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Sustainability criteria for the blue economy

Main report

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Main report

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List of abbreviations

ASC	Aquaculture Stewardship Council
BESF	Blue Economy Sustainability Framework
CICES	Common International Classification of Ecosystem Services
CINEA	European Climate, Infrastructure and Environment Executive Agency
EAP	Environment Action Programme
EC	European Commission
ESG	Environmental, Social, and Governance
ESIA	Environmental and Social Impact Assessments
EIB	European Investment Bank
ETIS	European Tourism Indicator System
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GES	Good Environmental Status
GVA	Gross Value Added
IUCN	International Union for Conservation of Nature
IUU	Illegal, Unreported and Unregulated
LCA	Life Cycle Analysis
GVA	Gross Value Added
MCA	Multi Criteria Analysis
MSC	Marine Stewardship Council Organisation
OECD	for Economic Co-operation and Development
PES	Payment for Ecosystem Services
RACER	Relevant, Acceptable, Credible, Easy, Robust
SDG	Sustainable Development Goal
SME	Small and Medium-sized Enterprise
TOE	Tonnes of oil equivalent
WWF	World Wide Fund for Nature
UN	United Nations
UNEP	United Nations Environment Programme
UNEP-FI	United Nations Environment Programme Finance Initiative
VCA	Value Chain Analysis

"The challenge of climate change only exacerbates the existing pressures coming from marine pollution, unsustainable resource use or illicit activities. At the same time, the blue economy offers opportunities for sustainable economic development. So, I am convinced that we can restore our marine environment while also bringing benefits to our coastal communities, and the economy at large."

Commissioner Virginijus Sinkevičius speech
at Ocean Governance Stakeholder Forum,
Brussels 22 April 2020

Abstract

The blue economy is a pivotal component of global economies. There is international consensus that the blue economy boosts employment and innovation, and offers significant opportunities for economic development and investment, including to local communities. **The current output of the global blue economy, worth US $1.5 trillion, is expected to double by 2030[1].** In addition to its potential to drive significant economic and socio-economic development, the blue economy can play a central role in alleviating the pressures on land resources and fostering climate change mitigation and adaptation. In this context, the need to develop and promote sustainable blue economy activities has become critical, based on a common understanding at the international level of the activities and practices that contribute to it. This study is a step towards the establishment of such a common understanding by developing a set of criteria to assess the sustainability of blue economy activities. The outcome of this study is an outline of a **Blue Economy Sustainability Framework**, which provides a preliminary set of sustainability criteria and indicators across various blue economy sectors. Additional input from stakeholders would be essential to further develop and refine the Framework.

[1] OECD (2016): The Ocean Economy in 2013: https://iwlearn.net/documents/2852

Disclaimer

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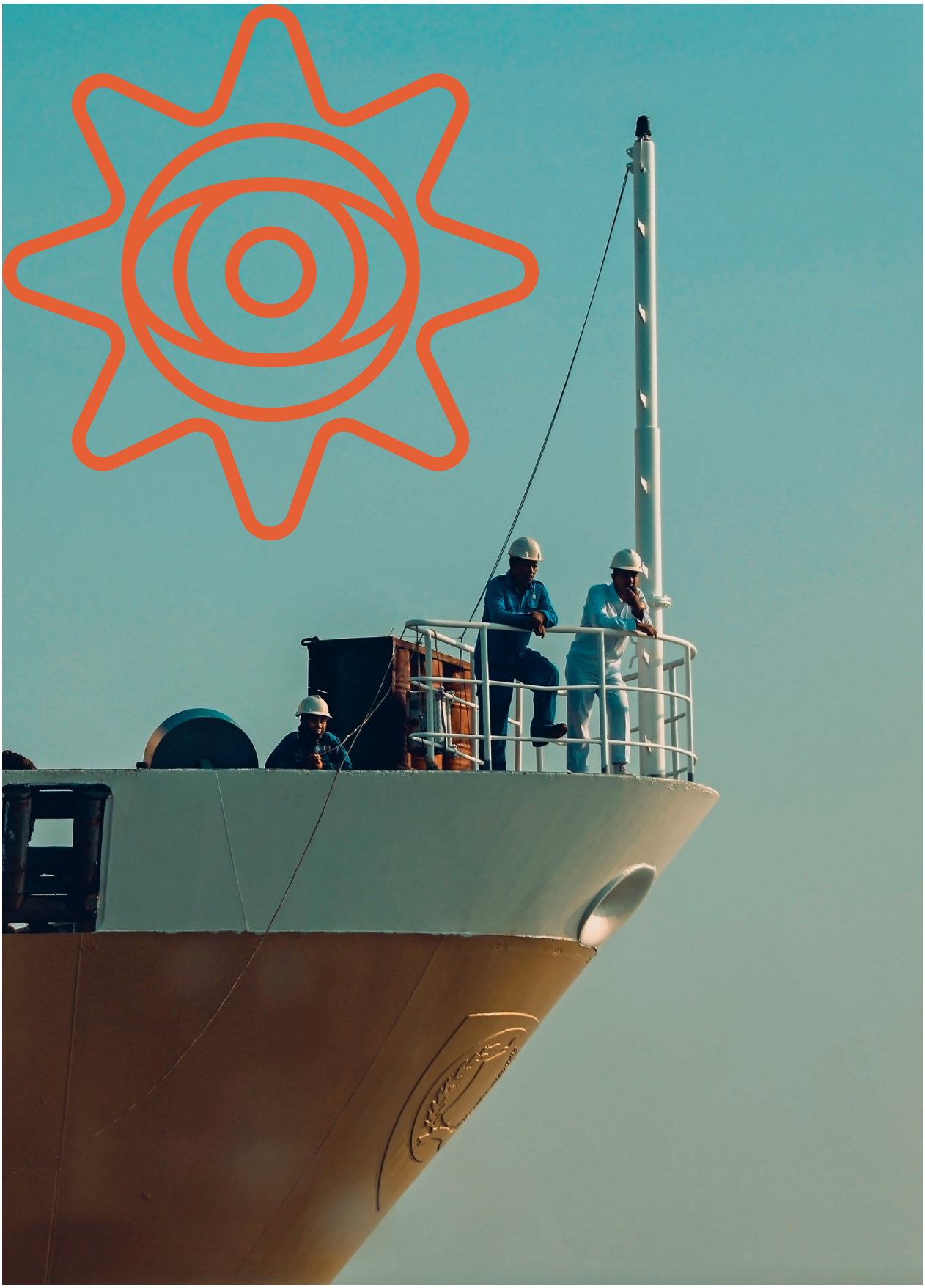


PART 1

INTRODUCTION: CONTEXT OF THE STUDY

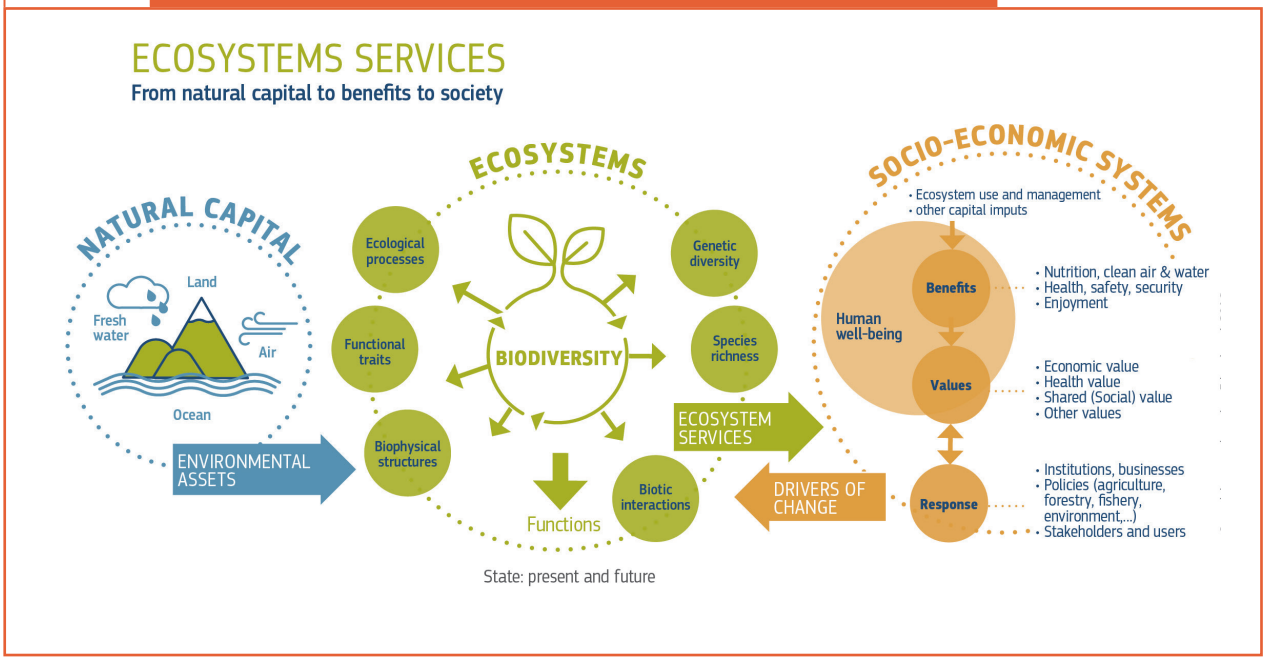
Supporting a shift towards a sustainable blue economy

The European Commission seeks to support a shift away from unsustainable marine and maritime activities and to increase investments in the sustainable blue economy.[2] To do so, there is need to establish a common understanding – at the European Union (EU) and global level – of how blue economy activities can have sustainable or unsustainable outcomes and to raise awareness of potential economic and non-economic gains from sustainable investments and practices. The concept of the blue economy is a pivotal component of global economies. There is international consensus that the blue economy boosts employment and innovation, and offers significant opportunities for economic development and investment, including to local communities. **The blue economy contributes 2.5% of global GDP and provides employment to an estimated 1.5% of the global workforce.** Furthermore, its current output of €1.32 (US $1.5) trillion is expected to double by 2030.[3]

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52018DC0097&from=EN
[3] Nature (2020): Rebuilding marine life. Accessed 02 July 2020. https://www.nature.com/articles/s41586-020-2146-7

The ocean's stock of natural assets, with its biotic and abiotic components and services, is referred to as natural capital. This ocean-based natural capital provides the ecosystem services that constitute the foundation for the activities of the blue economy and related socio-economic development. The flows of goods and services provided by the marine and coastal ecosystem services can be divided into three categories according to the **Common International Classification of Ecosystem Services (CICES): provisioning services** (such as food, water and energy), **regulating services** (such as climate and weather regulation) **and cultural services** (such as recreational benefits)[4]. Yet, **the ocean's natural capital and its related services are fragile to (cumulative) pressures from human activities.** With growing concerns over the impacts of climate change and human activities on marine habitats and biodiversity, the blue economy has gained increasing attention, particularly in relation to the oceans' provisioning and regulating services.[5]

FIGURE 1: Natural capital, ecosystem services and its use in socio-economic systems



Source: European Commission, Blue Economy Report 2020 [6]

[4] CICES Classification Guidelines: https://cices.eu/content/uploads/sites/8/2018/01/Guidance-V51-01012018.pdf
[5] Duarte, C.M., Agusti, S., Barbier, E. et al. (2020): Rebuilding marine life. Nature 580, 39–51. https://doi.org/10.1038/s41586-020-2146-7.
[6] EC (2020): The EU Blue Economy Report 2020. https://ec.europa.eu/maritimeaffairs/sites/maritimeaffairs/files/2020_06_blue_economy_infographics_hd.pdf

The United Nation's Sustainable Development Goal 14 aims to **"conserve and sustainably use the oceans, seas and marine resources for sustainable development"**. The need to "protect, conserve and enhance the EU's natural capital" is a clear policy target of the EU's 2020 Biodiversity Strategy,[7] a first priority for the 7th Environment Action Programme (7th EAP) and an explicit aim of the Green Deal, and thus one of today's top priorities for the European Commission. The concept of preserving natural capital is also included in other relevant European policies, such as the Marine Strategy Framework Directive[8] and the Commission Decision on Good Environmental Status (GES),[9] linking ecosystem components to anthropogenic activities and pressures, and aiming to "protect the resource base upon which marine-related economic and social activities depend".

