fewer chemicals and medicines like antibiotics, better respects fish welfare, and creates future-proof jobs[41], all while producing high-quality, nutritious seafood** and aquatic plants. The environmental impact of aquaculture is largely determined by the production method*** used[42]. The fact that aquaculture by-products can be used in several ways also promotes higher circularity in the sector.

Value chain[43, 44]



NON-EXHAUSTIVE

Fisheries

Inputs

Broodstock

Eggs

Seedlings

Equipment

Disease battling & fish welfare

Aquafeed

Rearing & Harvesting

Aquatic plants

Crustaceans

Molluscs

Fish

By-products***

Freight Transport

Shipping & Ports

Land transport

Processing

Slaughtering

Filleting

Further processing

Packaging

Storage

Blue Biotechnology

Customers

Retail/HoReCa

End consumers

Notes: *Water-based systems include cages, pens and inshore/offshore systems; land-based systems include rainfed ponds, irrigated or flow-through systems, tanks, raceways and recirculating aquaculture systems; integrated farming includes livestock-fish, agriculture and fish dual use aquaculture, irrigation ponds and multi-trophic integrated farming systems; **Includes fish, molluscs, crustaceans and aquatic plants farmed in marine, freshwater and brackish water environments;***These methods can be classified as high-risk (e.g. open net pens, ponds) or low-risk (e.g. closed systems, raceways) depending on how likely they are to affect the environment surrounding them; ***By-products include fish skin, scales, bones, heads, guts, frames, etc.

- ■ Phases of the value chain
- ■ Key Aquaculture subsectors
- ■ Other VC sectors/subsectors
- ■ Other related sectors
- B B BlueInvest sectors

Sources: FAO (1992)[38]; Funge-Smith & Phillips (2001)[39]; Aquaculture Stewardship Council Foundation[40]; European Commission (2021)[41]; SeaChoice[42]; Marvin, Asselt, Kleter, & Meijer (2020)[43]; Expert Interviews[44]; PwC Analysis

Key innovations and technologies

Cont. ▶

● BlueInvest ● Other examples

Innovation	Description	Value proposition	Examples
Genetic improvement of species	The use of genetics to understand genome function, exploit genotype-to-phenotype prediction, make genetic improvements in finfish, control fish reproduction, manipulate chromosome sets in shellfish and control diseases in fish[45]. It includes both selective breeding (using the best specimens for reproduction) and genetic engineering techniques (which affect fish genetics) such as fish gender reversal[46].	The application of genetic techniques makes it possible to predict disease propensity, increase disease resistance and reduce the existence of infectious diseases within the aquaculture ecosystems[45]. The goal is to enhance precision breeding, drive competitiveness within the sector and enhance food and nutrition security[47]. Gender reversal produces more males, which are fleshier, bigger and consume less feed[46].	Xelect Ltd (UK)[47] AQUA-FAANG[48] Benchmark Genetics (Norway)[49] TIL-AQUA[50]
Improving recirculating aquaculture systems (RAS)	Projects to enhance the performance of RAS, which are a type of aquaculture setup that uses a closed or semi-closed loop water circulation system to recycle and reuse water within the system[45, 51]. In an RAS system, water is circulated through various tanks and filters to remove waste and maintain quality[51].	Better performing RAS reduce water waste and deliver improved energy efficiency, better adaptability to salt water use, improved water filtering and better output rendering. It also enables the digitalisation of aquaculture, with the use of IoT and sensors, and can be paired with renewables for more energy efficiency[45, 51]. RAS are scalable and can be located almost anywhere, including urban environments.	Landing Aquaculture BV Eloxiras
Aquaculture digitalisation	The installation of sensors, cameras, IoT equipment, automatic feeders, etc. inside tanks/ponds in order to monitor fish health and welfare, algae and bacteria in the water, track inventories and calculate the amount of water needed, the condition of the water and the amount of feed, etc.[45] The IoT technologies can be complemented by cloud computing[52].	These devices measure and regulate environment conditions such as water temperature, the amount of water required and the amount of feed needed, thereby increasing predictability, cost efficiency and speed of production[45, 52]. They also offer an early warning system for harmful algae and cyanobacteria blooms, and make it possible to identify fish with diseases and monitor production remotely without human intervention[53].	Microbia Environment SAS BioThoT Biosort start-up – iFarm project[54]
Satellite monitoring	The use of satellites to monitor farms in remote locations that do not support fibre connections[55].	The use of satellites enables the uninterrupted monitoring of production on farms that are located further from the coast and reduces the number of in-person interventions needed, thus increasing efficiency. This setup also allows for the production of fish in deeper water[53, 55].	SAFI Project[56] Planetek Aquaculture[57]
Fish handling systems	Systems for handling, pumping, processing and cooling the produced species in a way that ensures better fish welfare.	Handling systems improve fish welfare by reducing stress and mortality, increase quality by reducing stress during harvest and pre-rigor mortis time, and decrease carbon emissions, costs and risks of disease.	MMC First Process (Norway)[58]
Remotely operated vehicles (ROVs) for aquaculture[51]	Robots controlled from outside the marine environment that are equipped with cameras and can execute underwater tasks that would normally have to be done by humans.	ROVs can perform tasks that demand a skilled workforce and expensive protective underwater gear. With the help of ROVs, farmers can inspect nets quickly and without leaving their desks.	Nido Robotics

Value chain category: Broodstock Equipment Disease Battling & Fish Welfare Aquafeed Rearing / Harvesting

Sources: Global Seafood Alliance (2021)[45]; Hyland (2013)[46]; Xelect-Genetics[47]; Company websites[48, 49, 50, 54, 57, 58]; The Insight Partners (2021)[51]; Gupta, Gupta, & Hasija (2022)[52]; EUMOFA (2023)[53]; Economist Impact (2022)[55]; Cordis[56]

● BlueInvest ● Other examples

Innovation	Description	Value proposition	Examples
Oral vaccines[59]	New vaccines that can be fed to fish instead of being injected individually.	Oral vaccine administration reduces time and costs compared with individual fish vaccination. It also facilitates vaccine distribution, reduces stress for fish and thus the risk of death during and after the vaccination. It lowers the risk of illness in fish production and so increases fish welfare.	ProbioVaccine[59] MSD Animal Health[60]
Alternative feed sources[51]	The creation of fish feed from sources other than small catch. Some promising options include plant-based solutions (like soybean protein), algae and insects. Although high-quality algae improves fish health and nutrition, it is still expensive.	Fish meal alternatives present an opportunity to sustainably scale aquaculture production by reducing dependency on fish meal and fish oil made from recycled fish parts which, due to overfishing, are becoming ever more scarce.	Mealfood Europe S.L. (Tebrio) Ynsect[61] EniferBio[62]
Offshore mollusc production	Molluscs are cultivated/bred inland and produced in offshore farms: horizontal cables are placed close to the surface and attached to the seabed using an anchorage system, then lanterns are attached along the horizontal cable and shellfish are put inside them to grow[63].	Offshore mollusc farming reduces dependency on freshwater and land, increases the scalability of production and has minimal environmental impact.	Oceano Fresco[64]
Offshore macroalgae cultivation	The development of innovative solutions to produce algae that are resistant to the harsh offshore environment and maximise output.	Offshore macroalgae farming reduces infrastructure and logistics costs, does not require freshwater and fertilisers, regenerates ocean health, increases biomass yields and improves profitability. More detailed and accurate modelling will decrease risks and improve project viability.	OceanWide Seaweed ApS[65] The Seaweed Company[66]
Crustacean production in RAS[67]	Crustaceans such as shrimp are produced inland using innovative RAS systems.	RAS systems facilitate sustainable crustacean production that emits less contamination and pollution, better manages with the large and steady flow of waste generated by crustaceans during the rearing process and is able to adapt to specific water conditions, such as salt levels.	Local Ocean[68] Lisaqua[69]
Integrated multi-trophic aquaculture (IMTA)	The farming of various species with different trophic levels together in one aquaculture system, using a circular economy approach[53, 70]. In IMTA production, the uneaten feed and waste of one species are recaptured and converted into feed, fertiliser and energy for another species. One example could be the production of fish, sea urchins and seaweed together in one system[70].	IMTA enables a circular-economy approach to aquaculture production, decreases the environmental impact of production, optimises the use of space and reduces waste. It can also have a positive impact on the growth rates of certain species, such as sea urchins[71].	IMPAQT[72]

Value chain category: Broodstock Equipment Disease Battling & Fish Welfare Aquafeed Rearing / Harvesting

Sources: The Insight Partners (2021)[51]; EUMOFA (2023)[53]; The Portugal News (2021)[59]; MSD Animal Health (2022)[60]; Company websites[61, 62, 65, 66, 68, 69, 72]; Clímaco (2020)[63]; GOPARITY (2021)[64]; Innovation News Network (2022)[67]; Correia, et al. (2020)[70]; OpenLearn Create (2021)[71]

4.2

Blue Biotechnology

Definition

Blue biotechnology is the **application of science and technology to aquatic organisms**, using biological and chemical methods, to produce knowledge, goods and services[73].

Organisms include **microorganisms** (bacteria, microalgae and fungi), **algae, vertebrates** (fish) and **invertebrates** (e.g. sea cucumbers, sea urchins, sponges, shellfish, starfish and jellyfish) and applications include everything from **extracting chemical products from the living organisms**, all the way through to **optimising the production and processing** of the chemical produced by these organisms into marine-derived products, often for commercial purposes[52].

These products may be **destined for use in a diverse range of subsectors**: cosmetics, food, feed and nutraceuticals, pharmaceuticals, energy and biofuels, enzymes, and biopolymers for packaging, clothing, etc.[73].

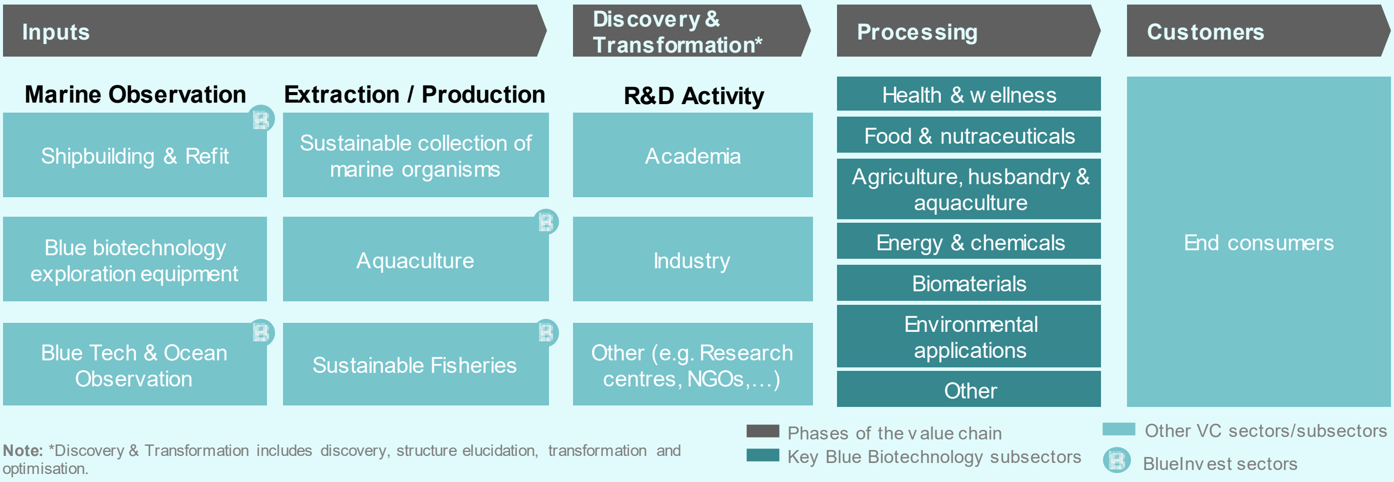
Green transition

If based on renewable resources, industrial biotechnology, blue or otherwise, can **save energy** and **reduce CO_2 emissions**. In fact, it is estimated that the sector has the potential to mitigate climate change by between 1 billion and 2.5 billion tons of CO_2 equivalent per year by 2030[74].

For example, there are already some processes in place that use the bacteria and micro- and macroalgae found in industrial wastewater to produce exopolysacharides (EPS), degradable bioplastic polyhydroxyalkanoates (PHA) and spirulina for several biotechnological applications[44]. Similarly, blue biotechnology SMEs typically perform lifecycle analyses to reduce their CO_2 emissions and energy usage[44]. Such activities mean that the sector is well positioned to **reduce pollution and waste** and can contribute to the green transition of other sectors[52].