Next to its potential for economic development and significant socio-economic implications, a sustainable blue economy plays a central role in alleviating the pressures on land resources and fostering climate change mitigation and adaptation. In this context, the need to develop and promote sustainable blue economy activities has become critical. **The European Commission has set out to define a sustainable blue economy and to facilitate the establishment of a common understanding at the international level of activities and the practices that contribute to the sustainable development of the blue economy.** This study is a step towards the establishment of such a common understanding. It contributes to the EU Commission's initiative on investment in the blue economy by raising awareness about the potential economic and non-economic gains from sustainable blue economy activities, thus making the case for an international **Blue Economy Sustainability Framework (BESF).**

[7] .EC (2011): Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions - Our life insurance, our natural capital: an EU biodiversity strategy to 2020 (COM/2011/244).
[8] EU (2008): Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) (OJ L 164, 25.6.2008, pp. 19–40)
[9] EU, 2017, Commission Decision (EU) 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU (OJ L 125, 18.5.2017, p. 43-74)

OVERALL AIMS OF THIS STUDY ARE THUS TO:

- Define a sustainable blue economy and identify (un)sustainable blue economy activities.
- Develop a blueprint for a BESF, based on sustainability criteria and indicators, which can be applied to blue economy activities and illustrates how environmental, social, economic and governance dimensions of sustainability can be measured within the blue economy sectors.
- Promote the application of such sustainability criteria at the international level.

THIS REPORT IS STRUCTURED AS FOLLOWS:

- Chapter 2 provides a working definition of a sustainable blue economy and identifies the main sectors of the blue economy at the global level.
- Chapter 3 provides the outcomes of the analysis of existing sustainability frameworks for the blue economy.
- Chapter 4 presents the set of sustainability criteria for the blue economy developed for this study.
- Chapter 5 outlines the outcomes of the case studies, on which the set of sustainability criteria have been tested.
- Chapter 6 provides recommendations, based on the outcomes of the research step and aimed at policy-makers, investors and economic operators, to facilitate the uptake of the BESF.

PART 2

DEFINING A SUSTAINABLE BLUE ECONOMY AND IDENTIFYING THE MAIN SECTORS AND TRENDS

The fragmented understanding of what a blue economy entails hampers the definition of what a sustainable blue economy ought to be. This chapter describes the outcomes of the research steps taken to provide a working definition of a sustainable blue economy and identifies maritime and land-based sectors and activities that pose the greatest threat to economic, social and environmental sustainability in the global blue economy.

2.1 Building on the existing definitions of a sustainable blue economy

According to the European Commission (2020) *"the blue economy encompasses all sectoral and cross-sectoral economic activities related to the oceans, seas and coasts"*.[10] To develop a working definition of a sustainable blue economy, the study team analysed 32 existing definitions and reviewed these against aspects related to economic, social, environmental and governance sustainability. From the discussions had with experts of the Peer Review Group, the following important points were considered in the identification of the sectors, threats and trends, and in the development of the working definition of a sustainable blue economy:

Despite much attention put on environmental sustainability in recent years, economic and financial aspects have remained the focal point in promoting blue economy activities. Yet, social and environmental aspects are central if these are to be truly sustainable economic activities. Social sustainability builds on the provision of equal opportunities, social stability and inclusive growth. It should provide quality employment and the improvement of livelihoods. In parallel, it is necessary to protect and/or preserve habitats and ecosystems, as economic activities depend on sustained natural resources. Yet, these ocean-based goods and services are fragile to human (economic) activities, either through the direct utilisation of natural resources (e.g. coastal spaces for urbanisation, fishing, or aquaculture) or through the intake of emissions and pollution sources that originate from indirect activities that occur further upstream in the supply-chain.

Functioning as a carbon sink, oceans absorb and store emissions and pollution sources, playing a vital role in the regulation of the global carbon cycle. Pollution levels have increased since the 18th

century, and seas and **oceans now contain nearly 40% of human-sourced carbon dioxide from the atmosphere** – with deregulating and negative effects on the ocean's natural capital and ecosystem services.[11] The protection and preservation of ocean-based habitats and biodiversity should thus be complemented by the aim to reduce emissions and pollution that negatively impact the oceans. One increasingly recognised way to reduce the overall impact of emissions and pollution is the use of circular economy principles. **Promoting a circular economy can contribute to reducing the negative effects of activities on the world's oceans by rethinking, reusing and recycling materials and products**, thus enabling pollution- and emission-intensive industries to mitigate their impacts while also providing a range of new and sustainable business opportunities.

[10] EC (2020): The EU Blue Economy Report 2020: https://blueindicators.ec.europa.eu/published-reports_en
[11] Aquatic Life Lab, 2002: Ecosystem functioning and services. Available at: http://www.aquaticlifelab.eu

2.2 Maritime and marine sectors and activities of a global blue economy

As a second step, established and emerging[12] maritime and marine activities were identified and categorised. The list of sectors builds on the sectors identified in the European Commission's Blue Economy Report 2018,[13] and were validated in consultation with the members of the common Peer Review Group. Figure 2 presents the list of established and emerging sectors identified in the course of this study. Sectors in **blue** are emerging sectors presented in addition to those identified by the European Commission. In June 2020,[14] the European Commission published its Blue Economy Report 2020 in which the naming and grouping of sectors are slightly different to those presented in Figure 2. Nonetheless, the sectors defined in Figure 2 below capture the same blue economy sector activities as those defined in the EU Blue Economy Report 2020.

FIGURE 2 Sectors of the blue economy

▲ *Source: own construction, 2020*

[12] Established sector: meaning those that have traditionally contributed to the blue economy. Emerging sector: emerging and innovative sectors for which reliable data are emerging.
[13] EC (2018): The 2018 annual economic report on the EU blue economy. https://op.europa.eu/en/publication-detail/-/publication/79299d10-8a35-11e8-ac6a-01aa75ed71a1
[14] EC (2020): The EU Blue Economy Report 2020: https://blueindicators.ec.europa.eu/published-reports_en

As a third step, the research team identified trends and threats related to the different blue economy sectors based on a literature review, expert opinions and mappings at the sub-sectoral level. The detailed results of the analysis can be found in Annex 3: *Threats and trends affecting blue economy sectors* (please refer to the attached annex document). **A trend is defined as the general development or change in a blue economy situation or in the way that sectors are behaving in the blue economy; a threat is defined as the possibility that something unwanted will happen.**

Climate change is both a trend and a threat with significant potential impacts across blue economy activities and, vice versa, economic activities that affect the biosphere and ecosystem services. A common example is the receding Arctic ice, a result from increasing climatic pressures (such as increased temperature) and which puts at risk fragile polar ecosystems as well as the economic activities of local communities, through the degradation of marine environments and the concentration of fish stocks/variety – yet, also offering new shipping passages and oil drilling sites and presenting considerable economic development potential for the region. Because economic activities and human welfare are closely interlinked with the availability of natural resources, anything threatening the sustainability of these natural resources can also have a negative impact on the economic and/or social sustainability dimension. Social awareness is also growing, with a focus on social equity, the role of women in the living resources sector and the health and safety of workers.

Mitigation and adaptation activities are trending, and these support the tackling of the effects of climate change. Mitigation refers to measures and initiatives that aim to reduce and curb emissions and pollution along the value chain, whilst adaptation refers to the aims to reduce the effects and consequences of climate change. Strategies thus differ in the activities of the value chain they target and offer numerous opportunities. Mitigation of emissions requires the identification of the source of polluting and emitting activities that are affecting ocean ecosystems. For maritime and ocean-based activities, upstream input to the value-chains can be land-based, thus mitigation strategies need to consider both 'in-water' and land-based activities.

New and innovative technologies, including those used to increase access and productivity and to reduce the environmental footprint, are changing the landscape for several blue economy sectors. Sectors are investing in productivity and process optimisation through digitalisation, Big Data, robotics, drones and AI. However, emerging sectors, including the "green" sectors, may present negative environmental impacts, such as disrupting seabed habitats for renewable energy production, or bycatch in the removal of marine litter and plastics. Here, circular economy approaches are gaining momentum, from integrated multi-trophic aquaculture, to the retrofitting of vessels, recycling of old fishing gear and processing of by-products.

The research step clarified the interaction between climate change and blue economy sectors, and the need for an assessment framework that allows a review of the sustainability of any activity, and consequently promotes a shift towards a more sustainable blue economy. To create the framework, we first developed a working definition of a sustainable blue economy.

Based on the discussion above, we propose that a sustainable blue economy should include all related marine, ocean-based, coastal, and land-based activities that directly or indirectly link to the blue economy. A clear identification of its sectoral scope provides the framework to promote and solidify the baseline for the development of appropriate policies and strategies towards a sustainable blue economy. We include all sectors, as this allows currently unsustainable sectors and activities to be captured, which in turn will enable a shift towards more economically, environmentally, and socially sustainable activities that are based on a sustainable governance system that ensures a well-managed and regulated use of ocean resources.

WORKING DEFINITION OF A SUSTAINABLE BLUE ECONOMY

A sustainable blue economy promotes economic growth, social inclusion and improved livelihoods while ensuring the environmental sustainability of the natural capital of the oceans and seas. For the purpose of this report, the sustainable blue economy encompasses all sectoral and cross-sectoral economic activities related to the oceans, seas and coasts. It comprises emerging sectors and economic value based on natural capital and non-market goods and services through the conservation of marine habitats and ecosystem services

PART 3

FRAMEWORK FOR THE SUSTAINABILITY MANAGEMENT OF A BLUE ECONOMY

The working definition and identified sectors enabled the research team to select 30 existing sustainability frameworks for the blue economy sectors and activities. Two types of frameworks have been considered: generic frameworks (containing common indicators) and sub-sectoral frameworks. The review of these frameworks provides the basis for the development of the BESF, building on an extensive database of tested and established criteria and indicators that measure the sustainability of activities. The aim of this review of frameworks, including the critical analysis of the selected priority frameworks, is to assess the relevance of these for blue economy activities and to identify relevant criteria and indicators as input to the framework that is developed here. This chapter outlines the outcomes of the review of the existing frameworks. The methodology applied to the critical review can be found in Annex 4: *Methodology for the critical review of frameworks for sustainability management* (please refer to the attached annex document). In addition, Annex 5: *Critical review of sustainability frameworks for a sustainable blue economy* (submitted excel file) serves as the reference document for the results and discussion provided hereafter.

3.1 Prioritisation and analysis of existing frameworks for sustainability

A Multi Criteria Analysis (MCA) was conducted for 30 identified sustainability frameworks for prioritisation in terms of their relevance to the development of a BESF. The MCA is a decision support method that offers a structured approach to compare the frameworks on the basis of a set of aspects, with the aim of identifying and prioritizing those frameworks that are most relevant to the overall objective of the study – more specifically, with the aim of developing a set of sustainability criteria and indicators for the blue economy. By allocating points for certain selected aspects, frameworks were prioritised based on their potential use and relevance.

These aspects took into account the *domain* covered by a framework, namely focusing on 'marine', 'coastal' or 'broader than marine and coastal' areas; the *'geographic scope'*, looking at the geographical boundaries of the analysed framework, in terms of local, national, regional or global level focus. Furthermore, *sustainability dimensions* addressed in any of the analysed frameworks were considered: the three common pillars of sustainability, being environmental, economic and social sustainability, complemented by sustainable governance. Finally, a frameworks' use of *criteria,* which defines what is to be measured, and the use of indicators, in terms of how a *criterion* is measured, was considered.

Out of the 30 frameworks identified, 15 were prioritised for further critical analysis. This was based on an assessment of their relevance using the MCA method and looking specifically at the relevance of their criteria and indicators, reliance on data availability, degree of transparency as well as their applicability to different geographical locations, ability to identify risks for unsustainability, and potential to address the main threats and trends affecting blue economy sectors (as identified under Chapter 2). This provided a database of established and tested indicators which the research team used as a basis to develop the BESF. The structure of the BESF is also built upon the strengths of the existing frameworks, from which four, in particular, provided relevant methodology. These are presented further in this section.