Value chain[44]

NON-EXHAUSTIVE



Inputs

Marine Observation
- Shipbuilding & Refit
- Blue biotechnology exploration equipment
- Blue Tech & Ocean Observation

Extraction / Production
- Sustainable collection of marine organisms
- Aquaculture
- Sustainable Fisheries

Discovery & Transformation*

R&D Activity
- Academia
- Industry
- Other (e.g. Research centres, NGOs,…)

Processing
- Health & wellness
- Food & nutraceuticals
- Agriculture, husbandry & aquaculture
- Energy & chemicals
- Biomaterials
- Environmental applications
- Other

Customers
- End consumers

Note: *Discovery & Transformation includes discovery, structure elucidation, transformation and optimisation.

Sources: Expert Interviews[44]; EUMOFA (2023)[52]; European Commission[73]; OECD (2011)[74]; PwC Analysis

Key innovations and technologies

Cont.

● BlueInvest ● Other examples

Innovation	Description	Value proposition	Examples
Photobioreactors[75]	Cultivation systems designed to grow photoautotrophic organisms by using artificial light sources or solar light to facilitate photosynthesis. Photobioreactors (PBRs) are used to cultivate micro- and macroalgae, bacteria, as well as some mosses.	Compared to open systems, PBRs can better replicate cultivation conditions, reduce the risk of contamination, decrease CO_2 and nutrient losses and occupy a smaller area.	Power Algae Algoliner GmbH & Co. KG
Marine biorefinery[76]	Creation of multiple high-value products from marine biomass, which is rich in beneficial components including proteins, carbohydrates, lipids, small molecules, minerals and their derivatives.	Marine biorefinery allows for the production of input ingredients for all blue biotechnology-dependent industries from marine organisms and waste, thereby helping to maximise productivity and the effectiveness of applications.	Algaia[77] Nutramara[78] Olmix[79]
Marine enzyme applications[80]	Development of new applications for marine-sourced enzymes (proteins that help speed up metabolism and chemical reactions) in various biotechnology-dependent industries, including food, industrial chemicals, pesticides, cosmetics and nutraceuticals.	Marine enzymes can be produced on a larger scale and at a lower cost than chemical catalysts, yet have a similar or even stronger effect. Enzymes are also more environmentally friendly and, for food and feed, they can be healthier than other alternatives.	Tailorzyme[81] Novozymes[82]
Microalgae-based nutrients & supplements	A plant-based source of protein that utilises microalgae (photosynthetic microorganisms that absorb CO_2) to generate proteins, carbohydrates, lipids, minerals, vitamins, polyphenols, flavonoids and carotenoids[83, 84]. Additionally, microalgae (as well as other marine organisms) have new uses for nutraceuticals and food supplements[85].	Microalgae are rich in protein and can be produced in contained cultivation systems which have low water. Their production potential is 22-44 tons of protein per hectare. They offer an especially good source of protein for vegetarians and vegans[83]. Their potential uses for supplements are also extensive (e.g. protein, omega 3,…)[85].	Adriatic Algae Biotech Algaenergy S.A. Sophie's Bionutrients[86] Algonomi Oy
Fertilisers & pesticides sourced from marine organisms[87]	Organic fertilisers and pesticides created from marine organisms (e.g. seaweed, seagrass wrack and jellyfish biomass) for use in agricultural use.	In addition to being effective pest controllers, organic pesticides and fertilisers are far less harmful to the environment. Marine-based fertilisers are particularly rich in minerals.	VegaAlga[88] SEA2LAND[89] Allmicroalgae[90] Ficosterra[91]

Value chain subsectors:

General · Food & Feed · Nutraceuticals · Biofuels · Waste Reduction · Pharmaceuticals · Cosmetics

Sources: ScienceDirect (2020)[75]; Nguyen et al. (2022)[76]; Company websites[77, 78, 79, 81, 82, 86, 88, 89, 90, 91]; CORDIS (2019)[80]; Janssen et al. (2022)[83]; Saadaoui, et al. (2021)[84]; De Oliveira & Bragotto (2022)[85]; Emadodin, et al. (2020)[87]

● BlueInvest ● Other examples

Innovation	Description	Value proposition	Examples
Biofuels from marine resources[92]	Biofuels developed from marine biomass (e.g. aquatic plant, algae or animal biomass) and marine waste (e.g. ocean plastics). Research focuses particularly on: biofuel formulas to increase the efficiency of the production process, fuel consumption, cost reduction and minimising environmental impact. Some common biofuels are methanol, ethanol, methane and butanol.	Biofuels can serve as alternatives to fossil fuels, which are both finite and price volatile. Biofuels also generate less pollution.	BioQuest Alliance BioSFerA[93]
Bioplastics produced from or with marine resources[94]	Plastic-like materials that can be produced from biological materials (like corn, or, in this case, marine organisms) or through fermentation. Bioplastic production also incorporates new recycling techniques, such as enzyme recycling.	Marine-derived bioplastics provide a way to meet the ever-growing demand for plastic with a product made from recycled materials that requires less petroleum and generates less pollution and waste than traditional plastics.	Clenflex A/S Eranova Relicta s.r.l. FlexSea[95]
Cancer drugs and antibiotics from marine organisms	The analysis and use of marine organisms such as algae, invertebrates, bacteria, fungi and other aquatic organisms to isolate bioactive compounds and produce new drugs.	Marine-sourced drugs offer innovative and effective treatments for diseases that are currently incurable and often lethal. Additionally, marine fungi have proved to be an excellent source of bioactive compounds for antibiotic use[96].	PharmaMar[97] Ladiratuzumab vedotin from Seagen[98]
Marine-sourced vaccines and vaccine adjuvants	New vaccines for both humans and livestock that are derived from marine organisms or use marine organisms as adjuvants to increase the immune response.	Diseases with no currently known treatment could be prevented by using marine organisms in vaccines. Vaccine safety and efficiency can also be increased through the use of marine adjuvants.	Immunolab[99]
Marine-based cosmetics[100]	The use of naturally sourced marine compounds to develop cosmetic products such as creams.	Marine organisms can contain natural compounds that having hydrating, antioxidant, anti-aging or UV-protection properties. They also grow faster and are easier to handle, cultivate and scale up than plants, as production is not dependent on environmental conditions.	BELLEJO CyanoCare Kelp Blu Biotech Mungo Murphy Seaweed Company Ltd. IGNAE[101] BodyOcean[102]

Value chain subsectors:

General · Food & Feed · Nutraceuticals · Biofuels · Waste Reduction · Pharmaceuticals · Cosmetics

Sources: ETIP Bioenergy (2017)[92]; Company websites[93, 95, 97, 98, 99, 101, 102]; GAMEIRO (2019)[94]; Tortorella et al. (2018)[96] Biomar (2018)[100]

4.3

Blue Renewable Energy

Definition

Blue renewable energy is the **offshore, inshore and nearshore generation of clean and renewable power** from natural sources or processes that are naturally replenished. It covers **offshore wind energy, offshore photovoltaic production** and **ocean energy** – technologies that exploit the potential of tides, waves, geothermal gradients and salinity gradients to generate clean power[103].

All these energy sources have the potential to **connect to the grid** (mass distribution national electricity grids), be used directly by **end consumers** (off-grid) or be transformed into **blue fuel** such as hydrogen, methanol or ammonia[44].

Worldwide, the technologies available for renewable marine energy production are at differing stages of maturity. Only offshore wind bottom-fixed technologies have been adopted and commercially deployed on a wide scale; most of the others are at early stages of development[44]. Floating wind, tidal and wave energy devices have reached technological maturity and are in demonstration stage. As such, R&D activity is very important throughout the value chain of the blue renewable energy sector.

Green transition

Blue renewable energy has huge potential to contribute to sustainability[104], as the production and distribution processes entail much **less pollution** than those of most energy sources. Unlike fossil fuels, which are not only dirty but finite too, renewable energy is quasi-infinite. Additionally, offshore renewables **are not as limited by available** space as onshore renewables are. Therefore, blue renewable energy offers a solution for serving the world's needs in a sustainable and potentially scalable way.

Value chain[44, 105]

NON-EXHAUSTIVE

Materials & Components	Manufacturing	Services & Maintenance	Production	Storage & Distribution	Customers
Raw materials (e.g. metals, fibres) Components (e.g. blades, electronics)	Energy converters (e.g. wind turbines) Cables, connectors and substations Foundations, platforms, moorings & anchors	Project development Geotechnical services Construction, installation and commissioning Other services (e.g. leasing)	Offshore wind Wave Tidal Floating photovoltaic Geothermal gradient Salinity gradient Others	Grid-connected Off-grid (isolated) Blue fuel	Grid-connected users Off-grid users (Production for local use)

▬ Phases of the value chain

▬ Key Blue Renewable Energy subsectors

▬ Other VC sectors/subsectors

Sources: Expert Interviews[44]; European Commission[103]; European Commission JRC (2020)[104]; European Commission (2020)[105]; PwC Analysis

Key innovations and technologies

Cont. ▶

● BlueInvest ● Other examples

Innovation	Description	Value proposition	Examples
Smart components	Bolts, joints and other components that are able to signal their self-deterioration and structural integrity to a centralised system for easy monitoring.	The use of smart components reduces the risk of problems in offshore structures, lowers the need for constant monitoring and allows for quick and localised interventions offshore.	Wärtsilä Corporation[106]
Improved connection lines to the grid[107, 108]	The development of longer, more resilient and more dynamic cables that can handle higher voltages and lose less energy along the way.	The improved cables allow for larger wind farms, enable platforms to be built further from the coast and, in the case of dynamic cables, ensure floating wind plants can adapt to movement.	Nexans[109] Amprion[110]
Grid-connectable floating wind farms[107, 108]	The installation of wind turbines on floating substructures that are tethered with mooring lines and anchors. The floating platforms do not require a structure to be fixed to the ocean bed and can therefore be built in deeper waters, further from the coast.	Floating wind farms expand the availability of energy production to many other places (particularly southern European countries), increase production (the winds further from the coast are stronger) and reduce coastal pollution, as well as noise and visual pollution for communities.	X1 Wind Hexicon AB
Improved viability of floating offshore photovoltaic[108]	Photovoltaic arrays mounted on rafts that are anchored out in open water, with subsea cables to channel the power back to land.	This setup uses available space offshore and enables solar energy to be produced from the sun at open sea (away from barriers to sun exposure like buildings).	HelioRec SolarDuck
Floating tidal devices[111, 112]	Energy devices that can be placed where tidal energy is highest, producing energy from the rise and fall of tides.	These devices can significantly decrease the levelised cost of energy (LCOE) of tidal energy since tides are stronger and produce more energy on the surface, despite the higher risks associated with waves.	Magallanes Renovables Arrecife Energy Systems
New designs and processes for wave energy systems[112]	The development of new solutions for wave energy production that are less costly, more robust and durable, yet still light and flexible, so that they are better able to handle rough conditions at sea and produce high amounts of energy at the same time.	The systems enable higher amounts of energy to be produced from waves with significantly lower LCOEs, making the energy generation process profitable and, therefore, establishing wave energy as a viable alternative to other energy sources.	Eco Wave Power Crestwing ApS CorPower Ocean AB AW-Energy Oy GEPS Techno[113]

Value chain category:

Components

Cables

Energy Technology

Services & Maintenance

Storage & Distribution

Sources: SET Wind (2022)[107]; Toulotte (2022)[108]; Company websites[106, 109, 110, 113]; European Commission JRC - Clean Energy Technology Observatory (2022)[111]; European Commission JRC (2018)[112]

● BlueInvest ● Other examples

Innovation	Description	Value proposition	Examples
Osmotic energy systems[114]	Power systems that harness the energy produced by the difference in the salt concentrations of river water and seawater. The systems may use one of two methods: reverse electrodialysis and pressure retarded osmosis.	Osmotic energy systems can be installed at river mouths and generate energy from the naturally occurring mixing of salt water and fresh water. They could potentially be embedded in desalination systems.	Sweetch Energy[115]
Offshore geothermal energy systems[116]	Systems that harvest the energy contained in the heat emanating from the Earth's core via marine environments.	Heat from the Earth is a constant source of renewable energy that could provide round-the-clock energy production regardless of climate conditions.	CeraPhi Energy (UK)[117]
Hybrid electricity generating systems[107, 118]	Installations that integrate multiple energy sources within one offshore power system. Example combinations could be wave-solar or wave-wind.	Hybrid systems increase the predictability and reliability of energy supply, raise overall energy production, maximise space usage and optimise investment (e.g. by utilising common cables and infrastructure).	REDstack PHARES Ushant Island Floating Power Plant
Multi-purpose technologies[118]	Systems with multiple industrial purposes, one of which is energy production. They exploit synergies between the industries/purposes to increase efficiency (e.g. the use of a geothermal gradient energy system in sectors like desalination, aquaculture, water treatment, etc.).	Multi-purpose technologies enable economies of scope, optimise investment (e.g. by utilising common infrastructure) and increase the efficiency of Blue Economy sectors.	Sinn Power Ocean Harvesting
Digitisation of maintenance[119]	The installation and use of (1) common digital interfaces between control systems, (2) connected sensors to measure the forces provided by plant structures, (3) digital twins to monitor changes of loads on structures in real time, and (4) cameras or drones to obtain information about the interventions and/or resources required.	All these technologies allow for fewer, shorter and less staff-intensive maintenance interventions, which reduces both the costs and the risks of operating energy-producing systems at sea.	Elements Works Esteyco Elwave
Hydrogen from renewables[44, 107]	An electrolyser is installed on offshore wind turbines or other offshore systems to extract hydrogen from water. The hydrogen is then transported to shore through a dedicated pipeline.	Produced hydrogen from renewable sources can be stored in transportable batteries that can be used at a time convenient to the user, whereas on-grid energy must be used immediately or else it will be lost. Additionally, hydrogen batteries facilitate the production of energy further from the coast where connection to the grid might be inviable.	Agnes[120] Lhyfe[121]

Value chain category:

Components Cables Energy Technology Services & Maintenance Storage & Distribution

Sources: Expert Interviews[44]; SET Wind (2022)[107]; UN Climate Technology Centre & Network (2011)[114]; Company websites[115, 117, 120, 121]; Richter (2019)[116]; IRENA (2020)[118]; Alcimed (2022)[119]

4.4

Blue Tech & Ocean Observation

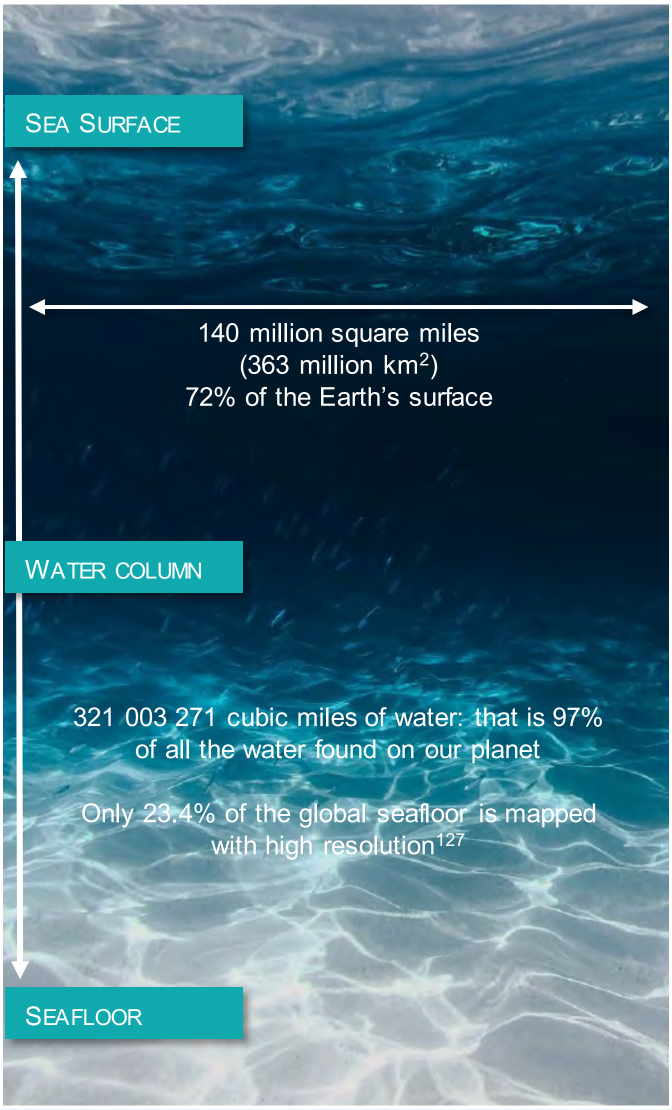
Definition

The blue tech and ocean observation sector consists of activities involved in **turning ocean data into ocean information** for services, science, policymakers and management[5], and centres around data collection, modelling and prediction[44], as well as the supply of the associated instruments and infrastructure. Instruments include ocean sensing and imaging tools and new systems integration schemes; infrastructure includes marine robots, undersea cable observation systems, sensor-equipped submarine telecommunication and power cables, float arrays, fixed and mobile platforms, and ocean-going research vessels. All of these are supported by blue digital technologies[122].

In addition to ocean observation, there is also the observation of human activity in the ocean, carried out by subsectors such as **maritime surveillance, security and defence**, which are integral to EU and national agency efforts to **safeguard European seas**. Maritime defence focuses mostly on navies, while maritime security and surveillance ensure the safety of navigation, the technological and operational safety of ships and the rescue of people in distress[123].

Green transition

The digital transformation of the sector and the data it generates **enhances our understanding of ocean processes and the impacts of human activities** affecting all ocean-related sectors. This knowledge allows for more targeted actions to improve ocean ecosystem health, predict climate change impacts, and increase resilience and adaptation[124, 125]. The maritime defence[126], through investments in innovation and improved surveillance technologies, also play a key role in the control and enforcement of conservation measures[5], including the use of satellites and drones to help achieve environmental preservation and decarbonisation targets.



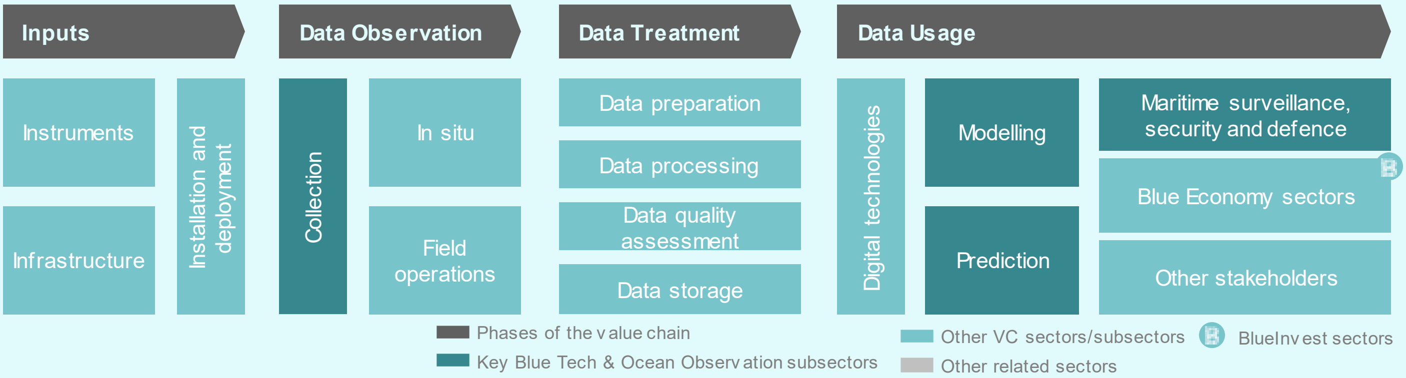
140 million square miles
(363 million km^2)
72% of the Earth's surface

321 003 271 cubic miles of water: that is 97% of all the water found on our planet

Only 23.4% of the global seafloor is mapped with high resolution[127]

Value chain* [124]

NON-EXHAUSTIVE



Note: *The **data collection** activity comprises the use of inputs to capture data (in situ observation involves the automatic collection of data, whereas field operations involve displacement to collect it). **Data treatment** covers **data preparation**, during which raw data is cleaned up and prepped for the following stage of **data processing**, during which the cleaned data is translated into usable information, then **data quality assessment**, which is the process of evaluating and measuring the validity of the processed data by comparing it against selected criteria, and finally **data storage**, which is the process of recording and preserving the validated data. **Data usage** covers the various applications of the data, including modelling and prediction (simulating the state of the ocean and predicting how it will change), enabled by the use of digital technologies (e.g. artificial intelligence, digital twin and the internet of underwater things).

Sources: European Commission (2022)[5]; Expert Interviews[44]; Stevens et al. (2021)[122]; EMSA (2022)[123]; European Marine Board (2021)[124]; CINEA (2021)[125]; European Union External Action Service (2021)[126]; The Nippon Foundation-GEBCO[127]; PwC Analysis

Key innovations and technologies

● BlueInvest ● Other examples

Innovation	Description	Value proposition	Examples
Smart sensors for ocean monitoring and vessel recognition	Sensors equipped with technology that can process real-time data about environmental conditions, take measurements (e.g. of ocean salt content and temperatures) and provide a complete view of the underwater ecosystem and the real conditions a vessel is in.	Sensors, including those incorporated in the underwater cables, facilitate multilevel decision-making and enhance capacity to act locally and globally. Their output helps to solve problems of safety, security and environmental protection, and increases knowledge of the ocean.	Advanced Ocean Technologies ELWAVE SaMMY SeaTopic SAS
Unmanned sea systems for data collection and surveillance tasks	Automated robots, drones used for onshore and offshore aerial missions, and water robots, which can be underwater or surface vehicles. The systems are capable of collecting real-time ocean data, and as such are used for inspections and exploration.	Data collection from the sea and coast allows for a better understanding of how changes in the ocean affect weather, climate, wildlife and other Blue Economy sectors, and support monitoring and surveillance tasks such as rescue missions, first-aid assistance and the inspection of illegal activities.	Notilo Plus NetH2O Xsun SAS VirtualDive Proteus Innovation DotOcean N.V.
Float arrays & floating and fixed platforms for ocean observation	Floats and platforms that are capable of monitoring and sharing data about the current status of the ocean, and that support the operation and maintenance of offshore platforms for other purposes (e.g. wind turbines).	Floats are capable of measuring temperature and salinity throughout the world's oceans and deliver data in real time, making it possible to fight climate change and its effects more efficiently.	Euro-Argo RISE[128] Flotant[129]
Digital twin	Digital representations of the ocean compiled from real-time and historical data that can be used to monitor and predict interactions between natural phenomena and human activities.	Digital twins give us a better understanding of the past and present status of the ocean, allowing for credible predictions and therefore facilitating more informed decisions.	Destination Earth[130] Iliad[131]
Digital technologies for ocean observation	Technologies such as high-performance computing (HPC), artificial intelligence (AI), big data and the internet of underwater things (IoUT) that enhance connectivity among underwater instruments and infrastructure, support the modelling and prediction of data and enhance the taxonomy of images and acoustics.	Applying these digital technologies to the ocean ecosystem can accelerate our understanding of the oceans and ensure that decisions are based on reliable, harmonised and verified data. These technologies also support monitoring activities and efforts to ensure the safety of maritime transport and the protection of marine environments.	Wsense Srl ReadytoSail - Actiontracker solutions Sinay

Value chain category: Inputs & Data Observation - Instruments & Infrastructure Data Treatment & Usage - Blue Digital Technologies

Sources: Company websites[128, 129, 130, 131]

4.5

Coastal & Maritime Tourism

Definition

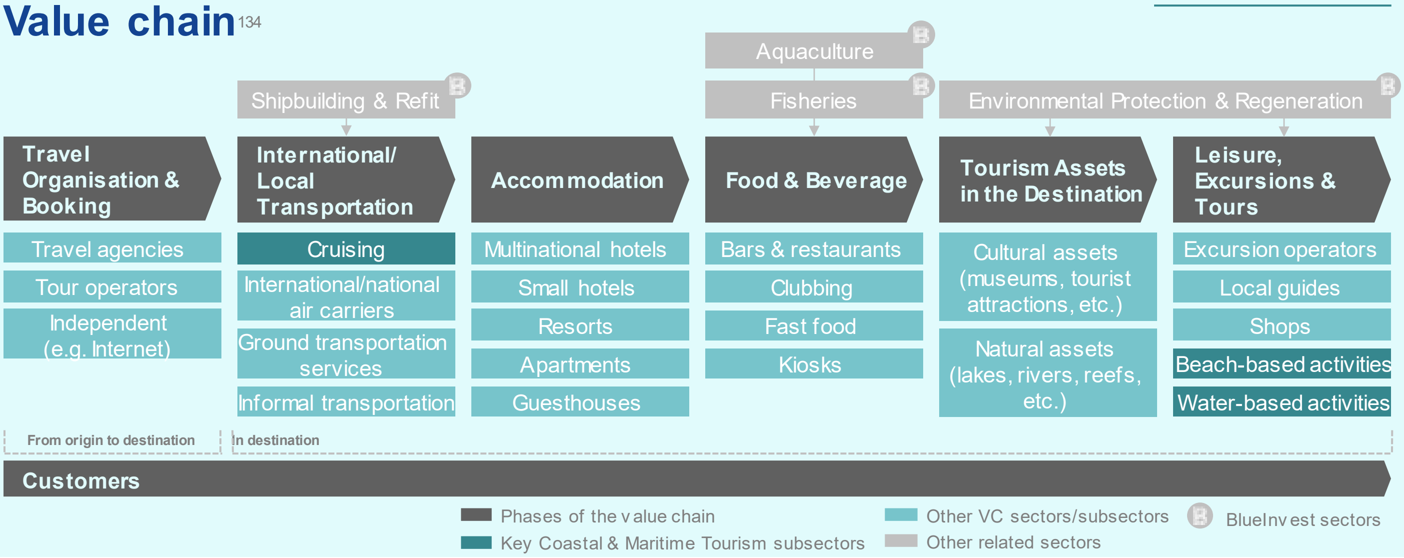
Coastal and maritime tourism is the range of social, cultural and economic activities involved in providing services for tourism taking place in or around coastal or marine environments. It includes **beach-based recreational activities, non-beach, land-based activities in the coastal and surrounding area**, and the manufacturing and supply of goods and services associated with these activities. Maritime tourism includes **water-based recreational activities** (e.g. surfing, canoeing, sport fishing, whale and seabird watching, sailing, and yachting), the **cruising industry** and the **manufacturing and supply of related equipment and services**[5, 132].