3.2 Discussion on the critical review of existing frameworks for a blue economy

With the prioritization of the 15 frameworks, key strengths have been identified for the development of the BESF. In order to fulfill its objectives, the BESF should integrate the four dimensions of sustainability and be able to address all sectors of the blue economy identified in the previous chapter in a harmonized way. Furthermore, the framework should be applicable at different scales (company, clusters of companies and sectors), levels (local to national) and geographic zones. The analysis of the 15 prioritised frameworks assessed the ability of the frameworks to cover those key aspects for the BESF. The strengths of each framework were extracted and are presented in Table 1. Four of the 15 frameworks were analyzed in more depth, analyzed below and summarized in Table 2. The BESF can build upon those strengths. This analysis is complementary to the MCA presented in Annex 5. One main difference between the analyzed frameworks and the BESF is that the reviewed frameworks focus on a specific sector, while the BESF is cross-cutting and multi-sectorial, providing a common structure and approach. Traditionally, sectors are managed individually. But under the notion of blue economy they are considered integrally, with several common horizontal elements linking them. Those common elements are addressed in the BESF by means of the common criteria and indicators, building upon the strengths of existing frameworks.

TABLE 1 (A) Strengths identified per analysed framework

FRAMEWORK	SUSTAINABILITY DIMENSIONS				COVERS THE FOUR DIMENSIONS OF SUSTAINABILITY	USE OF CRITERIA	USE OF INDICATORS	COMBINATION OF INDICATORS AND CRITERIA	BASELINE / KEY INDICATORS	COMBINES SECTORS OF THE BLUE ECONOMY	APPLICABLE TO SEVERAL LEVELS AND LOCATIONS	SCORING MECHANISM	SUGGESTION FOR THE BLUE ECONOMY SUSTAINABILITY FRAMEWORK
	ECONOMIC	ENVIRONMENTAL	GOVERNANCE	SOCIAL									
SUSTAINABLE DEVELOPMENT GOALS *(UN, 2019)*[15]	✓	✓	✓	✓	✓	-	✓	-	-	-	✓	-	The SDGs are an internationally accepted guideline which should be reflected in our BESF.
SUSTAIN *(Sustain, 2019)* [16]	✓	✓	✓	✓	✓	-	✓	-	-	-	✓	✓	The structure and methodology are relevant but should be tailored to the blue economy. As a decision-support tool, it gives a numerical value to individual indicators.
COVER INDICATORS FOR THE BLUE ECONOMY *(Giraud et al. 2017)* [17]	✓	✓	-	-	-	-	✓	-	-	✓	-	-	The set of key indicators per sector aims to capture the status of the blue economy. The indicators are not specifically related to sustainability. Yet, this is the only framework which focuses on the blue economy through a cross-sectoral approach.
SUSTAINABILITY INDICATORS FOR AQUACULTURE *(Valenti et al. 2018)* [18]	✓	✓	-	✓	-	✓	✓	✓	-	-	✓	-	The structure and methodology are very relevant. The indicators defined cover most aspects of aquaculture and the framework contains indicators relevant to the aquaculture sector.
FISHERY PERFORMANCE INDICATORS *(Anderson et al. 2015)* [19]	✓	✓	-	✓	-	-	✓	-	-	-	✓	✓	The structure is relevant but uses dimensions and indicators 'in reverse' when compared to most other frameworks. Rather than attempting to measure a few indicators with high precision, Anderson et al. (2018) use multiple metrics that capture important aspects using a 1 to 5 scale that can be scored—imprecisely but accurately—based on expert assessment. This is a relevant method for focusing on one sector, but difficult to replicate for several sectors.
MARINE STEWARDSHIP COUNCIL (2019))[20]	-	✓	✓	✓	-	-	✓	-	-	-	✓	✓	The framework presents detailed indicators on fisheries that are useful for the (sub)sector-specific indicators. The indicators focus mainly on environmental aspects.
AQUACULTURE STEWARDSHIP COUNCIL *(2019)*[21]	-	✓	✓	✓	-	✓	✓	✓	-	-	✓	✓	The framework presents detailed indicators on aquaculture that are useful for the (sub) sector-specific indicators.

[15] UN (2019). Sustainable Development Goals. Retrieved from https://www.un.org/sustainabledevelopment/sustainable-development-goals/on 15-11-2019.

[16] Sustain (2019). Measuring Coastal Sustainability: The sustain policy tool. Retrieved from http://www.sustain-eu.net/ on 15-11-2019.

[17] Giraud, J., Lafitte, A. & Fosse, J. (2017). Blue economy; economic activities and sustainable development. Plan Blue. Notes 34. Valbonne, France. Retrieved from https://planbleu.org/sites/default/files/publications/note_34_en_web.pdf on 22-11-2029.

[18] Valenti, W. C., Kimpara, J. M., Preto, B. D. L., & Moraes-Valenti, P. (2018). Indicators of sustainability to assess aquaculture systems. Ecological indicators, 88, 402-413.

[19] Anderson J.L., Anderson C.M., Chu J., Meredith J., Asche F., Sylvia G., Smith M. D., Anggraeni, D., Arthur, B., Guttormsen, A., McCluney, J. K., Ward, T., Akpalu, W., Eggert, H., Flores, J., Freeman, M. A., Holland, D. S., Knapp, G., Kobayashi, M., Larkin, S., MacLauchlin, K., Schnier, K., Soboil, M., Tveteras, S., Uchida, H. & Valderrama, D. (2015). The Fishery Performance Indicators: A Management Tool for Triple Bottom Line Outcomes. PLoS ONE 10(5): e0122809.

[20] MSC (2019). Get Certified Your guide to the MSC fishery assessment process. Retrieved from https://www.msc.org/docs/default-source/default-document-library/for-business/for-fishery-clients/fisheries-get-certified-2019.pdf on 18-11-2019.

[21] ASC (2019). Certifying environmentally and socially responsible seafood. Retrieved from https://www.asc-aqua.org/ on 15-11-2019.

TABLE 1 (B) Strengths identified per analysed framework

FRAMEWORK	SUSTAINABILITY DIMENSIONS				COVERS THE FOUR DIMENSIONS OF SUSTAINABILITY	USE OF CRITERIA	USE OF INDICATORS	COMBINATION OF INDICATORS AND CRITERIA	BASELINE / KEY INDICATORS	COMBINES SECTORS OF THE BLUE ECONOMY	APPLICABLE TO SEVERAL LEVELS AND LOCATIONS	SCORING MECHANISM	SUGGESTION FOR THE BLUE ECONOMY SUSTAINABILITY FRAMEWORK
	ECONOMIC	ENVIRONMENTAL	GOVERNANCE	SOCIAL									
Renewable energy sustainability *(Cîrstea et al. 2018)*[22]	✓	✓	✓	✓	✓	✓	-	-	-	-	✓	✓	The framework develops a composite index to reveal development stages of renewable energy sustainability. The index calculates a score which allows nuances in the sustainability scale. However, the index compares countries, not sectors. Most indicators are relevant to the energy sector and for the identification of appropriate indicators in the energy sector as part of the BESF.
Sustainability Assessment Framework for Renewable Energy Technology *(Luong et al. 2012)*[23]	✓	✓	-	✓	-	✓	✓	✓	-	-	✓	-	The structure and methodology are very relevant, and most indicators are relevant to the BESF.
Assessment of sustainability indicators for renewable energy technologies *(Evans et al., 2009)*[24]	✓	✓	-	✓	-	-	✓	-	-	-	✓	-	The structure is not relevant, but the range of sustainability indicators is relevant to the BESF.
An integrated framework for sustainability assessment of seawater desalination *(Ibrahim et al. 2018)*[25]	✓	✓	-	✓	-	✓	✓	✓	-	-	✓	✓	The indicators are relevant to the BESF and can be universally applied to other desalination technologies and/or other countries.
Sustainability assessment of ports *(Schipper et al. 2017)*[26]	✓	✓	✓	✓	✓	-	✓	-	-	-	✓	✓	The article contains relevant indicators for the sustainability assessment of ports. It determines the efficiency and sustainability of each of the case study port plans, relative to other ports, through a scoring mechanism.

[22] Cîrstea, S., Moldovan-Teselios, C., Cîrstea, A., Turcu, A., & Darab, C. (2018). Evaluating renewable energy sustainability by composite index. Sustainability, 10(3), 811.

[23] Luong, S., Liu, K., & Robey, J. (2012). Sustainability assessment framework for renewable energy technology. Technol. Sustain. Built Environ. Cent, 1-8. Retrieved from https://www.reading.ac.uk/web/files/tsbe/Luong_TSBE_Conference_Paper_2012.pdf on 22-11-2019.

[24] Evans, A., Strezov, V., & Evans, T. J. (2009). Assessment of sustainability indicators for renewable energy technologies. Renewable and sustainable energy reviews, 13(5), 1082-1088. Retrieved from https://relooney.com/NS4053-Energy/0-Harold_18.pdf on 22-11-2019.

[25] Ibrahim, Y., Arafat, H. A., Mezher, T., & AlMarzooqi, F. (2018). An integrated framework for sustainability assessment of seawater desalination. Desalination, 447, 1-17. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0011916418310841 on 22-11-2019.

[26] Schipper, C. A., Vreugdenhil, H., & De Jong, M. P. C. (2017). A sustainability assessment of ports and port-city plans: Comparing ambitions with achievements. Transportation Research Part D: Transport and Environment.

TABLE 1 (C) Strengths identified per analysed framework

FRAMEWORK	SUSTAINABILITY DIMENSIONS				COVERS THE FOUR DIMENSIONS OF SUSTAINABILITY	USE OF CRITERIA	USE OF INDICATORS	COMBINATION OF INDICATORS AND CRITERIA	BASELINE / KEY INDICATORS	COMBINES SECTORS OF THE BLUE ECONOMY	APPLICABLE TO SEVERAL LEVELS AND LOCATIONS	SCORING MECHANISM	SUGGESTION FOR THE BLUE ECONOMY SUSTAINABILITY FRAMEWORK
	ECONOMIC	ENVIRONMENTAL	GOVERNANCE	SOCIAL									
A CONCEPT OF A SUSTAINABLE MARITIME TRANSPORTATION SYSTEM *(IMO, 2019)*[27]	✓	✓	✓	✓	✓	✓	✓	✓	-	-	✓	-	Various guidelines or goals are identified that must be met in order to implement a sustainable maritime transportation system (SMTS). A broad perspective on sustainability is offered, the scope is too large for the BESF, but the guidelines are reflected in the BESF.
THE EUROPEAN TOURISM INDICATOR SYSTEM ETIS *(European Commission, 2016)*[28]	✓	✓	-	✓	-	✓	✓	✓	✓	-	-	-	The structure and methodology are relevant to the BESF. The distinction between core and supplementary set of indicators is made and the indicators are also relevant to the BESF.
OBSERVATORY OF SUSTAINABILITY OF THE ALGARVE REGION FOR TOURISM *(Farinha et al, 2019)*[29]	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	The framework covers the four sustainability dimensions and provides a relevant criteria and indicators for the tourism sector in a coastal region. The relevance of indicators and criteria have been tested on stakeholders.

[27] IMO (2019). World Maritime Day: a concept of sustainable maritime transportation system. London, United Kingdom.Retrieved from http://www.imo.org/en/About/Events/WorldMaritimeDay/WMD2013/Documents/CONCEPT%20OF%20%20SUSTAINABLE%20MARITIME%20TRANSPORT%20SYSTEM.pdf 22-11-2019.

[28] European Commission (2016). The European Tourism Indicator System: ETIS toolkit for sustainable destination management. Publications Office of the European Union. Luxembourg. Retrieved from https://ec.europa.eu/docsroom/documents/21749 on 22-11-2019.

[29] Farinha, F., Oliveira, M. J., Silva, E. M., Lança, R., Pinheiro, M. D., & Miguel, C. (2019). Selection process of sustainable indicators for the Algarve region—Observe Project. Sustainability, 11(2), 444.

The structure of the frameworks and suitability of the criteria and indicators as key inputs for the development of the BESF are discussed further in this section, together with the applicability of scoring mechanisms.