Green transition

The sector is highly dependent on the quality of coastal and marine ecosystems for attracting visitors, and it is particularly vulnerable to threats such as climate change and biodiversity loss. Well-managed tourism can **support conservation**, contribute to **sustainable development** and provide income opportunities and a better quality of life for coastal communities. In 2022, the EC identified 27 action areas for accelerating the green and digital transition and for improving the resilience of the EU tourism industry[133]. These include, *inter alia*, sustainable mobility, circularity of tourism services, green transition of tourism companies and SMEs, data-driven tourism services, and peer learning and networking for SMEs.

NON-EXHAUSTIVE

Value chain[134]



Aquaculture B

Shipbuilding & Refit B | Fisheries B | Environmental Protection & Regeneration B

Travel Organisation & Booking	International/ Local Transportation	Accommodation	Food & Beverage	Tourism Assets in the Destination	Leisure, Excursions & Tours
Travel agencies	Cruising	Multinational hotels	Bars & restaurants	Cultural assets (museums, tourist attractions, etc.)	Excursion operators
Tour operators	International/national air carriers	Small hotels	Clubbing	Natural assets (lakes, rivers, reefs, etc.)	Local guides
Independent (e.g. Internet)	Ground transportation services	Resorts	Fast food		Shops
	Informal transportation	Apartments	Kiosks		Beach-based activities
		Guesthouses			Water-based activities

From origin to destination | In destination

Customers

- Phases of the value chain
- Key Coastal & Maritime Tourism subsectors
- Other VC sectors/subsectors
- Other related sectors
- B BlueInvest sectors

Sources: European Commission (2022)[5]; European MSP Platform (2018)[132]; European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (2022)[133]; OECD, UNWTO (2013)[134]; PwC Analysis

Key innovations and technologies

● BlueInvest ● Other examples

Innovation	Description	Value proposition	Examples
Digital platforms for tourism services and activities[135]	Online spaces for value-creating interactions between service/product providers and customers/users. Interactions take place within the platform, facilitating the exchange of goods or services for a form of currency. Specific platforms are being developed for charter yachts, boat rental and sharing, marine services and the management of tourism flows in natural and cultural heritage sites.	Real-time data-driven insights enable users to make better informed decisions. Platforms are disrupting the way the sector is run from end-to-end and impact the way destinations facilitate tourism, develop products, gather data, access markets and attract visitors.	HERIT-DATA[136] Hoomvip[137] Seasy - Making Sea Life Easy Wavy GmbH Boatsandgo KANARA Sport[138] Actiontracker Solutions Raceix
Virtual reality (VR) and remote tourism[139, 140]	Immersive technology to enhance traveler experience before and/or after arriving at the destination.	Destinations, attractions, hotels and tour operators can offer new ways to engage, at low-cost. Customers can "try before you buy".	Envjoy Nature Smartify (UK)[141] The Amsterdam VR Company[142]
Augmented Reality (AR) in hospitality and coastal navigation[143]	Enhanced real-world visions created through the overlay of computer-generated content, allowing virtual content to interact with the real environment. AR can also relate to auditory or olfactory augmentations that are not originally part of the real environment.	Complete and pleasant visiting experience for the user. Several hoteliers are exploring AR and it is also being used as a visual navigation assistant.	Sea Coast App[144]
Sustainable boating and sustainable marine floating modules	More sustainable ships used for tourism purposes, which emit less emissions, are made of greener materials and are more energy-efficient[145]. Sustainable marine floating modules[146] contribute to the development of oceanic interface areas and optimise mooring facilities for yachting and leisure.	Can reduce the environmental impact of pleasure boats and ships. Sustainable marine floating modules are environmentally friendly, safe and adaptable to their individual environments.	e-Boats Experience Green City Ferries La Bella Verde OC-Tech Plavi svijet d.o.o. XOUVA Seafloatech
Sustainable tourism management	Initiatives aimed at promoting marine protection and ocean literacy[147] (e.g. underwater museums, sustainable sports[148, 149], sustainability classification and assessment of beaches[150]) and platforms that enhance the marine chartering offering, providing experiential citizen activities that encourage marine life protection[151].	Fosters a greater sense of care and appreciation for marine life among visitors, leading to greater preservation of beaches and the marine environment.	The Underwater Museum of Cannes[147] Xplore Blue AllWaves BV Costa Nostrum Sustainable Beaches Plastic Playgrounds

Value chain category: Travel Organisation & Booking; International/ Local Transportation; Accommodation; Food & Beverage; Tourism Assets at the Destination; Leisure, Excursions & Tours

Sources: The World Bank (2018)[135]; Company websites[136, 137, 138, 141, 142, 144, 147]; Tourism Australia (2018)[139]; World Economic Forum (2021)[140]; Sabil & Han (2020)[143]; BlueInvest[145, 146, 148, 149, 150, 151]; Cannes Tourist Office (2021)[147]

4.6

Environmental Protection & Regeneration

Definition

Environmental protection and regeneration of marine environments, including activities to **prevent ocean pollution** and **restore and strengthen biodiversity** in coastal areas[152].

Protecting the natural environment is a main focus area. This includes **monitoring water environment conditions** according to physical, chemical and biological parameters[153], **noise, air pollution and land- or sea-based sources of litter**[5] (e.g. single-use plastics and fishing gear[154]) that may harm the environment, the health of organisms and economic structures[155]. Actions should ensure a favourable conservation status for ecosystems where habitats are of sufficient size and quality, and species populations are large enough to ensure survival in the medium to long term[156].

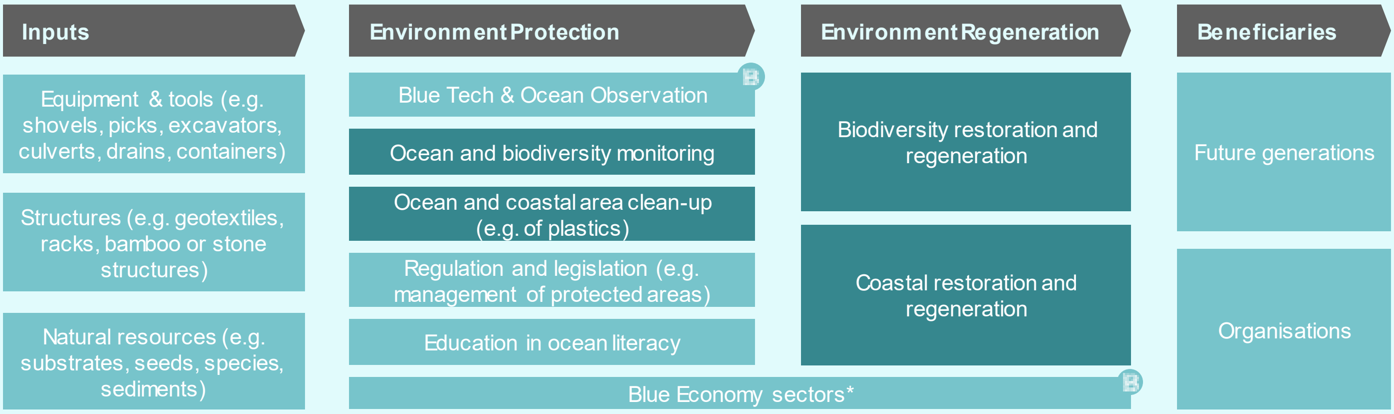
Regeneration and the restoration of biodiversity to improve the health and resilience of coastal ecosystems is another major focus area. Activities are primarily in coral reefs, mangroves and seagrass beds, and to a lesser extent, beaches, sand dunes, salt marshes and lagoons. While regeneration aims at more resilient and diverse ecosystems, restoration focuses on returning an ecosystem to its original state after damage or degradation.

Green transition

Environmental protection and regeneration is critical to tackling the mounting environmental pressures we face on our planet[157]. Green transition for this sector refers to the integration of **marine ecosystem preservation and ocean pollution control within all economic activities**. Developments should enable the blue economy to thrive while conserving and regenerating the marine environment, ensuring a just and inclusive transition[158] for future generations.

NON-EXHAUSTIVE

Value chain[159]



Inputs
- Equipment & tools (e.g. shovels, picks, excavators, culverts, drains, containers)
- Structures (e.g. geotextiles, racks, bamboo or stone structures)
- Natural resources (e.g. substrates, seeds, species, sediments)

Environment Protection
- Blue Tech & Ocean Observation Ⓑ
- Ocean and biodiversity monitoring
- Ocean and coastal area clean-up (e.g. of plastics)
- Regulation and legislation (e.g. management of protected areas)
- Education in ocean literacy

Environment Regeneration
- Biodiversity restoration and regeneration
- Coastal restoration and regeneration

Beneficiaries
- Future generations
- Organisations

Blue Economy sectors* Ⓑ

▬ Phases of the value chain ▬ Key Environmental Protection & Regeneration subsectors ▬ Other VC sectors/subsectors Ⓑ BlueInvest sectors

Note: *In order to protect and regenerate, Blue Economy sectors need to minimise the negative impacts of their acitivities.

Sources: European Commission (2022)[5]; Sobral (2022)[152]; Omer (2019)[153]; European Commission (2018)[154]; National Geographic[155]; European Parliament, Council of the EU (2004)[156]; OECD (2019)[157]; European Commission[158]; ICRI, Pôle-Relais (2020)[159]; PwC Analysis

Key innovations and technologies

● BlueInvest ● Other examples

Innovation	Description	Value proposition	Examples
Smart devices for environmental data collection	Underwater sensors and robots and technologies that collect real-time data on the health of ecosystems.	More informed decision-making towards biodiversity protection, environmental pollution and ocean sustainability.	The Sea Opportunities SRL Meton Innovatence FuVeX Civil SL Microbia Environment SAS
Monitoring for ocean protection	Platforms using AI and big data to monitor environmental impact on the ocean: wildlife detection, marine data gathering, mapping and quantification of environmental parameters.	Rapidity and ease of transforming quantitative and qualitative data into actionable insights to help solve problems linked to ocean pollution, biodiversity and coastal protection.	SciDrones Sea Going Green WIPSEA Arctur d.o.o. (Ltd.)
Solutions to prevent ocean plastic pollution	Solutions include the creation of artificial shorelines to mitigate plastic concentration and floating devices that prevent plastic waste in rivers from entering the sea.	Lowers the risk of entanglement or ingestion of plastic waste by marine animals, helping to curb marine biodiversity loss.	The Ocean Cleanup[160] Plastic Fischer[161] Mold srl Clewat Oy Blue Circular PostBranding Project
Carbon removal technologies	Carbon storage in the deep-sea floor in the form of organic compounds, used as carbon credits or the conversion of CO_2 into high-value products for multiple industries.	Can greatly reduce greenhouse gas emissions, contribute to decarbonisation, and produce renewable geothermal energy and building materials, among other products.	GEA@275™ Oceanfield Blusink[162]
Nature-based solutions (NBS) to restore and regenerate marine environments	Solutions include structures to protect endangered areas; restoration and regeneration of different marine habitats such as coral reefs and mapping of current and future environment scenarios.	Enables the protection, sustainable management and/or restoration of natural ecosystems (e.g. via artificial reef structures aimed at accelerating reef creation), and in parallel addresses societal challenges such as climate change, human health, food and water security, and disaster risk reduction.	S39 Hybrid Design Kft. MERCES[163] EMERTOX[164] ARC Marine LTD ARTREEFS[165] REEFY[166]
Biodiversity monitoring technologies	Bioacoustics and environmental DNA technologies that gather biodiversity data and wildlife insights and monitor biodiversity status.	Helps to overcome labour-intensive challenges of traditional wildlife surveyance by facilitating the analysis of large quantities of data and delivering more accurate results, supporting the protection of endangered species.	EnviroDNA Carbon Rewild

Value chain category: Ocean and Biodiversity Monitoring · Ocean and Coastal Area Clean-up · Biodiversity Restoration and Regeneration · Coastal Restoration and Regeneration

Sources: Company websites[160, 161, 162, 163, 164, 165, 166]

4.7

Fisheries

Definition

Capture fishery is the term used to describe the harvesting of naturally occurring living resources in both marine and freshwater environments[167]. Also called wild catches or capture fishery, the sector covers the **harvesting of aquatic plants, fish, mollusks, crustaceans and other marine species**.

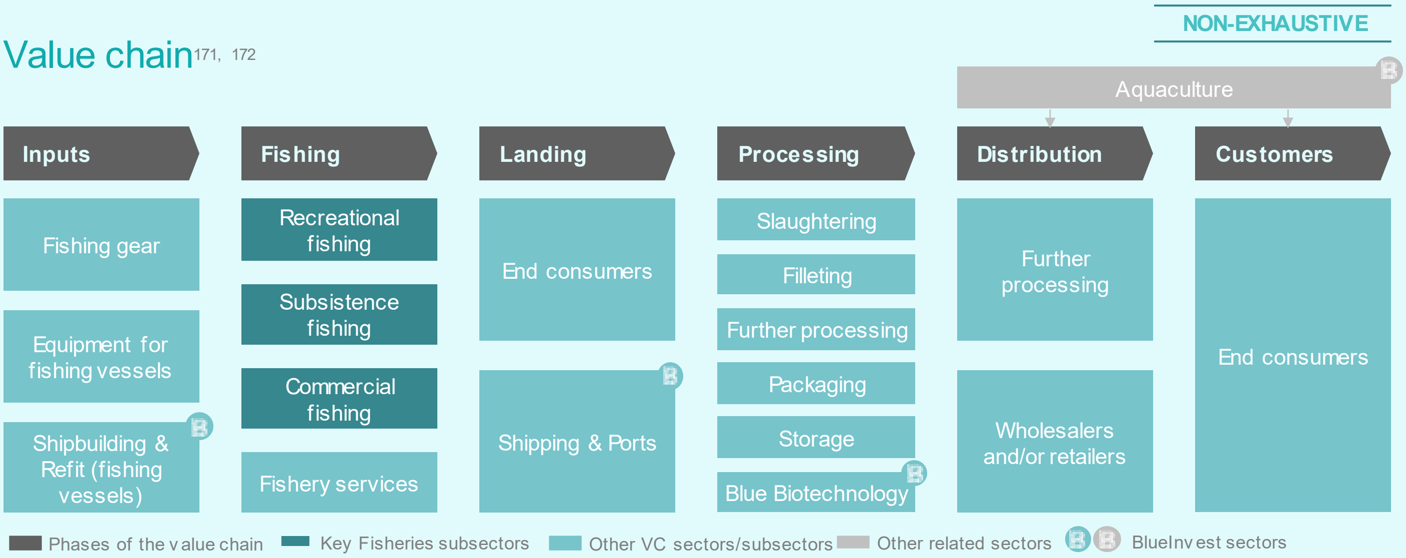
There are three types of fishery: **recreational** (for leisure), **subsistence** (for direct consumption) and **commercial or industrial** (small-scale business or large-scale for-profit activity)[168]. As recreational fishing represents less than 1% of global catches[169], it will be left out of the scope of this chapter. Subsistence fishing uses a variety of fishing gear to capture different species, whereas industrial fishing tends to use gear for intensive fishing (such as purses, seines and trawlers), and usually targets one species.

The sector also covers a series of **fishery-adjacent activities**, such as monitoring.

Green transition

Sustainable fishing aims to leave enough fish in the ocean to enable species regeneration and protect marine habitats. It translates into taking care not to overfish, minimising any negative environmental and social impacts and complying with relevant legislation and regulations[168]. It is hard to measure how sustainable fishery is due to the complexity of its impact. Instead, we can monitor the **transparency of its sustainability practices**. Fisheries may be certified by respected private entities (e.g. the Marine Stewardship Council (MSC))[170], acknowledged as participants in fishery improvement projects (working towards certification), classified as fisheries under management (monitored by public entities) or unmonitored fisheries, in which case their sustainability practices are mostly unknown[44].

Value chain[171, 172]



Sources: Expert Interviews[44]; FAO (2015)[167]; UN Atlas of the Oceans (2016)[168]; Freire, et al. (2020)[169]; Marine Stewardship Council[170]; Tang et al. (2020)[171]; World Economic Forum (2020)[172]; PwC Analysis

Key innovations and technologies

● BlueInvest ● Other examples

Innovation	Description	Value proposition	Examples
Bycatch reduction devices	Smart gear that uses lasers, LED, sensors and IoT to capture target species and make others swim away, thus providing a more effective method for reducing bycatch[173, 174].	These technologies help fisherfolk to catch the right fish, therefore substantially lowering the amount of bycatch, improving fishing revenues, saving more fish, supporting fisherfolk and protecting an essential food source[175, 176].	SafetyNet Technologies Smartfish H2020[173]
Anti-waste fishing gear[177]	Gear that is either biodegradable (e.g. nets made from naturally decomposable materials) or recoverable (e.g. retractable cages).	The use of anti-waste fishing gear decreases the costs associated with replacing lost gear and mitigates the impact of ghost gear on biodiversity.	Resqunit (Norway)[177] Sealive EU[178] E-REDES[179]
Electronic monitoring systems	Networks of sensors (combined with computer vision technology and machine learning[180, 181]) and cameras that automatically compute the quantities of fish caught (total or per species), bycatch, weight of hauls, etc.[182, 183].	The implementation of these systems makes it easier to meet fishing quotas and enables higher selectivity in fishing methods via fast monitoring, control and identification of bycatch. Bycatch can be returned to the sea faster, increasing its chances of survival[175, 184].	Remote Electronic Monitoring (REM)[182]
Fish tracing apps/ platforms for consumers	Apps/platforms that use cloud, blockchain, QR codes, and databases to allow consumers to trace seafood throughout the supply chain[181].	These apps/platforms enable consumers to make better decisions about what they are consuming and help them opt for more sustainably caught products from outfits that respect animal welfare and provide reasonable work environments throughout the supply chain[181].	Seafood Tomorrow Traceability Tool[185] S-Group[186]
Maritime surveillance technologies to prevent IUU fisheries	Technologies such as drones, sensors and IoT that have been developed or adapted to prevent IUU fisheries. Current solutions like Vessel Monitoring Systems (VMS), long-range identification and tracking (LRIT), vessel detection services (VDS) and terrestrial automatic identification systems (AIS) are often limited* in their capacity[184, 185, 187, 188].	These technologies can provide maritime guards with a real-time live feed of the oceans and store data in the cloud, thereby reducing the effort and resources required from coastal and sea guards. Additionally, unlike existing technologies (e.g. VMS), they provide non-cooperative surveillance systems**, meaning they cannot easily be tampered with by captains of vessels engaging in IUU fishing[184, 188].	TopView SRL
Fish tracing apps/ platforms for market players	Apps/platforms that track where, when and how much fish is caught, to whom it is sold and at what price. The information gathered is automatically shared with authorities and fisherfolk[181].	These apps/platforms give fisherfolk more control over their activities, allow them to make higher profits and ensure their rights are protected and fair treatment is secured. They also help to prevent overfishing as fisherfolk can see when quotas have been reached[181].	Sinay Seafood App
Fish health control[189]	Technology used to identify and treat diseases and parasites in caught fish and fish parts.	Controlling fish health reduces the risk of putting poor quality fish into the market, contaminating healthy catches or releasing larvae and parasites into the areas where fishing fleets operate.	TEDEPAD® by marexi Nofima (Norway)[190]

Value chain category: Fishing Gear Ship Equipment Fishery Services Fishing

Notes: *Limited ranges, dependency on equipment onboard the vessel, etc.; **Cooperative surveillance systems have equipment installed onboard vessels and thus surveillance capacity can be influenced by vessels (their effectiveness rely on vessels cooperation). Non-cooperative surveillance systems are autonomous from vessels.

Sources: Cordis (2022)[173]; Seafood Harvesters of America (2021)[174]; European Commission (2022)[175]; BlueInvest[176, 188]; BlueBioValue (2022)[177]; Company Websites[173, 177, 178, 179, 182, 185, 186, 190]; Environmental Defense Fund[180]; Ortiz (2019)[181]; IUU Watch (2019)[182]; NOAA Fisheries[183]; OECD (2017)[184]; European Fisheries Control Agency[187]; Marexi[189]

4.8

Shipbuilding & Refit

Definition

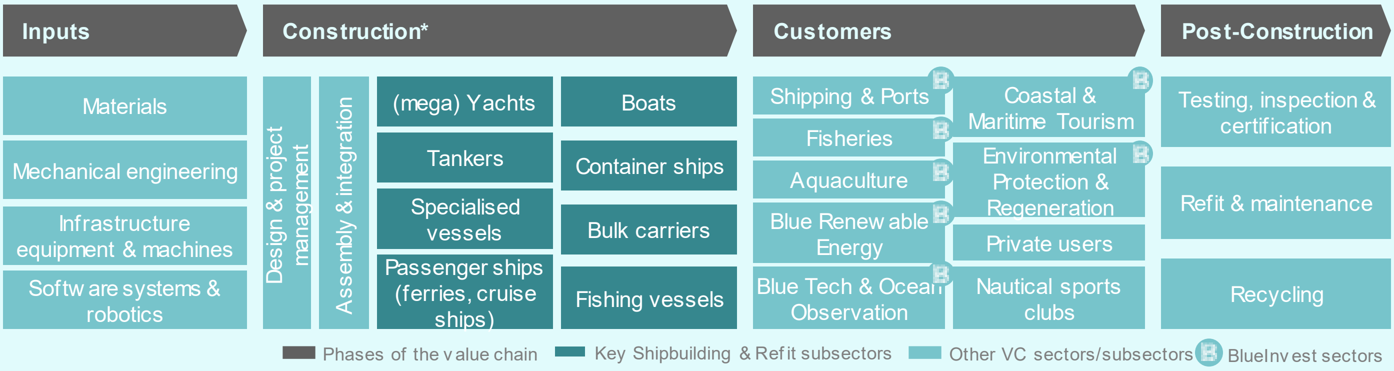
Shipbuilding and refit defines the **production of vessels** and the delivery of the **products and services (marine equipment)** needed for the **building, maintenance, repair and refitting** of the vessels[5]. Companies in the industry operate in shipyards, which are fixed facilities with dry docks and manufacturing equipment[191]. The sector is typically subdivided according to **vessel type** (**cargo-carrying vessels** such as bulk carriers, oil tankers, container ships or gas carriers, or **passenger-carrying vessels** such as ferries or cruise ships), which is the subsector classification used in this report. Alternatively, it can be divided according to **vessel size** (ships or boats, with the latter tending to be small- to mid-sized vessels with lower carrying capacity than the former[192]) or **end user type** (the **commercial sector** – e.g. water transport companies and the offshore energy industry – and the **naval sector** tend to acquire larger vessels, whereas **private individuals, sports clubs, fishing and aquaculture outfits** tend to acquire smaller vessels)[193].

Green transition

Green shipbuilding and refit includes the concepts of "green ship" and "green shipyard". "Green ship" refers to **green ship design**, which aims to **cause minimal damage to the environment** by reducing material and energy consumption during construction, recycling parts and accessories removed during maintenance, and reusing as many materials as possible once a ship has been retired[194]. "Green shipyard" ensures that **material and energy resources are used as efficiently as possible** during the building phase to reduce emissions during integrated hull construction, outfitting and painting[194]. The sector's green transition is **powered by advances in technology** that allow vessels to use propulsion systems and e-fuels to decrease emissions, consume less energy and become more energy efficient.