STRUCTURE OF THE FRAMEWORK

Structuring a framework around the three dimensions of economic, environmental, and social sustainability is a well-accepted and a commonly used approach – although dimensions can be named differently or can integrate different aspects. In Cîrstea et al. (2018)[30], for example, the governance dimension becomes the institutional dimension, while the frameworks looking at the tourism sector couple the social dimension to cultural impact. Although the governance dimension is absent in most of the frameworks analysed, it is important to integrate this dimension and the corresponding indicators to reflect all aspects of sustainability for the blue economy. The frameworks from SUSTAIN (2019), Farinha (2019) and Cîrstea (2018) explicitly cover the four dimensions. In terms of geographic level, most of the selected frameworks are applicable to several levels. Valenti et al. (2018)[31] has developed a framework for assessing the sustainability of aquaculture systems at company, local, regional, national, global and sectoral levels. Such a flexible approach that can be applied at different levels is incorporated into the BESF.

SUITABILITY OF CRITERIA AND INDICATORS

The use of "criteria" or "indicators" is not consistent across the different frameworks. Some frameworks refer to other concepts, such as targets,[32] issues[33] or factors.[34] Thus, for the purpose of this study, the definition proposed by Valenti et al. (2018) has been used:

> *"indicators are relevant variables to be measured that reflect each criterion and can be determined qualitatively or quantitatively. A unit is associated to each indicator".*[35]

The methodology 'dimension-criteria-indicators' provides a clear structure for a framework to review the sustainability of an activity. The combination of criteria and indicators is relevant for identifying how to measure (indicators) as well as what to measure (criteria). The BESF, developed in this study, is thus divided into the four dimensions - each covering specific criteria, which are features or characteristics of the systems that are being assessed and monitored. Most frameworks were found to contain suitable indicators, yet not all indicators related or referred to specific criteria. In total, more than 500 indicators were identified. Annex 10: *Comprehensive database of blue economy criteria and indicators* (please refer to the attached annex document) lists identified and potentially useful criteria and indicators for the BESF. This list provided the groundwork to identify the common and subsector-specific criteria and indicators for the BESF. Some frameworks applied their criteria and indicators to case studies in order to fine-tune indicators and specifically applied

[30] Cîrstea, S., Moldovan-Teselios, C., Cîrstea, A., Turcu, A., & Darab, C. (2018). Evaluating renewable energy sustainability by composite index. Sustainability, 10(3), 811.
[31] Valenti, W. C., Kimpara, J. M., Preto, B. D. L., & Moraes-Valenti, P. (2018). Indicators of sustainability to assess aquaculture systems. Ecological indicators, 88, 402-413.
[32] UN (2019). Sustainable Development Goals. Retrieved from https://www.un.org/sustainabledevelopment/sustainable-development-goals/on 15-11-2019.
[33] Sustain (2019). Measuring Coastal Sustainability: The sustain policy tool. Retrieved from http://www.sustain-eu.net/ on 15-11-2019.
[34] Luong, S., Liu, K., & Robey, J. (2012). Sustainability assessment framework for renewable energy technology. Technol. Sustain. Built Environ. Cent, 1-8. Retrieved from https://www.reading.ac.uk/web/files/tsbe/Luong_TSBE_Conference_Paper_2012.pdf on 22-11-2019.
[35] Valenti, W. C., Kimpara, J. M., Preto, B. D. L., & Moraes-Valenti, P. (2018). Indicators of sustainability to assess aquaculture systems. Ecological indicators, 88, 402-413.
[36] For instance, Ibrahim et al. (2018), Anderson et al. (2015), Schipper et al. (2017), Cristea et al. (2018)

methodologies.[36] This iterative process was also integrated in the development of the indicators for the blue economy (task 4). Furthermore, some frameworks, such as the European Tourism Indicator System (ETIS) toolkit for sustainable destination management, make a distinction between core and supplementary indicators. The core indicators gather the essential, key or baseline information necessary for a sustainability assessment, whilst the supplementary indicators are complementary and more in-depth.[37] This approach, namely providing key indicators that should be used as the bare minimum for a sustainability review of activities, is an approach that the study team has also adopted for the BESF developed in the course of this study.

SCORING MECHANISMS

Scoring mechanisms allow for the prioritisation of indicators within a framework by providing a rank or a weight to each individual indicator. Seven of the analysed frameworks have such an approach, the majority of which are sector specific (see Table 1). These frameworks differ in terms of their approaches in using scoring mechanisms. Some make use of scales, i.e. indicators are scored through scales or ranges from 1 to 10 (e.g. SUSTAIN, 2019).[38] Others, such as Anderson et al. (2015),[39] use multiple metrics that capture different aspects of a dimension using a scale from 1 to 5 to be scored through expert assessment. This method is relevant when the focus is on one sector, but difficult to replicate for several sectors – which is what the BESF aims to cover. Scoring mechanisms are also used for certification schemes, such as Aquaculture Stewardship Council (ASC) and Marine Stewardship Council (MSC). These schemes attribute a score to each performance indicator whereby a minimal score is required for a product to achieve certification. Other frameworks use the process of normalizing data. Cîrstea et al. (2018)[40] use a standardization by a z-score calculation performed (largely) on a historical dataset of the indicators, while Ibrahim et al. (2018)[41] perform the normalization through a linear utility function, assigning 0 to the lowest value and 1 to the highest value.

Scoring mechanisms offer the advantage of allowing for an easier understanding and comparability of indicators. Using a scoring mechanism (or a scale) also allows for easier application of the framework when the data accessibility is limited (e.g. in developing regions) as it allows for less accuracy in collecting data. On the contrary, the application of scales when adequate data is available may result in indicators that are more imprecise. The reduced precision of scoring approaches can induce difficulty to detect (incremental) changes. Besides this, a scoring mechanism would make it more difficult to apply the framework at different levels. This is because the performance of a particular sector will very according to geographical contexts. Therefore, comparisons cannot be based wholly on the scores of different examples (with varying geographical contexts) that apply the same scoring range. This is not considered useful within the context of this study, as it requires a broad sectoral scope and global view of blue economy activities. For this reason, a scoring mechanism will not be elaborated in this context.

[36] For instance, Ibrahim et al. (2018), Anderson et al. (2015), Schipper et al. (2017), Cristea et al. (2018)

[37] European Commission (2016). The European Tourism Indicator System: ETIS toolkit for sustainable destination management. Publications Office of the European Union. Luxembourg. Retrieved from https://ec.europa.eu/docsroom/documents/21749 on 22-11-2019.

[38] Sustain (2019). Measuring Coastal Sustainability: The sustain policy tool. Retrieved from http://www.sustain-eu.net/ on 15-11-2019.

[39] Anderson J.L., Anderson C.M., Chu J., Meredith J., Asche F., Sylvia G., Smith M. D., Anggraeni, D., Arthur, B., Guttormsen, A., McCluney, J. K., Ward, T., Akpalu, W., Eggert, H., Flores, J., Freeman, M. A., Holland, D. S., Knapp, G., Kobayashi, M., Larkin, S., MacLauchlin, K., Schnier, K., Soboil, M., Tveteras, S., Uchida, H. & Valderrama, D. (2015) The Fishery Performance Indicators: A Management Tool for Triple Bottom Line Outcomes. PLoS ONE 10(5): e0122809

[40] Cîrstea, S., Moldovan-Teselios, C., Cîrstea, A., Turcu, A., & Darab, C. (2018). Evaluating renewable energy sustainability by composite index. Sustainability, 10(3), 811.

[41] Ibrahim, Y., Arafat, H. A., Mezher, T., & AlMarzooqi, F. (2018). An integrated framework for sustainability assessment of seawater desalination. Desalination, 447, 1-17. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0011916418310841 on 22-11-2019.

3.3 Key outcomes of the critical review of existing frameworks

The 15 selected frameworks provide useful insights, not only in terms of structure, but also in terms of the methodology used and relevance of the indicators applied. Most frameworks are structured around the sustainability dimensions and are applicable to different geographical regions. This provides a useful basis for the development of the BESF. The sectoral frameworks present a number of relevant criteria and indicators to include in the BESF. Cross-sectoral frameworks such as SUSTAIN (2019) and Giraud et al. (2017) are interesting due to their ability to address several sectors. However, of the 30 frameworks analysed, only Giraud et al. (2017) focuses on multiple blue economy sectors. This illustrates a clear gap in the current literature which is addressed in developing the BESF. Four frameworks are especially relevant for the development of the BESF in the sense that they provide interesting input on the crucial elements for the framework; namely the four dimensions of sustainability, a cross-sectoral approach for the blue economy and the flexibility for an application at different scales, levels and geographic zones. These frameworks are further analysed below and summarized in Table 2.

▸ **THE SUSTAIN FRAMEWORK,** developed for policymakers and focused on coastal areas, provides a useful structure and methodology as a basis for the BESF. "SUSTAIN has developed an indicator-based methodology [...] which enables a self- assessment approach for local and regional authorities, to evaluate their sustainability performance for the purpose of improving the management of coastal zones" (SUSTAIN, 2019). The framework relies on the environmental, economic, social and governance dimensions of sustainability which, as explained above, is necessary for the BESF. SUSTAIN's cross-sectoral character is also particularly useful for the BESF. The structure of indicators identified for each dimension and associated to a unit can form a basis for the BESF. In addition to the structure, a number of SUSTAIN's indicators are also useful for the BESF, because they address some sectors of the blue economy and are structured around the four dimensions of sustainability. The indicators in SUSTAIN are mainly quantitative indicators, except for the governance dimension. Some indicators also follow a cross-sectoral approach. A limitation to SUSTAIN, however, is that the framework focuses on coastal zone management and the set of indicators is therefore not totally suitable and complete for the blue economy.

▸ **VALENTI ET AL. (2018)** has developed "a portfolio of quantitative indicators of economic, environmental and social sustainability to assess different aquaculture systems".[42] This framework introduces criteria as an additional aspect in the structure of dimensions, indicators and units. Criteria are "specific features or characteristics of the systems that we want to assess and monitor" and "indicators are relevant variables to be measured that reflect each criterion and can be determined qualitatively or quantitatively. A unit is associated to each indicator"[43]. A clear distinction between "what to measure" (criteria) and "how to measure" (indicators) is useful for a clear logic and ease of use for the BESF. The framework of Valenti et al. (2017) also offers flexible indicators that can be applied at different scales, such as at the company, local, regional, national, global and sectoral levels. In the paper, indicators are developed that are "quantitative, broad, scientifically sound, easy to understand and interpret, feasible to obtain". The framework aims to "allow performing diagnostics, identifying strengths and weaknesses, setting goals and determining actions".[44] With respect to the requirements of the BESF, a gap of the framework is its focus on only one sector and its exclusion of the governance dimension.

▸ **GIRAUD ET AL. (2017)**[45] is interesting to consider when developing the BESF as it is the only framework identified which addresses the blue economy as such, with a core set of indicators for the Mediterranean Blue Economy dashboard. From the perspective of BESF, an identified gap is the lack of focus on sustainability. Furthermore, the proposed indicators for five sectors[46] of the blue economy are addressed separately from one another. Common or cross-sectoral elements are not included. Also, the framework of Giraud et al. (2017) is tailored specifically to the Mediterranean region. This results in another gap, namely the lack of flexibility to be adapted to multiple scales, levels and geographical scopes. In conclusion, Giraud et al. (2017) is useful as it provides a first attempt towards a framework for the blue economy. However, it also shows the difficulty in keeping consistency in a framework addressing multiple sectors and the challenge of addressing cross-sectoral aspects.

▸ **THE EUROPEAN TOURISM INDICATOR SYSTEM (ETIS),** toolkit for sustainable destination management, provides an appealing answer to addressing cross-sectoral aspects. The BESF will need to include common and sector-specific indicators which undeniably leads to a vast number of indicators. ETIS suggests a distinction between a core set of indicators and a set of complementary indicators. This aspect is useful for the BESF in order to balance the number of indicators. Also, ETIS suggests an alternative for an easy application of key/baseline indicators, the minimum requirement for the application of the framework. ETIS follows three dimensions of sustainability (economic, environmental and social) in the structure 'dimensions-criteria-indicators' similar to Valenti et al. (2018). As a sectoral framework, it contains criteria and indicators that are only fully relevant to the tourism sector when developing the sustainability assessment.