Value chain[192, 195]

NON-EXHAUSTIVE



Inputs
- Materials
- Mechanical engineering
- Infrastructure equipment & machines
- Software systems & robotics

Construction*
- Design & project management
- Assembly & integration
- (mega) Yachts
- Tankers
- Specialised vessels
- Passenger ships (ferries, cruise ships)
- Boats
- Container ships
- Bulk carriers
- Fishing vessels

Customers
- Shipping & Ports
- Fisheries
- Aquaculture
- Blue Renewable Energy
- Blue Tech & Ocean Observation
- Coastal & Maritime Tourism
- Environmental Protection & Regeneration
- Private users
- Nautical sports clubs

Post-Construction
- Testing, inspection & certification
- Refit & maintenance
- Recycling

Note: ***Container ships:** characterised by their large capacity and the ability to load and unload containers quickly; **Bulk carriers:** characterised by their large capacity to transport unpackaged goods (i.e. raw materials); **Tankers:** characterised by their large capacity and being designed to carry hazardous materials safely (i.e. oil and chemical products); **Passenger ships:** transport people, and can range in size from small ferries to large cruise ships; **Boats:** smaller vessels usually used for recreational activities (except some commercial types such as tugboats); **Specialised vessels:** characterised by their onboard machinery/equipment for performing specific tasks related to different marine industries (i.e.offshore vessels, dredgers, research vessels; **(mega) Yachts:** characterised by their length of 24 metres or more, mega yachts are typically professionally crewed, whereas regular yachts are usually smaller and privately owned; **Fishing vessels**: used for commercial and recreational fishing, and can range in size from small boats to large factory ships.

Sources: European Commission (2022)[5]; Technavio (2020)[191]; The Business Research Company (2021)[192]; IBISWorld (2020)[193]; Rahman & Karim (2015)[194]; Collins et al. (2018)[195]; PwC Analysis .

Key innovations and technologies

Cont.

● BlueInvest ● Other examples

Innovation	Description	Value proposition	Examples
Development of advanced materials	The development of advanced and lightweight shipbuilding materials, which traditionally fall into three groups: metals, composites (fire-proof composite hulls[196]) and polymers. New materials are constantly being added to the list (e.g. ceramics, advanced high-strength steel and other nanomaterials).	The aim is to improve safety and reliability of vessels, save weight and increase the efficiency of manufacturing and maintenance processes. The longer endurance of materials also supports circular economies.	COMPA Repairs Northern Light Composites Srl Fassmer[197] TriboBlend[198]
Digital twin and 3D designing & scanning	The creation of a 3D virtual replica of a physical vessel, which allows it to be virtually designed, optimised and simulated before the physical construction phase is initiated. The twin is a piece of software fed with data (i.e. computer-aided design – CAD - data) that evolves to reflect changes to the physical product[199, 200].	3D design and digital twin technologies enable simulation, automation and efficiency of ship design and construction processes. These technologies also facilitate the early detection of potential future hazards in ship design, construction and operation systems, thereby increasing operational efficiency and safety.	3D Maritim[201] Syroco[202]
Virtual reality (VR) and augmented reality (AR) for design review and visualisation	VR consists of placing a person into a digitally created virtual location, which facilitates the process of layering and the identification of design non-conformities[203]; AR consists of digitally enhancing the regular view of a situation, in real time and in a real world situation such as ship maintenance/inspection.	VR and AR solutions allow shipyards to streamline manufacturing processes and improve training and service efficiency through inspection optimisation and field maintenance. One sample use case is skilled workforce being able to perform work remotely without the need to travel to a shipbuilding site.	Augment Warning – Wartsila[201] Vuforia[204]
Use of 3D printing and other advanced manufacturing techniques to improve the construction process	A printing technique known as additive manufacturing (AM) that creates and replicates 3D objects by depositing materials (usually) in layers[205]. Instead of requiring the cutting and welding of various alloys, customised and lightweight spare parts and structures are produced on demand via a simple printing process.	The lower-weight materials used in AM are key to maximising fuel efficiency and minimising carbon emissions of vessels[206]. The technique also contributes to process automation, reduces waste by producing custom parts according to specific requirements and improves efficiency.	Moi Composites[207] Tanaruvisualis[208] RAMLAB[209]
Green shipyard practices	Techniques and approaches to shipbuilding that aim to reduce material and energy consumption and environmental pollution in ship manufacturing and services, recycle the parts and accessories used in ship maintenance and reuse the majority of materials after ship decommissioning[194].	Green shipyard practices help to minimise the harmful emissions released during the manufacturing, servicing and decommissioning of vessels, thereby aiding to reduce pollution, save resources, improve efficiency and promote a circular economy.	Leviathan GmbG[210] Lean and Green Shipbuilding techniques at Shipyard Brodotrogir[211] Resurgam - Friction Stir Welding[212]

Value chain category:

Materials Design & Engineering Assembly & Integration Maintenance & Repair Decommissioning

Sources: Rahman & Karim (2015)[194]; J.Spaniol & J.Rowland (2022)[196]; Company websites[197, 198, 201, 202, 204, 207, 208, 209, 210, 211, 212]; Navantia[199]; DNV (2022)[200, 206]; Praveen (2021)[203]; TWI[205]

● BlueInvest ● Other examples

Innovation	Description	Value proposition	Examples
Smart, connected shipyards	Smart and connected shipyards are those powered by a scalable, flexible and low-latency 5G network which enables the use of technologies like the internet of things (IoT), big data and AI.	5G networks combined with IoT, big data an AI solutions enable predictive maintenance and remote technical assistance for shipyards, with the possibility to make immediate corrections, eliminate time-consuming rework[213] and allow for a more efficient construction of safer and more sustainable vessels[214].	Bionic System Solutions (BSS) CSI Control Systems[215]
Robotics in shipyards	Robots such as vessel- and weld-inspecting drones, underwater scanning and repairing robots and anti-fouling robots that are able to perform welding, blasting, heavy lifting, inspection, scanning and other shipbuilding tasks.	The use of robots is highly desirable in shipyards, especially for repetitive processes[216], as it increases the efficiency of operations while sparing the labour force the most dangerous tasks[191] and helping to plug the labour gap at shipyards.	Resurgam[212] Robotnik[217] RB3D[218] Bisonte Sp. z o.o.
Autonomous ships	Ships controlled remotely, without the need for seafarers to be on board. The ship's operating system is able to make decisions and determine actions by itself.	Autonomous ships can increase safety and reduce crewing costs, allowing for a more efficient use of space in ship design and a more efficient use of fuel.	Massterly[219] Ladar Ltd[220] Buffalo Automation[221]
Eco-ships: renewable sources of energy to power ships	The development of technologies to use renewable sources of energy (wind and sun) in auxiliary propulsion/engine systems instead of conventional energy sources.	The main added value of renewable energy-powered ships is the reduction in harmful emissions and fuel consumption.	E-LLOYD Norsepower Rotor Sails[222] Bureau Veritas[223] PowerUP[224] Ecomar Propulsion ZPARQ[225]
Eco-ships: alternative fuels and other technologies	Use of new technologies for shipbuilding, such as ballast-free ships, sulphur scrubber systems, waste heat recovery systems, speed nozzles, exhaust gas recirculation systems, advanced rudder, and use of alternative fuels such as hydrogen or liquified natural gas (LNG) in propulsion and auxiliary engines. Examples of eco-ships are hydrogen- and electric-powered fishing vessels that incorporate electric propulsion, exhaust gas scrubbing and airlift systems.	Eco-ships aim to increase fuel efficiency and deliver substantial energy savings while minimising negative environmental impacts such as carbon emissions[191], ballast water and sediments.	DMA TECH Hasytec Electronics GmbH Wartsila[226] Bawat S/A[227] Skeleton Technologies[228] Loran (Norway)[229] Olenergies[230]

Value chain category:

Materials · Design & Engineering · Assembly & Integration · Maintenance & Repair · Decommissioning

Sources: Technavio (2020)[191]; Company websites[212, 215, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230]; Lloyd's Register (2022)[213]; Recamán Rivas[214]; Fernández[216]

4.9

Shipping & Ports

Definition

The shipping and ports sector covers the **transportation of freight and passengers by water**, and **all the activities** and **infrastructure** that enable it. Shipping is indissociable from ports and vice versa, as maritime transport must start and end at a port, and ports are designed to receive merchant vessels and handle their cargo and/or passengers[231].

“Shipping” encompasses the following subsectors[5]: **passenger transport** (tourism or commuting services), **freight transport** (transport of any type of good), and **other transport-related services** (e.g. ship management). Both **passenger** and **freight transport** can be segmented according to the type of water environment (sea, coastal and inland).

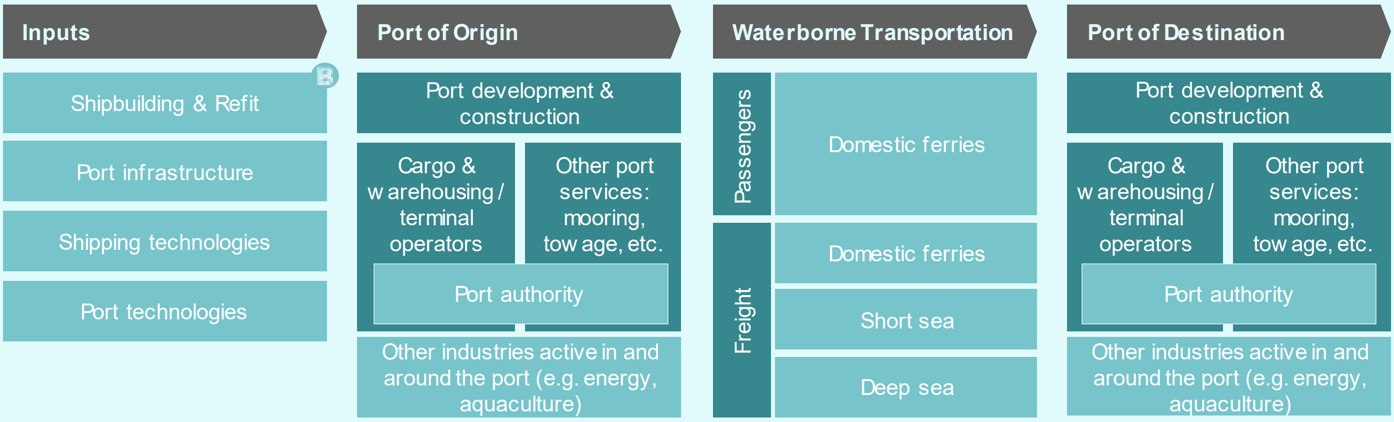
“Ports” are crucial infrastructures of strategic importance that support significant flows of goods and people[5]. They vary in size and scope, from very large ports (hubs) down to small or regional ports[231]. “Ports” encompasses the following subsectors: **port development & construction** (the erection of new ports and/or expansion of existing ones), **cargo and warehousing/ terminal operations** (the handling, warehousing and storage of cargo) and **other port services** (provision of port services like mooring, towage and onshore power supply to ships).

Green transition

The notion of sustainable shipping and ports is based on two key concepts: “green shipping” and “green ports”. “Green shipping” seeks to implement more **sustainable ship operating strategies** (e.g. by using cleaner fuels and optimising routes). The latter seeks to transform port processes, structures and policies to **lessen their negative environmental and climate impact**[232] (e.g. by adapting infrastructure to the rising water levels, digitising operations, promoting higher transparency in sustainability reporting, powering industry with renewable energy sources and electrifying port infrastructure[233]).

Value chain*

NON-EXHAUSTIVE



Inputs
- Shipbuilding & Refit
- Port infrastructure
- Shipping technologies
- Port technologies

Port of Origin
- Port development & construction
- Cargo & warehousing / terminal operators
- Other port services: mooring, towage, etc.
- Port authority
- Other industries active in and around the port (e.g. energy, aquaculture)

Waterborne Transportation
- Passengers
  - Domestic ferries
- Freight
  - Domestic ferries
  - Short sea
  - Deep sea

Port of Destination
- Port development & construction
- Cargo & warehousing / terminal operators
- Other port services: mooring, towage, etc.
- Port authority
- Other industries active in and around the port (e.g. energy, aquaculture)

Note: *The value chain excludes the activities of **hinterland transportation** (pre-carriage of passengers / freight to the port of origin and from the port of destination to the final destination).