[42, 43, 44] Valenti, W. C., Kimpara, J. M., Preto, B. D. L., & Moraes-Valenti, P. (2018). Indicators of sustainability to assess aquaculture systems. Ecological indicators, 88, 402-413

[45]. Giraud, J., Lafitte, A. & Fosse, J. (2017). Blue economy; economic activities and sustainable development. Plan Blue. Notes 34. Valbonne, France. Retrieved from https://planbleu.org/sites/default/files/publications/note_34_en_web.pdf on 22-11-2029.

[46]. The five sectors consist of energy, fisheries, tourism, maritime transport and bio-prospection

TABLE 2 Strengths and limitations identified for 4 frameworks

	STRENGTHS (from the perspective of BESF)	LIMITATIONS (from the perspective of BESF)
SUSTAIN *(Sustain, 2019)*	▸ Cross-sectoral framework ▸ Clear structure combining dimensions, indicators and units ▸ Covers the four dimensions of sustainability ▸ Applicable to several scales, levels and geographical zones	▸ Focus on coastal zone management, not specifically the blue economy
INDICATORS FOR THE BLUE ECONOMY *(Giraud et al., 2017)*	▸ Multiple sectors ▸ Focus on the blue economy ▸ Simple but clear structure	▸ No focus on sustainability ▸ Five sectors considered separately (no cross-sectoral indicators) ▸ Focus on one specific region
SUSTAINABILITY INDICATORS FOR AQUACULTURE *(Valenti et al., 2018)*	▸ Introduces the combination of criteria with indicators ▸ Clear structure and definition of (interconnection of) criteria and indicators ▸ Relevant sectoral indicators for the BESF ▸ Applicable to several scales, levels and geographical zones	▸ No indicator for the dimension of governance ▸ Sectoral framework (aquaculture
ETIS *(European Commission, 2016)*	▸ Introduces the combination of criteria with indicators ▸ Introduces the combination of key and complementary indicators ▸ Covers the four dimensions of sustainability ▸ Relevant sectoral indicators for the BESF	▸ Sectoral framework (destination management)

▸ In conclusion, none of the existing frameworks provide the combination of elements that is required for the BESF; namely the four dimensions of sustainability, a cross-sectoral approach for the blue economy and the flexibility for an application at different scales, levels and geographic zones. However, the literature provides enough input to combine those elements by extracting strengths from existing frameworks. This approach and methodology has resulted in a coherent BESF that, while not going into the technical (vertical) depths of a specific sector, offers a way to look at multiple sectors simultaneously (horizontally) across a cross-sectoral and harmonized system. Therefore, the framework can be used as a tool for setting goals, determining actions, assessing the effectiveness of actions and the efficacy of interventions in the progress towards sustainability. The balance between the four dimensions ensures a holistic perspective of sustainability, while also bringing together the measurement of variables of very different natures.

PART 4

TOWARDS THE DEVELOPMENT OF SUSTAINABILITY CRITERIA AND INDICATORS

4.1 About the development process

The selection of criteria and indicators presented hereafter form the core of the BESF. A similar development process has followed for both generic, sector-specific and operational criteria and indicators. Firstly, the selection is based on the proposed definition of the blue economy (Chapter 2) and expert judgement of the study team. The selection of criteria and indicators are based on the analysis of the frameworks – which provided a database of over 500 indicators (see Chapter 3).

The final set of indicators developed for the BESF underwent several processes of review and fine-tuning. First and foremost, the indicator set has been tested on various **case studies** (see Chapter 5). It also underwent an expert review. The methodology applied to the case studies and the **expert review** can be found in the annex document (see Annex 7: *Methodology for the development of a set of sustainability criteria and indicators).*

The expert review was conducted in June 2020 as a final validation of the BESF. A total of 30 experts were selected, based on the type of expert (network organization, industry, private company, consultant), blue economy sector coverage and geographical spread. The gathering of responses was conducted via EU Survey and, as of the 26th of June, 13 experts have submitted a response to the questionnaire (43%). The results will be organized into four categories 1) no action needed, 2) add to guidelines, 3) share comment with the parallel project "Unsustainable Finance in the Blue Economy", 4) modify indicators. Regarding category 2) most comments related to clarifications of concepts such as "local/region" and "vulnerable groups". Therefore, a glossary has been added to the guideline (please see document attached). Based on the outcomes of the iterative process, combining the lessons learned from the case studies and the expert review via the EU Survey, a database showcasing the development of indicators and criteria along the course of the study was developed (see Annex 10: *Comprehensive database of blue economy criteria and indicators*).

4.2 The Overall Concept

The structure of the BESF follows a so-called **'nesting' approach:** linking criteria and indicators to the four dimensions of sustainability (economic, environmental, social and governance). For each dimension, a number of key sustainability aspects have been clustered into sustainability criteria. Indicators have then been derived from these criteria – allowing for the measurement of key sustainability aspects. The indicators establish the core of the framework, providing a powerful tool to analyse the complexity and characteristics of sectors in a structured and coherent way. The application of the framework allows for monitoring the evolution of the same system – e.g. through case studies or over time. Such a framework also reveals limitations and elements that need to be improved to evolve towards a more sustainable system.

The BESF provides a series of highly relevant sustainability topics (the criteria) which have been further developed into indicators. The units of these common and (sub)sector-specific indicators provide a means of measuring the sustainability criteria for a particular activity, company or sector. Therefore, the framework could be used, for example, as a tool to assess the sustainability of investment projects in order to facilitate setting goals, determining actions, assessing the effectiveness of actions and the efficacy of interventions to follow the progress made towards sustainability. The balance between the four dimensions ensures a holistic perspective of sustainability, while also bringing together the measurement of variables of very different natures. The proposed framework is intended as an early attempt to provide a tool for public and private investors who wish to promote an integrated approach vis-à-vis the various blue economy sectors. The application of this framework facilitates informed decision making of such public and private investors and helps identify where actions from policy makers are needed to enhance a sustainable blue economy.

As a conceptual approach, we have first considered Life Cycle Assessment (LCA) analysis. This methodology is typically used to assess the environmental impacts associated with all the stages of the lifecycle of a product or service.[47] A LCA typically focuses on energy, material inputs and environmental releases, and it evaluates environmental impacts associated with these inputs and releases. By interpreting these results, informed decisions can be made with an overview of the impacts of a particular product or service.[48] Due to its focus on a narrower environmental dimension,

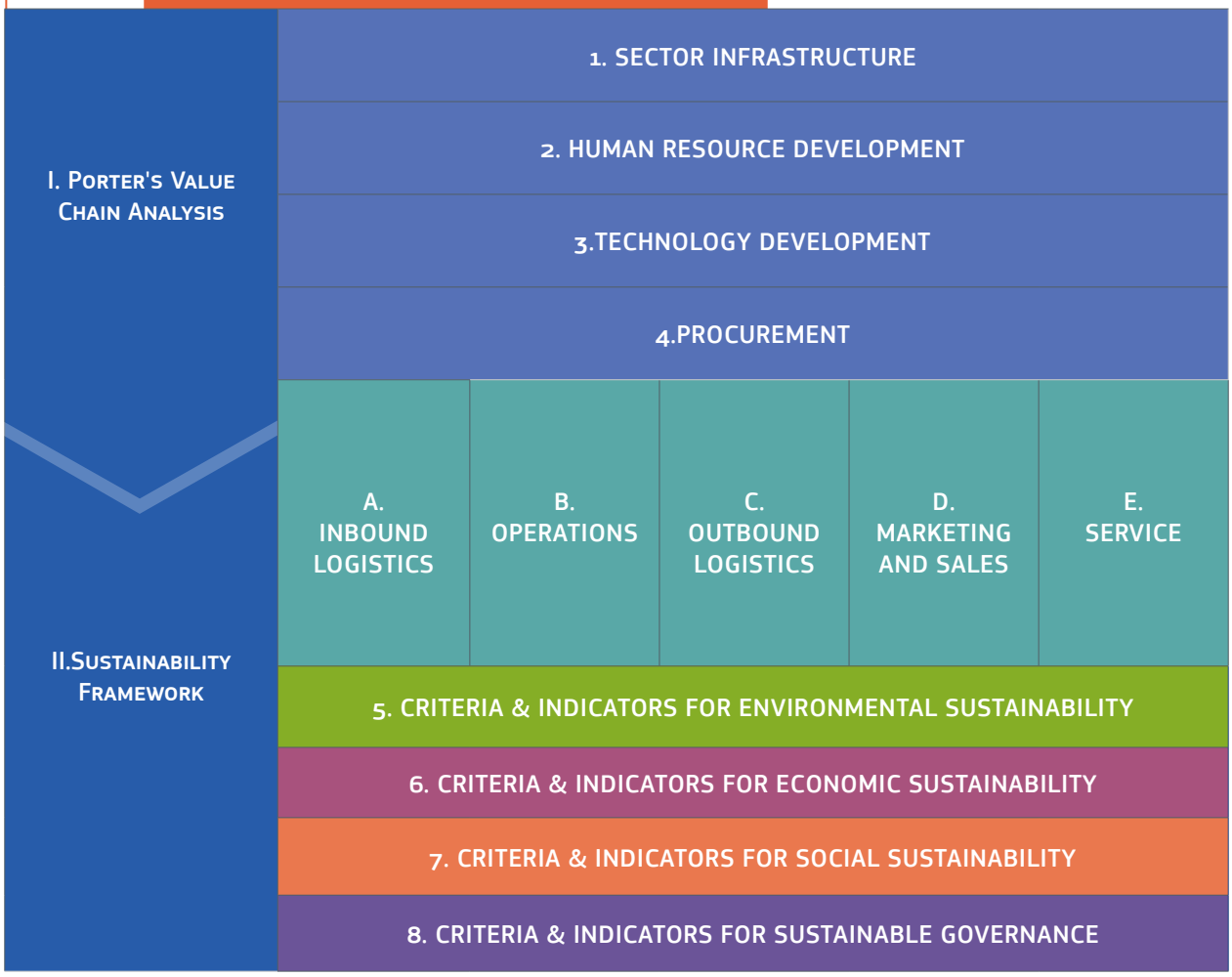
[47] Ilgin, M.A. & Surendra M. G. (2010). Environmentally Conscious Manufacturing and Product Recovery (ECMPRO): A Review of the State of the Art. Journal of Environmental Management. 91 (3): 563–591.

LCA often provides highly detailed insights on a few selected environmental pressures caused by a product or service. However, for this study a broad focus is required. It should not only include the environmental dimension, but also the economic, social and governance dimensions. Furthermore, LCA does not provide a methodological structure to distinguish between the primary and support activities of a sector, which can then be screened for sustainability constraints and opportunities.

Therefore, a more comprehensive **Value Chain approach** has been opted for as a more useful methodology for this study. This approach provides a horizontal and qualitative narrative of the sustainability aspects in all of the segments of the value chain underlying a blue economy sector.

Subsequently, the framework has been operationalised through the development of a set of indicators for each of the four dimensions for a vertical, in-depth and quantitative approach, focussing on the operational part of the value chain. A detailed description of the methodology applied in this task is outlined in Annex 7.

FIGURE 3 The Blue Economy Sustainability Framework approach



Source: own construction, 2020

[48] EPA (2012). Life Cycle Assessment (LCA). Retrieved from: https://web.archive.org/web/20120306122239/http://www.epa.gov/nrmrl/std/lca/lca.html on 1 May 2020

The proposed BESF has also been inspired by the **SUSTAIN framework**[49] and integrates relevant criteria and indicators derived from the outcomes of Task 3. Through the proposed methodology, the generic sustainability issues of a sector can be traced to specific segments of the value chain.

4.3 About Porter's Value Chain Analysis (VCA)

The objective of the Value Chain Analysis (VCA) approach is to introduce and characterise a blue economy sector. The theoretical background originates from Porter (1985): a value chain is defined as "a set of activities that a business carries out to create value for its customers". The VCA consists of activities that a firm operating in a specific industry performs in order to deliver a valuable product.[50] It focuses on the process of organizations, seeing manufacturing (or service) organizations as a system made up of subsystems. Each subsystem has inputs, transformation processes and outputs which require resources such as money, labor, materials, equipment, buildings, land, administration and management. The VCA is useful to examine the business activities in order to see how they are interconnected and to understand which of them add value.[51] While this study does not focus on how value is added to products and services, it uses the methodology of the VCA to consistently and structurally analyze the sustainability aspects of the primary and support activities of a sector. This allows for screening each blue economy sector in a generic manner on sustainability aspects.

Porter's VCA enables the analysis of sectors based on different segments in the production cycle, including a) inbound logistics, b) operations, c) outbound logistics, d) marketing & sales and e) service. For example, the VCA can expose operational misalignments and the misallocation of economic, human and environmental resources within chains, as well as the underlying authority or power relationships – hence helping identify opportunities for improvements in sustainability throughout the value chain. Furthermore, the identification of different phases in the production cycle is important as segments do not have the same degree of (un)sustainability. A 'quick scan' VCA aims at identifying the generic opportunities and constraints regarding the environmental, economic, social and governance sustainability of each segment, using a combination of methods such as a literature study, interviews, focus groups and/or expert judgement.

Understanding the interlinkages between the activities of the value chain allows a look beyond the traditional boundaries of a sectoral approach. While the quick scan VCA provides a horizontal and qualitatively oriented narrative of the sustainability aspects in all the segments of the value chain of a blue economy sector, the set of criteria and indicators allows for a vertical, in-depth and quantitative approach – focusing specifically on the operational part of the value chain. As such, the VCA provided an interesting complementary tool to the set of indicators as it helped identify contextual elements that contribute towards the sustainability of the operational part of the value chain. The framework of indicators is developed to be applicable at different levels (local, sectoral or national) and the VCA presents a similar flexibility. The methodology functions extremely well for primary sectors producing a single and straightforward manufactured product. Examples of such sectors include fish and shellfish harvesting and aquaculture. For these sectors it was not complicated to identify the five segments of inbound logistics, operations, outbound logistics, marketing and sales and service. The methodology, however, presents some limitations when being applied to secondary and tertiary sectors that do

[49] SUSTAIN was one of the framework assessments: an indicator-based methodology and scoring system which enables a self- assessment approach for local and regional authorities, to evaluate their sustainability performance for the purpose of improving the management of coastal zones"

[50] Porter, Michael E. (1985). Competitive Advantage: Creating and Sustaining Superior Performance. New York.: Simon and Schuster. ISBN 9781416595847. Retrieved 9 September 2013.

[51] Pallaoro, R. (2017). Value chain. Retrieved December 6, 2019, from Quizlet website: https://quizlet.com/it/253412570/value-chain-flash-cards/

not involve the production and marketing of a single manufactured product. Examples of such sectors include renewable energy, desalination, transport infrastructure. These sectors typically do not manufacture a product (primary sector) but instead produce finished goods (secondary sector) or deliver a service (tertiary sector).[52] It was specifically a challenge to clearly identify the segments of inbound logistics and operations and outbound logistics for secondary and tertiary sectors. This limitation was mitigated by focusing on common phases that can be distinguished within a secondary or tertiary sector. These common phases were then aligned as much as possible with the five segments. An example is the extraction of minerals (dredging). The common phases of prospecting and exploration, as well as planning and design were identified first and marked as inbound logistics. Activities such as construction and exploitation, land-use and planning and waste management were marked as part of the operational segment. Distribution and transport and the use of sediment were marked as outbound logistics.

Yet, the VCA revealed new insights in sustainability constraints and opportunities throughout the value chain of a blue economy sector that may not have been found by means of applying the criteria and indicators alone. The same applies vice versa, as the criteria and indicators reveal certain sustainability aspects that would not have been found by means of a VCA. In Table 3, an overview of the identified strengths, limitations and mitigation measures is provided.

TABLE 3 Overview of strengths, limitations and mitigation measures for conducting a VCA

STRENGTHS	LIMITATIONS	MITIGATION MEASURE
▶ Identify main opportunities and constraints of sustainability in all segments of the value chain	▶ It is extremely time consuming to conduct a detailed and in-depth sustainability assessment of all segments. Only a generic quick scan assessment is realistic	▶ The generic, horizontal and qualitative approach of VCA should be complemented with a specific, vertical, in-depth and quantitative approach of criteria and indicators on the operational segment
▶ VCA easily applied to primary sectors	▶ Applying VCA to secondary and tertiary sectors more complicated than inbound logistics, operations and outbound logistics are not easy to distinguish	▶ Identify common phases of a secondary/ tertiary sector first and then align these phases with inbound logistics

[52] For more information on primary, secondary and tertiary sectors please consult https://www.economicshelp.org/blog/12436/concepts/sectors-economy/

4.4 Proposed common criteria and indicators

The selection of common criteria and indicators presented hereafter form the core of the BESF. The selection is based on the proposed definition of the blue economy (Chapter 2) and the insights from the assessment of existing frameworks (Chapter 3). Furthermore, expert judgement of the study team was used to develop a preliminary sector of criteria and indicators. The preliminary set of criteria and indicators was amended and updated based on feedback from industry and other experts. More information on the exact methodology on the involvement of industry and other experts can be found in Annex 7. An overview of the different means (e.g. via Peer Review Group, surveys, interviews and the high-level focus group) in which stakeholders were invited to provide feedback on the indicators and criteria has been included in Annex 9. Finally, a database providing an overview of the development of indicators is provided in Annex 10: *Comprehensive database of blue economy criteria and indicators.*

The common criteria and indicators are based on the analysis of the frameworks – which provided a database of over 500 indicators (see Chapter 3). The set of 44 common indicators are presented below in Table 4 to Table 7.

Out of the common criteria presented, 20 of these have been selected as 'key indicators', establishing an essential and required set of criteria and indicators for conducting a review of the sustainability of a given activity.[53] The selection has been carried out based on the RACER methodology (see Annex 7: *Methodology for the development of a set of sustainability criteria and indicators for more details*) where all common indicators have been scored and selected. The preliminary set of key indicators was discussed with the Client and further refined. To highlight the identified key indicators, their codes are shaded in the Table 4 to Table 7. The remaining common criteria and indicators presented in the tables below enable the collection of supplementary information for a deeper analysis of the sustainability.

Due to the broad world-wide coverage of sectors, scales (company level, clusters of companies and sectors) and levels (local, sub-national and national), the current framework does not provide criteria and indicators for specific types of sub sectors. For fish and shellfish harvesting, for instance, encircling methods (e.g. purse seine), towed gear methods (e.g. beam trawling) and static gear methods (e.g. long lines) are not distinguished. The proposed criteria and indicators are therefore a first attempt to provide a multi-sectoral framework with world-wide coverage. Based on stakeholder input the framework can be further developed and refined. The criteria and indicators below are explained in detail in the Guidelines which are provided as an accompanying document. The Guidelines provide further details on how to use the criteria and indicators as well as with definitions of key concepts.

[53] The need for the development of a key set of criteria and indicators emerged as a recommendation from the Peer Review Group.

TABLE 4 **Proposed common criteria and indicators for the environmental dimension**

CODE	CRITERIA	INDICATOR	UNIT
C.EN.1	MITIGATION	Gross value or percentage of revenue invested in environmental causes related to the sector's activities directly (e.g. mitigation, restauration, monitoring) or indirectly (offsetting).	▶ m EUR/year or % of revenue/year
C.EN.2	EMISSIONS TO AIR	Emissions of CO2, SOx, NOx, and P.M.	▶ Tonnes of CO2 equivalent / year ▶ Tonnes of SO2 equivalents / year ▶ Tonnes of NO2 equivalents / year ▶ Tonnes of pollutant / year
C.EN.3	IMPACT ON ECOSYSTEMS	Extent of coastal and marine habitat positively/negatively impacted	▶ Area of positively and negatively impacted habitat in hectares
C.EN.4		Threatened species (IUCN red list) of known species	▶ %
C.EN.5		Support given to local entities working on the protection, conservation and management of local biodiversity and landscapes	▶ % of turnover dedicated to such support or ▶ If in-kind support (such as making manpower or machinery available free of charge, or donating land), specify.
C.EN.6	LEVEL OF ENERGY CONSUMPTION	Energy consumption	▶ Tonnes of oil equivalent (TOE) /year
C.EN.7		Energy demand met by renewable energy	▶ % total primary energy supply
C.EN.8	ENERGY EFFICIENCY	Measures taken to increase energy efficiency	▶ Yes / no. If yes, specify
C.EN.9	WASTE / WASTE WATER MANAGEMENT	Waste generated and recycled Wastewater generated and reused	▶ Tonnes of waste generated and recycled /year ▶ Million m3 of wastewater generated and reused/ year
C.EN.10		Technology available for solid waste and wastewater treatment	▶ Yes/ No. If yes: specify

TABLE 5 **Proposed common criteria and indicators for the economic dimension**

CODE	CRITERIA	INDICATOR	UNIT
C.EC.1	CONCENTRATION OF BUSINESSES	Existence of clusters	Yes/No
C.EC.2	ECONOMIC BENEFITS	Total revenues generated by local enterprises	% total revenues generated by local enterprises
C.EC.3		Local public revenue generated through time (taxes, fees, etc.)	m EUR/year
C.EC.4	ECONOMIC VIABILITY	Gross value added (Size of the national / regional sector)	m EUR/year
C.EC.5		Sector specific investments in the region	m EUR/year
C.EC6		Turnover	m EUR/year
C.EC.7	EMPLOYMENT	Direct and indirect jobs	No. of direct and indirect jobs x1000 persons/year
C.EC.8	FINANCIAL VIABILITY	Additional streams of finance/investment attracted	m EUR/year
C.EC.9		Financial returns reinvested in local activities	% financial returns reinvested in local activities
C.EC.10		Financial self-sustainability of supported activities	Number of years required to achieve the full financial self-sustainability of supported activities (e.g. debt-to-equity ratio)
C.EC.11	FUNDING	Public/private funding	% of turnover
C.EC.12	COSTS	Average personnel costs	x1000 EUR / year
C.EC.13		Maintenance costs	Yes/ No. If yes: specify

TABLE 6 **Proposed common criteria and indicators for the social dimension**

CODE	CRITERIA	INDICATOR	UNIT
C.SO.1	EMPLOYMENT CONDITIONS	Average wage of employees compared to sector average or national average	▶ EUR/year
C.SO.2		Presence and activeness of labour unions in the company/sector	▶ Yes/no. If yes, specify
C.SO.3		Informal employment[54]	▶ % informal employment of total employment
C.SO.4	HEALTH AND SAFETY MANAGEMENT	Frequency of auditing by external health & safety experts	▶ No. of audits by external health and safety experts, including evidence of application in practice such as technical measures, regular medical screenings, etc.m EUR/year
C.SO.5		Existence of policies and measures to combat occupational diseases and accidents	▶ Yes/no, if yes: specify
C.SO.6	INCLUSIVENESS	Employees with no post-school diploma	▶ %
C.SO.7		Employment rate of vulnerable groups	▶ % vulnerable workers of total work force per social category (see guideline). For every social category define: • Gender (% male/female/other) • Average age
C.SO.8	FAIRNESS IN REMUNERATION	Evidence of unequal pay between social categories for equal work	▶ Yes/no, if yes: explain evidence, type of work and social categories affected, degree of discrimination in pay
C.SO.9	LEVEL OF ACCEPTANCE BY STAKEHOLDERS	Acceptance of environmental, economic and social impact by stakeholders	▶ No. of reported actions of stakeholders against environmental, economic or social impacts

[54] Please consult the Guidelines for more information on what the concept of informal employment entails