■ Phases of the value chain
■ Shipping & Ports subsectors
■ Other VC sectors/subsectors
Ⓑ BlueInvest sectors

Sources: European Commission (2022)[5]; Ecorys (2018)[231]; European Environment Agency (2021)[232]; European Institute of Innovation & Technology (2022)[233]; PwC Analysis

Key innovations and technologies

Cont. ▶

● BlueInvest ● Other examples

Innovation	Description	Value proposition	Examples
Smart port technologies[196, 234]	Automation, service integration, digitisation and data-driven techniques in combination with technologies such as the internet of things (IoT), big data and AI for port and ship infrastructure. These technologies aim to analyse data retrieved by sensors installed in the port/ship and apply predictive analytics to support decision-making (e.g. predicting the estimated time of ship arrivals, managing vessel delays caused by adverse weather conditions, etc.). Smart port technologies also include the use of blockchain in port contracts to record transactions and track information.	Smart technologies facilitate multilevel decision-making and improve safety and security both onboard ships and for port infrastructure, thanks to applications such as operational analytics, sustainability reporting, maintenance prediction, crew management, route enhancement, roll on/roll off shipping optimisation and freight pattern analysis. Blockchain ensures transparency through reliable data storage.	eYARD BuyCo Awake.AI[235] Flexidao[233] Everimpact PortXchange[236] SEAPort Solutions
Digital twin in the shipping & port ecosystem[237]	A dynamic digital representation of a port complex, terminal, or ship that describes its characteristics and properties as a set of equations. A digital twin includes both the hardware to acquire and process the data and the software to represent and manipulate it.	Digital twins are used to optimise port call operations and allow all operations in a port complex and onboard seagoing vessels to be monitored without the need to install a hardware system.	Teqplay BV We4Sea[238]
Port robotics[239]	Automated solutions capable of performing repetitive tasks that do not require specific skills. The main applications include security and inspection tasks, which can be done by robots or drones moving through the port to track facilities, equipment or cargo in real time, and automated transport or loading tasks, such as container handling and warehouse management, which can be done by automated guided vehicles (AGV).	The use of robots allows workers to avoid exposure to life-threatening conditions during maintenance and inspections, and increases efficiency levels by accelerating risk assessments through real-time remote monitoring.	Cargotec[240] AGV R[241] Airobotics[242]

Value chain category:

- Shipping Technologies
- Port Infrastructure
- Port Technologies
- Cargo & Warehousing / Terminal Operators
- Other Industries in and around the Port
- Waterborne Transportation

Sources: J.Spaniol & J.Rowland (2022)[196]; European Institute of Innovation & Technology (2022)[233]; Yongsheng Yang et al. (2018)[234]; Company websites[235, 236, 238, 240, 241, 242]; European Institute of Innovation & Marine Digital[237]; PierNext (2022)[239]

● BlueInvest ● Other examples

Innovation	Description	Value proposition	Examples
Ship electrification and sustainable propulsion systems	Ship electrification consists in the use of battery systems and energy storage solutions for ship propulsion to increase energy efficiency and reduce negative environmental impact. Other sustainable propulsion systems include the use of alternative sources of energy such as biofuels, wind energy (e.g wind-assisted propulsion), tidal energy, solar power and e-fuels like methanol, ammonia and green hydrogen.	The use of these solutions has a positive impact on emissions, marine noise, and energy efficiency, recovery and storage without affecting vessel productivity.	La Méridionale[243] Scandlines[244] HySiLabs[233] WISAMO[245]
Green port ecosystems[233]	Green port ecosystems refers to the implementation of infrastructure and practices to decarbonise logistics and shipping activities in ports. These include, among others, the use of renewable energy sources, energy efficiency measures, smart technologies to aid transportation and delivery, and shore-side electricity provision for docked ships.	Green port ecosystems are key for the renewable energy transition and can have a significant positive impact on the reduction of GHG emissions.	Elestor[233] Skeleton Technologies[228]
Decarbonising industries active in and around ports[233]	The decarbonisation of industries that operate within ports such as shipbuilding, chemicals, food, construction and electricity. Routes to decarbonisation include using renewable heat to run industrial processes, improving energy efficiency, electrifying processes, using green hydrogen as a feedstock, employing circular production models and re-using waste heat.	Decarbonisation drives emission reductions and energy efficiency in and around ports.	Eco-tech Ceram[233] Cascade Drives[233]
New infrastructures and products[233]	Research and development of new infrastructures and products to better manage cargo operations. Examples include an underwater hyperloop, which uses magnetised tracks to move goods faster through a vacuum-sealed tunnel, offshore container terminals and foldable containers that aim to save space on vessels.	Foldable containers reduce emissions and costs thanks to space maximisation; underwater hyperloops and offshore terminals make cargo operations more efficient by reducing congestion and emissions.	Navlandis[246] Holland Container Innovations (HCI)[247]

Value chain category:

- Shipping Technologies
- Port Infrastructure
- Port Technologies
- Cargo & Warehousing / Terminal Operators
- Other Industries in and around the Port
- Waterborne Transportation

Sources: Company websites[228, 243, 244, 245, 246, 247]; European Institute of Innovation & Technology (2022)[233]

4.10

Water Management

Definition

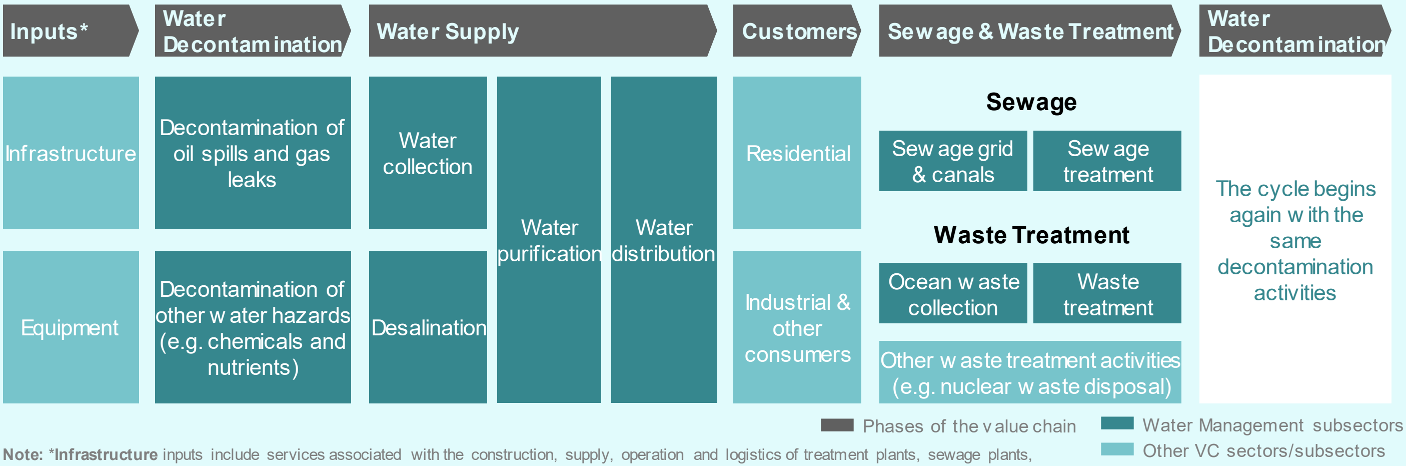
Water management covers services and infrastructure required for the water usage cycle: (1) **water supply**, which encompasses **water collection** (collecting and storing freshwater and groundwater), **desalination** (removing salt and other minerals dissolved in water), **water purification** (reducing the concentration of contaminants) and **water distribution** (delivering water to the premises of consumers); (2) **sewage**, which consists of operating sewer systems or sewage treatment facilities that collect, process and dispose of sewage; (3) **waste treatment**, which consists of capturing and processing solid or non-solid waste (e.g. microplastics), operating ocean floor landfills and disposing of and storing radioactive nuclear waste; and (4) **water decontamination**, which consists of removing any damaging substances in the water that cannot be dealt with by waste treatment activities, such as oil spills and other forms of pollution in oceans, seas and coasts[5].

Green transition

Green water management centres on **actions to prevent and/or repair the damage caused to our water sources by pollution or contamination**. This includes implementing stricter control measures, reducing pollution at the source and improving wastewater treatment processes to ensure discharge limits are known and respected. It includes **efforts to achieve carbon neutrality** across all sector activities by reducing energy usage at treatment plants and developing new, cleaner technologies, as well as efforts to engage in and promote a more sustainable and responsible use of water. Desalination is a vital component of **sustainable water management**, as it can supplement freshwater stocks and shore up supply as demand increases. Water management can also foster sustainability by recovering salt and other byproducts such as sewage sludge and converting them into other valuable resources, boosting sector circularity[248].

Value chain[5]

NON-EXHAUSTIVE



Note: ***Infrastructure** inputs include services associated with the construction, supply, operation and logistics of treatment plants, sewage plants, desalination facilities, etc.; **Equipment** inputs include filters and materials for sewers, water filters, sponges and robots for decontaminating water, etc.

Sources: European Commission (2022)[5]; Technavio (2021)[248]; PwC Analysis

Key innovations and technologies

● BlueInvest ● Other examples

Innovation	Description	Value proposition	Examples
Advanced filtration[249]	Using advances in nanotechnology to develop filtration membranes that remove hard-to-capture micropollutants, or advance biological filtration, using bacteria to purify water while converting energy from oxidation into electricity.	Nanocomposite membranes provide higher flux, permeability and selectivity than conventional solutions. Together with natural and self-cleaning filters, new advancements contribute to energy-saving and cost-effective water filtration.	Nanoseen[250] Likuid[251]
Digital water management[249]	Using AI, IoT sensors and advanced meters to automatically measure water quality and quantity; geographical information systems (GIS), digital twins and AR/VR to visualise and model situations across the water cycle; and 5G, blockchain and the cloud to ensure speed and data security.	Improves decision-making and efficiency in water utility companies by making it possible to monitor and identify toxicity levels and detect pollution episodes in the water, thereby enhancing safety and sustainability.	SeaTopic SAS WOLA PipePredict[252] SPHERAG[253] GoAigua[254]
Novel desalination techniques[249, 255]	Techniques that increase the energy efficiency of existing desalination plants by integrating renewable energies like solar power, implementing brine diffusers to reduce toxic brine discharges and applying alternative desalination techniques/solutions like wave-powered desalination buoys.	Decreases energy costs associated with desalination (currently 25% of the world's water management energy use) and make desalination more accessible and easier to implement in different regions.	Grino[256] Venturi Brine Desolenator Ecos
Energy production from wastewater byproducts[257]	Technologies that help treat sewage sludge and convert it into other resources such as phosphorus, fuel, nutrients, activated carbons for water treatment, soil remediation materials, biochar (biomass-derived charcoal) and synthesis gas (syngas).	More economical and ecological ways to treat and dispose of sewage sludge while creating added value, thereby contributing to a circular economy. This wastewater could replace 25% of nitrogen and 15% of phosphorus used to fertilise agricultural land, as well as 15% of the water used to irrigate the world's farmlands[258].	PYROCHAR[259] HTCycle[260] reNEW[261] BioQuest Alliance
New wastewater treatment methods[257]	Novel methods for reducing sludge from treated wastewater, such as thermal hydrolysis, microbial fuel cells (MFC) technology, solar photo catalysis and natural wastewater treatment technologies.	These technologies require less space and less wastewater than traditional methods, produce less sludge, use the sludge that is produced for energy production, generate more biogas and/or pollute less.	Veolia Water Technologies[262] TerraNova energy[263]
Microplastic reduction solutions[264]	Innovative solutions such as buoys and filters that capture and reduce the quantity of microplastics in the oceans.	Reduces pollution and improves conditions for ocean biodiversity, increases water quality and facilitates waste cleaning at a lower cost and higher efficiency than current solutions.	PurOceans Technology Sia Pharem Biotech
Oil spill remediation techniques[265]	The use of methods like magnetic soap, autonomous robots and ultra-absorbent sponges to clean up oil spills around the world.	New methods are designed to remove oil from the water as quickly and efficiently as possible.	Foru-Solution BV BiYOREM (Türkiye)[266]

Value chain category: Water Supply (Filtration) · Water Supply (Distribution) · Desalination · Sewage · Waste Treatment & Disposal · Remediation & Decontamination

Sources: StartUs Insights (2022)[249]; Company websites[250, 251, 252, 253, 254, 256, 259, 260, 261, 262, 263, 266]; World Bank, Viola (2020)[255]; NetSol Water Solution Pvt (2022)[257]; Mowbray (2022)[258]; Wear, Acuña, McDonald, & Font (2021)[264]; Goodier (2022)[265]

Annexes

A.1

Methodology note

Methodology

A 3-step methodology was generally applied to the Investor Report (see Figure A.1.1).

Fig. A.1.1: Methodology for the Investor Report

1 Scope definition

2 Primary data gathering and treatment

3 Secondary data gathering and analysis

1. Scope definition

The BlueInvest sectors were defined based on EU and international official classifications and technology types, ensuring consistency and comparability across 10 separate but interconnected sectors. A perspective on sustainability was provided in the green transition of each sector snapshot, and in considering its key innovations and sample technologies.

In terms of geographical scope, the report primarily focuses on the EU territory, including where relevant, the outermost regions.

Desk research and feedback from investors and experts were used to identify and map potential blue economy investors.

2. Primary data gathering and treatment

The investor survey in Chapter 3 targeted angel/private investors, asset managers/fund managers, asset owners and family offices, banks, enterprises/corporations (mainly those involved in inorganic growth), incubators/accelerators, national promotional banks, private equities and venture capitals.