TABLE 7 **Proposed common criteria and indicators for the governance dimension**

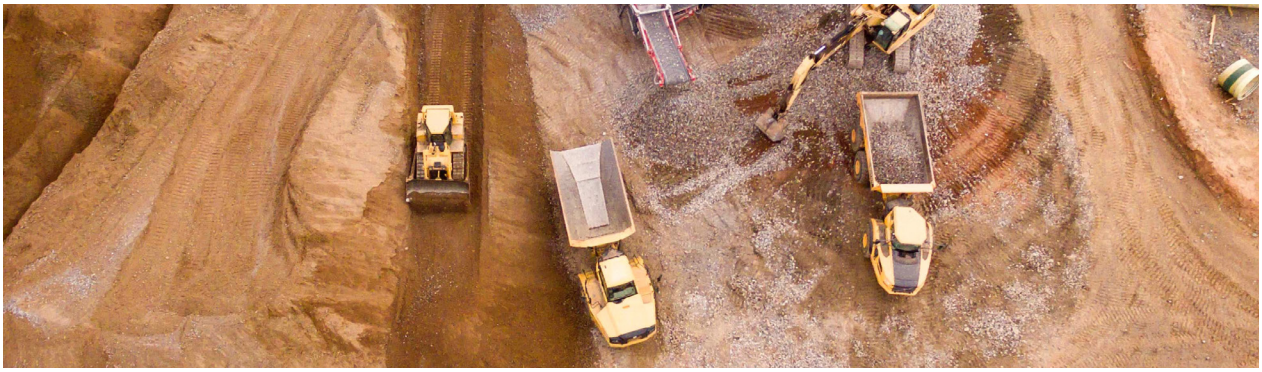
CODE	CRITERIA	INDICATOR	UNIT
C.GO.1	PERMITS	Typical permitting regime followed prior to operations	▶ Score1. 1. No permitting or environmental administration required; 2. Permit procedure required, but below EIA threshold; 3. Permit with EIA procedure.
C.GO.2	IMPACT ASSESSMENT	Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEnA) and Socio-Economic Assessment (SEcA) conducted and enforced via monitoring and evaluation	▶ Score 1. No EIA/SEnA/SEcA conducted, 2. EIA/SEnA/SEcA conducted but not implemented/ enforced 3. EIA/SEnA/SEcA conducted and enforced via monitoring and evaluation
C.GO.3	NATURE-BASED SOLUTIONS	Application of Nature Based Solutions	▶ Score 1. Relevant, but not applied 2. Applied to some extent [example] 3. Frequently applied [example] 4. Not applicable to the company/sector activities
C.GO.4	RISK MANAGEMENT	Existence / implementation of risk management plans taking into account the precautionary principle	▶ Score 1. No risk management plan 2. Risk management plan exists 3. Risk management plan exists, includes precautionary principles and is implemented
C.GO.5	STRATEGY AND VISION	Integration of SDGs in the company's strategy and operations	▶ % of activities covered by SDG reporting
C.GO.6	CLIMATE CHANGE	Measures taken for climate change adaptation	▶ Yes/no. If yes: specify
C.GO.7	INNOVATION	Attention to innovation (or investment in Research & Development)	▶ % revenue invested in Research & Development
C.GO.8	CERTIFICATION AND LABELLING	Existence of a sustainability label or certificate	▶ Score 1. No sustainability label or certification 2. Sustainability label(s) or certification exists/awarded (please specify) 3. Sustainability label(s) or certification applied
C.GO.9	SUPPLY CHAIN	Existence of supply chain policy	▶ Yes/no. If yes: specify
C.GO.10		Existence of Life Cycle Assessment policy	▶ Yes/no. If yes: specify
C.GO.11	LEVEL OF STAKEHOLDER ENGAGEMENT	WMechanism for stakeholder engagement	▶ Score 1. No stakeholder involvement 2. Occasional consultation with stakeholders, focused on public actors 1. Specific mechanism for stakeholder engagement besides public actors
C.GO.12	EDUCATION ON SUSTAINABILITY	Participation in information and training sessions about sustainability	▶ Yes/no, if yes specify

Due to the differences in nature between the blue economy sectors, the common **criteria and indicators** need to be complemented with criteria and indicators specific to subsectors. Criteria and indicators for subsectors have been developed in a similar manner to the common indicators; namely, based on the 15 frameworks that were critically analysed for their effectiveness and relevance, providing a database of over 500 indicators. The suitability of the preliminary set of criteria and indicators for the blue economy subsectors has been tested in the case studies (see Chapter 5). Based on the insights from the case studies, the preliminary set of criteria and indicators were then fine-tuned (please refer to Annex 7: *Methodology the development of a set of sustainability criteria* and indicators and Annex 10: *Comprehensive database of blue economy criteria and indicators*). Table 8 to Table 19 present criteria and indicators developed for the blue economy subsectors.

EXTRACTION OF MINERALS

TABLE 8 Proposed criteria and indicators for the subsector of extraction of minerals

ENVIRONMENTAL			
CODE	CRITERIA	INDICATOR	UNIT
SEM.EN.1	Impact on environment	Technologies applied to reduce the impact of dredging plume, noise, vibration and heat	No. and type of technologies No./year
SEM.EN.2	Impact on environment	Number of times that turbidity is not in compliance with regulations	No./year
ECONOMIC			
CODE	CRITERIA	INDICATOR	UNIT
SEM.EC.1	Economic viability	Production of marine aggregates (weight)	No. and type of technologies No./year
SEM.EC.2	Economic viability	Value of marine aggregates (monetary)	m EUR/year



EXTRACTION OF OIL AND GAS

TABLE 9 Proposed criteria and indicators for the subsector of extraction of oil and gas

ENVIRONMENTAL			
CODE	CRITERIA	INDICATOR	UNIT
SEOG.EN.1	Emissions to water	Produced water subject to treatment	% produced water subject to treatment
SEOG.EN.2	Oil spills response	Frequency of oil spill response exercises and trainings	No. of exercises and trainings/ year
SEOG.EN.3	Waste management	Existence of drilling waste management plan	Yes/no
SEOG.EN.4	Impact on environment	Technologies applied to reduce the impact of noise, vibration and heat	No. and type of technologies
SEOG.EN.5	Impact on ecosystems	Refuge effect for species	Yes/no, if yes: specify
ECONOMIC			
CODE	CRITERIA	INDICATOR	UNIT
SEOG.EC.1	Economic viability	Levelized cost of energy production	Euro/Tons of oil equivalent
SEOG.EC.2	Economic viability	Production 'oil and gas' (monetary)	m EUR/year
SEOG.EC.3	Economic viability	Production 'oil and gas' (tons)	Tons of oil equivalent/year

EXTRACTION OF WATER (DESALINATION)

TABLE 10 Proposed criteria and indicators for the subsector of extraction of water (desalination)

ENVIRONMENTAL			
CODE	CRITERIA	INDICATOR	UNIT
SDE.EN.1	Impact on ecosystems	Salinity increase	ppm above ambient salinity
SDE.EN.2	Impact on ecosystems	Temperature increase	°C above ambient temperature
SDE.EN.3	Infrastructure capacity	Amount of discharged brine	Million tons/year
SDE.EN.4	Chemical use	Discharge of chemicals.	Tons/chemical/year
ECONOMIC			
CODE	CRITERIA	INDICATOR	UNIT
SDE.EC.1	Economic viability	Levelized cost of water production	EUR/m3 product water
SDE.EC.2	Infrastructure capacity	Fresh water produced	m3/day
SDE.EC.3	Infrastructure capacity	Quality of water produced	TDS mg/L
SDE.EC.4	Infrastructure capacity	Volume of extracted seawater	m3/day
GOVERNANCE			
CODE	CRITERIA	INDICATOR	UNIT
SDE.GO.1	Risk management	Measures taken for strategic buffering in periods when water demand is low.	Yes/no. If yes specify
SDE.GO.2	Innovation	Reuse of brine, i.e. as source of valuable raw material	Yes/no. If yes specify

FISH AND SHELLFISH HARVESTING

TABLE 11 Proposed criteria and indicators for the subsector of fish and shellfish harvesting

ENVIRONMENTAL			
CODE	CRITERIA	INDICATOR	UNIT
SFH.EN.1	Status of stock	Exploitation of stock at Maximum Sustainable Yield	% stock exploited at Maximum Sustainable Yield (per species)
SFH.EN.2	Fishery management	Use of selective fishing techniques/gears	Yes/no. If no, specify
SFH.EN.3	Fishery management	Use of non-destructive fishing techniques/gears	Yes/no. If no, specify
ECONOMIC			
CODE	CRITERIA	INDICATOR	UNIT
SFH.EC.1	Economic viability	Production 'harvested fish and shellfish' (monetary)	m EUR/year
SFH.EC.2	Economic viability	Production 'harvested fish and shellfish' (weight)	Landings weight in tons/year
GOVERNANCE			
CODE	CRITERIA	INDICATOR	UNIT
SFH.GO.1	Fishery management	Multiannual management plans in place and implemented	Yes/no. If yes specify
SFH.GO.2	Fishery management	National Plan of Action for Illegal, Unregulated, Unreported Landings	Yes/no. If yes specify
SFH.GO.3	Fishery management	Quota system in place and implemented	Yes/no, if yes specify
SFH.GO.4	Fishery management	Fishing vessels equipped with electronic positioning and catch reporting device	% of the unit of analysis

FISH AND SHELLFISH PROCESSING

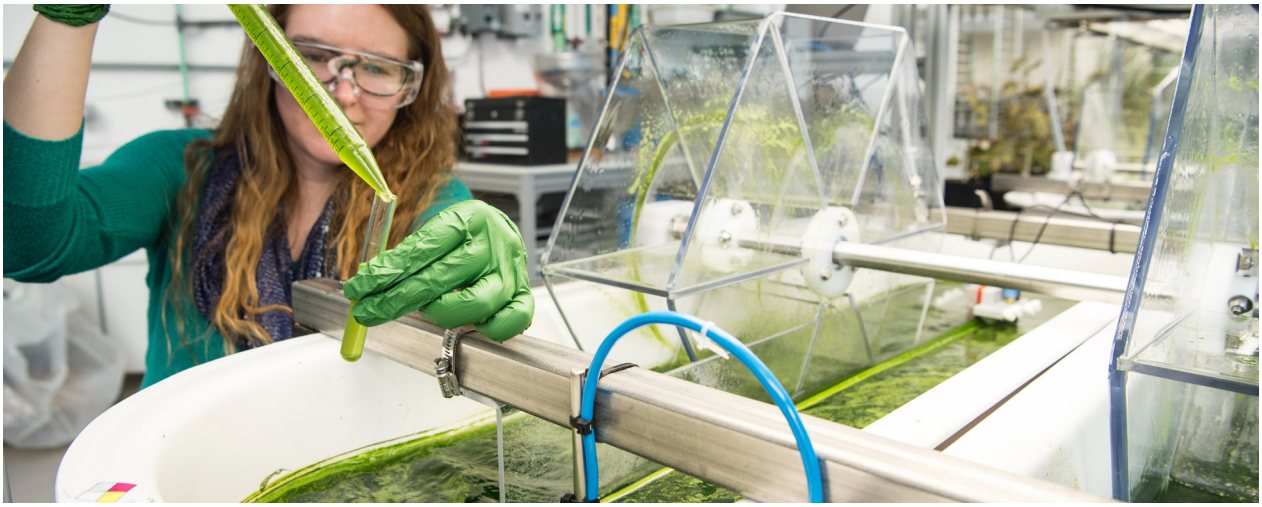
TABLE 12 Proposed criteria and indicators for the subsector of fish and shellfish processing

ENVIRONMENTAL			
CODE	CRITERIA	INDICATOR	UNIT
SFP.EN.1	Waste management	Treatment of waste water	Yes/no
SFP.EN.2	Waste management	Use of recycled packaging materials	Yes/no
SFP.EN.3	Waste water management	Re-use of fish waste	Yes/no
ECONOMIC			
CODE	CRITERIA	INDICATOR	UNIT
SFP.EC.1	Economic viability	Production 'processed fish and shellfish' (monetary)	m EUR/year
SFP.EC.2	Economic viability	Production 'processed fish and shellfish' (weight)	Tons / year
SFP.EC.3	Processing conditions	Access to ice / refrigeration	Yes/no
SFP.EC.4	Economic viability	Domestic fish production vs. imports	Tons/year
SFP.EC.5	Economic viability	Type of imports	Tons/year for the following categories: • (Frozen) whole fish • (Frozen) fillet and steaks • Canned fish and shellfish • Dried (frozen) fish • Fresh fish and shellfish
SOCIAL			
CODE	CRITERIA	INDICATOR	UNIT
SFP.SO.1	Social balance	Effect of fish input purchases on: • local prices • local harvesters • users of fish	Yes/no, if yes specify for each category
GOVERNANCE			
CODE	CRITERIA	INDICATOR	UNIT
SFP.GO.1	Supply chain	Existence and effective implementation of a company policy to ensure inputs/raw materials are obtained from sustainable sources	Score 1. Policy does not exist 2. Policy exists but not implemented 3. Policy exists and implemented

MARINE PLANT AND ALGAE HARVESTING

TABLE 13 Proposed criteria and indicators for the subsector of marine plant and algae harvesting