The respondents come from an original pool of 300 investors that had been contacted based on their previous engagement with BlueInvest and stated interest in investing in the blue economy. This mapping of investor profiles for the survey was complemented by desktop research on investors with relevant profiles (e.g. venture capital, private equity, asset managers, family offices, etc.) and portfolios (previous investments in any of the 10 sectors).

The investor survey was conducted between August and October 2022. 87 entities from 21 out of 27 EU countries and 6 other countries (including the UK, Norway and the USA) responded to the survey.

79% of survey respondents are based in Europe. All respondents were found to have a positive allocation of assets in Europe. In terms of industry, 44% of responses come from venture capital, 14% from private equity and 13% from the asset management industry. The rest consist of banks, enterprises, and incubators.

The survey results are limited by the size of the sample and the unequal distribution of investor types (44% of responses come from venture capital).

For the analysis, responses were assumed to fairly and adequately represent the views of the investors participating in the survey. The investor survey was divided into 6 categories of questions: **(1) Profile, (2) Strategy, (3) Interest & Drivers, (4) Barriers, (5) Opportunities** and **(6) Investment Criteria**. It had **34 questions** in total.

The first two categories focused on the respondent's organisation and investment strategies. Categories (3) to (6) directed attention towards the blue economy and considered responses only from investors who had invested in blue economy sectors in the past and/or planned to do so in future (76 responses).

Level	Single-choice options
0	We have not invested in the blue economy and we have no interest in investing in future
1	We have previously invested in the blue economy, but no longer invest in it and have no further plans to do so in future
2	We have not invested in the blue economy, but we might or plan to do so in future
3	We have invested in the blue economy in the last 3-5 years and will continue to invest in future

The survey considered investment drivers, barriers, opportunities and decision-making criteria. The results represent the respondents' ranked perceptions on key drivers, barriers, sector potential, and investment criteria.

The data has mostly been analysed in an aggregate manner. Partial responses to the survey were removed from the response pool, and only respondents who completed the survey fully have been included.

Primary data has been complemented by investor and expert interviews to cover the topics within this chapter.

3. Secondary data gathering and analysis

The "Sector opportunities" chapter of the report provides an overview of the 10 sectors. It covers the definition, green transition, value chain and main innovations of each sector. The following disclaimers apply to all sectors:

- **Value chains** – All value chains are defined on the basis of expert interviews and desk research;
- **Innovations** – The examples presented come predominantly from EU countries with some exceptional examples from third countries when case studies are relevant to showcase;

The approach to data gathering and analysis comprised of desktop research and expert interviews. When treating sources, priority was given to EU-funded research and publications and accredited international sources, followed by company and organisational websites.

Selection and analysis of deals

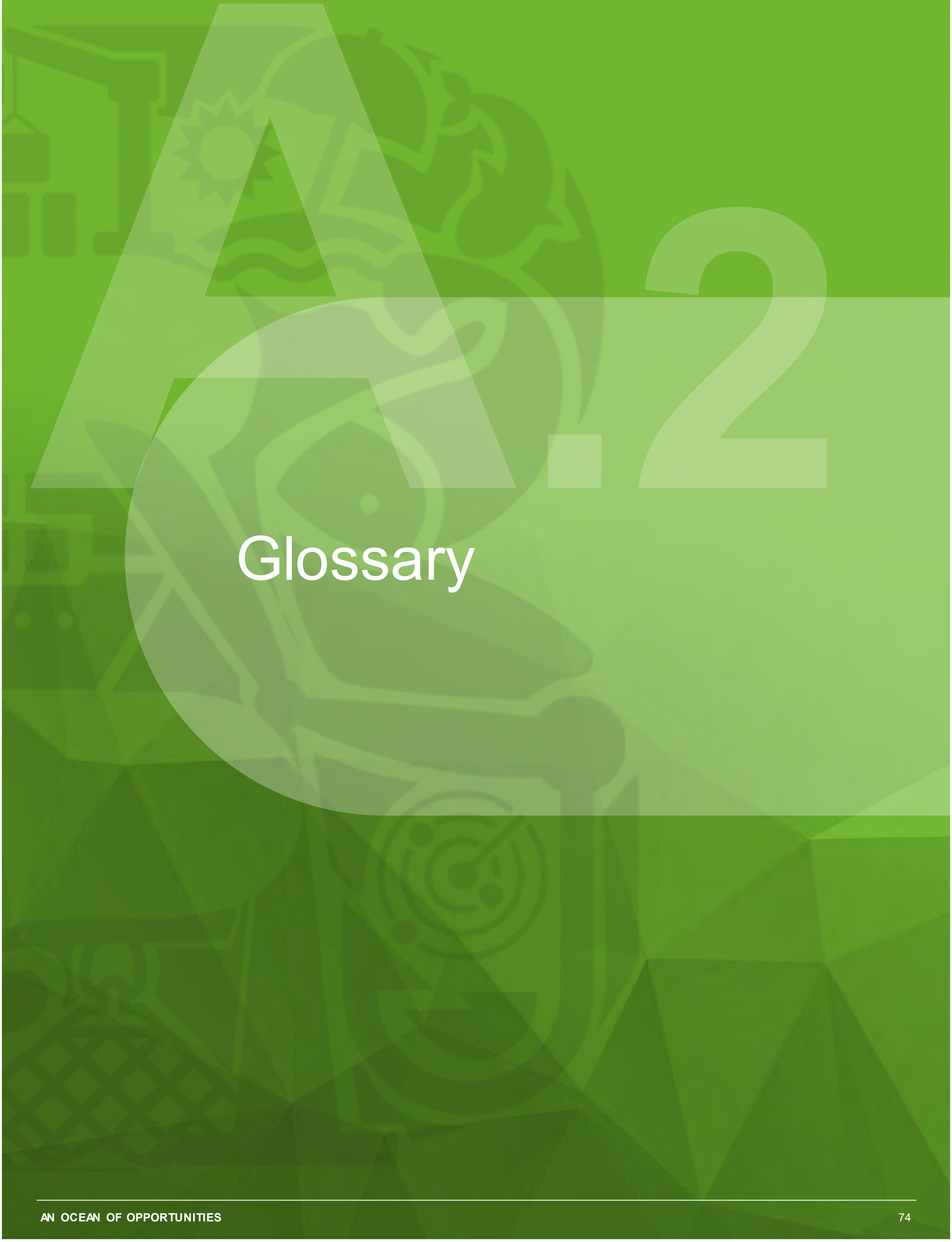
The chapter "EU blue economy investment ecosystem for innovation", analysed a database of financial deals involving EU companies in the period of January 2000 to February 2023.

Data was sourced from CB Insights, a commercial market intelligence database that is updated on a regular basis through "reliable machine learning to crawl, classify and extract millions of insights from unstructured documents from openly available market data*, analyst intelligence and experts input".

In selecting blue economy deals from the database, the following approach was taken:

- initial assumption that the commercial database has been quality controlled and cleaned for duplicates.
- definition of a set of 70+ key words covering the 10 blue economy sectors in focus in this report
- inclusion of enabling technologies relevant to blue economy value chains, as illustrated in this report under "sector opportunities"
- exclusion of companies with a singular focus on oil & gas, with the exception of relevant solutions with multiple offshore applications that may also apply to oil & gas
- deals not covered by the abovementioned filters were not included
- deals from pre-seed to IPO stage across all company sizes were analysed. Stock market transactions were not considered.
- the methodology and assumptions described accept a small margin of error and variation on the sectors mapped.

Note: *CB Insights



A.2

Glossary

Glossary

Cont. ▶

	Acronym	Definition
A	AAC	Aquaculture Advisory Council
	AFI	Alternative Fuels Infrastructure
	AGV	Automated Guided Vehicle
	AI	Artificial Intelligence
	AIS	Automatic Identification Systems
	AM	Additive Manufacturing
	AR	Augmented Reality
B	BE	Blue Economy
	Blue SOS	Blue Sustainable Ocean Strategy
C	CAD	Computer-aided design
	CAGR	Compound Annual Growth Rate
	CEF	Connecting Europe Facility
	CF	Cohesion Fund
	CFP	Common Fisheries Policy
	CGT	Compensated Gross Tonnage
	CO_2	Carbon Dioxide
E	EC	European Commission
	EEZ	Exclusive Economic Zone
	EIB	European Investment Bank
	EIF	European Investment Fund
	EMFAF	European Maritime, Fisheries and Aquaculture Fund
	EMODnet	The European Marine Observation and Data Network
	ERDF	European Regional Development Fund
	ESF+	European Social Fund+
	ESG	Environmental, Social, Governance
	ESPO	European Sea Ports Organisation
	ETA	Estimated Time of Arrival
	EU	European Union
	EU-27	The 27 European Union countries
	EU-ETS	EU's Emissions Trading System
	EUMOFA	European Market Observatory for fisheries and aquaculture
F	FAO	Food and Agriculture Organisation
	FCS	Favorable Conservation Status
	FTSE EMCS	Financial Times Stock Exchange Environmental Markets Classification System
G	GES	Good Environmental Status
	GHG	Greenhouse Gas
	GIS	Geographical Information Systems
	GRI	Global Reporting Initiative
	GT	Gross Tonnage
	GVA	Gross Value Added
	GW	Gigawatt
H	H&C	Heat & Cooling
	HoReCa	Hotels, Restaurants, and Catering
	HPC	High Performance Computing
	HR	Human Resources
I	IFDC Taxonomy	International Development Finance Club Taxonomy
	IMO	International Maritime Organisation
	IMTA	Integrated multi-trophic aquaculture
	IoT	Internet Of Things

	Acronym	Definition
	IoUT	Internet of Underwater Things
	IP	Intellectual Property
	IPCEI	Import Project of Common European Interest
	IUU	Illegal, Unreported or Unregulated
K	KWh	Kilowatt hour
L	LCOE	Levelized Cost Of Energy
	LDCs	Least-Developed Countries
	LIFE	L'Instrument Financier pour l'Environnement
	LNG	Liquified Natural Gas
	LRIT	Long-range Identification and Tracking
M	M&A	Mergers & Acquisitions
	MANPs	Multiannual National Strategic Plans
	MARPOL	International Convention for the Prevention of Pollution from Ships
	MFC	Microbial Fuel Cells
	MPAs	Marine Protected Areas
	MS	Member State
	MSC	Marine Stewardship Council
	MSFD	Marine Strategy Framework Directive
	MSP	Marine Spatial Planning
	MW	Megawatt
N	NATO	North Atlantic Treaty Organisation
	NBS	Nature Based Solution
	NGO	Non-Governmental Organisation
	NOx	Nitrogen Oxides
	NPB	National Promotional Bank
	NUTS 1	Nomenclature of Territorial Units for Statistics - major socio-economic regions
	NUTS 2	Nomenclature of Territorial Units for Statistics - basic regions for the application of regional policies
	NUTS 3	Nomenclature of Territorial Units for Statistics - small regions for specific diagnoses
O	ODC	Other Dry Cargo
	OECD	Organisation for Economic Co-operation and Development
	OMC	Open Method of Coordination
	ONCV	Other Non-cargo Carrying Vessels
	OTA	Online Travel Agency
P	PBRs	Photobioreactors
	PE	Private Equity
R	R&D	Research & Development
	R&D + I	Research & Development and Innovation
	RAS	Recirculating aquaculture systems
	RED	Renewable Energy Directive
	ROI	Return On Investment
	Ro-Ro	Roll-on, Roll-off
	ROVs	Remotely operated vehicles
	RRI	Responsible Research and Innovation
S	SAFE	Simple Agreement for Future Equity
	SASB	Sustainability Accounting Standards Board
	SBE	Small-Business Enterprise
	SDGs	Sustainable Development Goals

	Acronym	Definition
	SIDS	Small Island Developing States
	SMEs	Small and medium-sized enterprises
	SOLAS	International Convention for the Safety of Life at Sea
	SOx	Sulphur Oxides
	STCW	International Convention on Standards of Training, Certification and Watchkeeping
	SUP	Single Use Plastic
T	TEU	Twenty-foot Equivalent Unit
	TWh	Terawatt-hours
U	UK	United Kingdom
	UN	United Nations
	UNCTAD	United Nations Conference on Trade and Development
	UNDP	United Nations Development Programme
	UNEP FI	United Nations Environnent Programme Finance Initiative
	US	United States
	USV	Unmanned Surface Vehicles
	UUV	Autonomous Underwater vehicle
V	VC	Venture Capital
	VDS	Vessel Detection Service
	VME	Vulnerable Marine Ecosystem
	VMS	Vessel Monitoring Systems
	VR	Virtual Reality
W	WEF	World Economic Forum
	WFD	Water Framework Directive

A.4

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