ENVIRONMENTAL			
CODE	CRITERIA	INDICATOR	UNIT
SPH.EN.1	Status of stock	Exploitation of stock at Maximum Sustainable Yield	% stock exploited at Maximum Sustainable Yield (per species)
SPH.EN.2	Harvesting management	Use of selective harvesting techniques/gears	Yes/no. If no, specify
SPH.EN.3	Harvesting management	Use of non-destructive harvesting techniques/gears	Yes/no. If no, specify
ECONOMIC			
CODE	CRITERIA	INDICATOR	UNIT
SPH.EC.1	Economic viability	Production 'harvested marine plants and algae' (monetary)	m EUR/year
SPH.EC.2	Economic viability	Production 'harvested marine plants and algae' (weight)	Landings weight in tons/year
GOVERNANCE			
CODE	CRITERIA	INDICATOR	UNIT
SPH.GO.1	Harvesting management	National Plan of Action for Illegal, Unregulated, Unreported Landings	Yes/no.
SPH.GO.2	Harvesting management	Quota system in place	Yes/no.
SPH.GO.3	Harvesting management	Existence and enforcement of a stock management policy	Score 1. Policy does not exist 2. Policy exists but not enforced 3. Policy exists and enforced
SPH.GO.4	Harvesting management	Monitoring and inspection of harvesting efforts	Yes/no, if yes specify



AQUACULTURE

TABLE 14 Proposed criteria and indicators for the subsector of aquaculture

ENVIRONMENTAL			
CODE	CRITERIA	INDICATOR	UNIT
SAQ.EN.1	Chemical use	On-farm documentation available with detailed information on chemicals use, compliant with regulations (including anti-biotics)	Yes/no. If yes: specify
SAQ.EN.2	Supply chain	Existence and effective implementation of a company policy to ensure inputs/raw materials are obtained from sustainable sources	Score 1. Policy does not exist 2. Policy exists but not implemented 3. Policy exists and implemented
SAQ.EN.3	Farm management	Mortalities reduction program exists and implemented	Yes/no. If yes: specify
SAQ.EN.4	Farm management	Number of escape events	No. of escapes / year
SAQ.EN.5	Farm management	Number of escaped fish	No. of escaped fish / year
SAQ.EN.6	Water quality	Measures taken to reduce nutrient eutrophication	No. and type of measures taken
SAQ.EN.7	Water quality	Phosphorous (P) and nitrogen (N) concentrations	mg/L
SAQ.EN.8	Impact on ecosystems	Refuge effect for species	Yes/no, if yes: specify
ECONOMIC			
CODE	CRITERIA	INDICATOR	UNIT
SAQ.EC.1	Economic viability	Average size of farms	Hectares of land or water
SAQ.EC.2	Economic viability	Production 'farmed fish' (weight)	Tons/year
SAQ.EC.3	Economic viability	Production 'farmed fish' (monetary)	m EUR/year
SAQ.EC.4	Feed management	Realised Feed Conversion Ratio	Feed Conversion Ratio
SAQ.EC.5	Economic viability	Stocking density	No. of fry / m2

RENEWABLE ENERGY

TABLE 15 Proposed criteria and indicators for the subsector of renewable energy

ENVIRONMENTAL			
CODE	CRITERIA	INDICATOR	UNIT
SRE.EN.1	Impact on ecosystems	Species fatalities due to collisions	No. and type of fatalities/year
SRE.EN.2	Impact on ecosystems	Refuge effect for species	Yes/no, if yes: specify
ECONOMIC			
CODE	CRITERIA	INDICATOR	UNIT
SRE.EC.1	Economic viability	Distance from shore	Km
SRE.EC.2	Economic viability	Levelized cost of energy production	Euro/MWh
SRE.EC.3	Infrastructure capacity	Electrical capacity	MW
SRE.EC.4	Infrastructure capacity	Installed capacity relative to surface used	MWh/Km2
SRE.EC.5	Infrastructure capacity	Total gross electricity generation	MWh/year

TRANSPORT INFRASTRUCTURE

TABLE 16 Proposed criteria and indicators for the subsector of transport infrastructure

ENVIRONMENTAL			
CODE	CRITERIA	INDICATOR	UNIT
STI.EN.1	Introduction of invasive species	Onboard ballast water treatment system available and functioning	Yes/no
STI.EN.2	Oil spills response	Frequency of Oil Spill Response exercises and trainings	No. of exercises or trainings / year
STI.EN.3	Water quality	Measures taken to reduce nutrient emissions	Yes/no. If yes: specify
STI.EN.4	Use of shore power	Availability of shore power infrastructure in port	Yes/no
ECONOMIC			
CODE	CRITERIA	INDICATOR	UNIT
STI.EC.1	Economic viability	Production 'cargo capacity'	In Twenty Foot Equivalent Unit (TEU)/year
STI.EC.2	Economic viability	Production 'cargo capacity' (monetary)	m EUR/year
GOVERNANCE			
CODE	CRITERIA	INDICATOR	UNIT
STI.GO.1	Sustainable infrastructure	Measures taken to ensure reliable, sustainable and resilient infrastructure	Yes/no. If yes: specify
STI.GO.2	Hazardous waste management	Guidelines and plans for handling hazardous substances	Yes/no. If yes: specify

TRANSPORT SHIPPING

TABLE 17 Proposed criteria and indicators for the subsector of Transport shipping

ENVIRONMENTAL			
CODE	CRITERIA	INDICATOR	UNIT
STS.EN.1	Emissions to air	Measures taken to reduce emissions to air through exhaust cleaning	Yes/no. If yes: specify if measure involves disposal of sludge produced by Exhaust Gas Cleaning System
STS.EN.2	Emissions to air	Average fuel Sulphur content per bunkering	% avg, fuel Sulphur content per kind of fuel
STS.EN.3	Introduction of invasive species	Onboard ballast water treatment system available and functioning	Yes/no
STS.EN.4	Waste management	Waste management systems (sludge handling) available and functioning	Yes/no
STS.EN.5	Level of fuel consumption	Fuel consumption	Tons/kind of fuel/year
STS.EN.6	Impact on ecosystems	Sewage discharge in Particular Sensitive Sea Areas	Yes/no
STS.EN.7	Chemical use	Use of chemicals for antifouling, stern tube oils, external hydraulic fluids, gear oils for thrusters and controllable pitch propellers, boiler/cooling water treatment, cleaning agents, refrigerants.	Yes/no for each application. If yes: specify.
STS.EN.8	Use of shore power	Onboard infrastructure to connect to shore power	Yes/no
ECONOMIC			
CODE	CRITERIA	INDICATOR	UNIT
STS.EC.1	Economic viability	Cargo tonnage	Twenty Foot Equivalent Unit (TEU) /year
STS.EC.2	Economic viability	Production 'cargo capacity'	m EUR/year

TOURISM AND LEISURE INFRASTRUCTURE/ACTIVITIES[55]

TABLE 18 Proposed criteria and indicators for the subsector of tourism

ENVIRONMENTAL			
CODE	CRITERIA	INDICATOR	UNIT
STO.EN.1	Level of energy consumption	Specific energy use	kWh/m2yr
STO.EN.2	Level of water consumption	Water consumption per guest night	Litres/guest night
ECONOMIC			
CODE	CRITERIA	INDICATOR	UNIT
STO.EC.1	Economic viability	Number of tourists	No. of tourists/month
SOCIAL			
CODE	CRITERIA	INDICATOR	UNIT
STO.SO.1	Employment conditions	Seasonal jobs	Yes/no, if yes specify for each category
STO.SO.2	Social balance	Tourism density	Ratio of total number of nights spent relative to the total surface area of the region
STO.SO.3	Social balance	Tourism intensity[56]	Ratio of nights spent at tourist accommodation establishments relative to the total permanent resident population of the area
GOVERNANCE			
CODE	CRITERIA	INDICATOR	UNIT
STO.GO.1	Development control	Existence of land use or development planning processes, including tourism	% area subject to planning management
STO.GO.2	Development control	Existence of visitor taxes and fees with the aim of re-investing in mitigating or reversing negative effects on the local ecosystems and community	Yes/no, if yes specify
STO.GO.3	Supply chain	Existence and effective implementation of a company policy to ensure inputs/raw materials are obtained from sustainable sources	Score 1. Policy does not exist 2. Policy exists but not implemented 3. Policy exists and implemented

[55] Tourism infrastructure and tourism activities are considered under the same framework.
[56] Indicators STO.SO.3 does not cover cruise ships. Further, STO.SO.3 does not include day trippers

COASTAL DEFENCE AND FLOOD PROTECTION

TABLE 19 Proposed criteria and indicators for the subsector of coastal defence and flood protection

ENVIRONMENTAL			
CODE	CRITERIA	INDICATOR	UNIT
SCD.EN.1	Flood safety	Open vs. closed coastal defence or flood protection system	Open or closed system. If closed, specify impact on fish migration
SCD.EN.2	Flood safety	Existence of natural barriers	No. and type of natural barrier (e.g. (wetlands, mangroves, reefs)
SCD.EN.3	Impact on ecosystems	Refuge effect for species	Yes/no, if yes: specify
ECONOMIC			
CODE	CRITERIA	INDICATOR	UNIT
SCD.EC.1	Costs	Total construction costs	Million EUR
SCD.EC.2	Durability of structure	Estimated lifespan of the structure	No. of years
SCD.EC.3	Flood safety	Target flood protection system	1 failure/x number of years
SCD.EC.4	Durability of structure	Age of the structure	No. of years

The recommendations of experts (provided through the development of case studies as well as feedback received via a survey and interviews) have led to the fine-tuning of the subsector-specific indicators of the BESF. More information on the followed methodology for and outcomes of expert consultation can be found in Annex 7 and 8.

4.6 Subsectors without sustainability criteria and indicators

Sector specific criteria and indicators were only developed for sectors where information could be readily found in the literature. These sectors are generally established blue economy sectors. Frameworks with criteria and indicators for emerging sectors were not found in the literature. However, the common criteria and indicators can be applied. In Table 20 below, the subsectors are summarised and suggestions for potentially relevant criteria are proposed. These suggestions are based on the proposed sector specific criteria from the previous section of this report.

TABLE 20 subsectors without criteria and indicator

SUBSECTOR	DESCRIPTION	POTENTIALLY RELEVANT CRITERIA
EXTRACTION OF SALT	Indicators at this level are not readily available. Furthermore, the subsector is linked to both maritime and non-maritime activities.	▶ Economic viability (production weight/value – Economic) ▶ Processing conditions (e.g. zero discharge status - Economic) ▶ Technology (vacuum, purification - Economic) ▶ Co-existence with ecologically significant species or habitats ▶ Energy balance: electrical or mechanical energy input needed to produce one tonne of evaporated salt compared to one tonne of mined salt
STORAGE OF CO_2/CARBON SEQUESTRATION	A number of indicators, such as the economic value of blue carbon ecosystems per hectare, exist. (Ecosystem service value per hectare (US$); blue carbon burial rate[57] ; carbon price[58] ; change in the amount of carbon gained or lost over time; amount of carbon stored per unit area (carbon density)[59] are used to describe the carbon sequestration/blue carbon sector. Given the emerging nature of this subsector, a consolidated list of relevant subsector-specific criteria and indicators in the context of this assignment is not yet available.	▶ Carbon dynamics (e.g. carbon burial rate - Environmental) ▶ Carbon valuation (e.g. carbon price – Economic/Governance) ▶ Climate change (mitigation – Governance)
WASTE REMOVAL AND WASTE DISPOSAL	The scope of this subsector in the context of blue economy varies. Some organizations refer to waste treatment and disposal, others to waste recycling and storing, waste management and waste disposal. Sustainability criteria and indicators are not readily available at this level.	▶ Water quality (Environmental) ▶ Chemical disposal (Environmental) ▶ Regulations and measures (Governance) ▶ Degree or level to which waste handled by the entity or, project is recycled or re-used ▶ Value in monetary terms of the recycled/re-used waste of positively and negatively impacted habitat in hectares
HUNTING AND COLLECTING FOR OTHER PURPOSES	This sector is generally small scale, and often informal. Sustainability indicators are not readily available at this level. Some criteria and indicators of the Fish and shellfish harvesting subsectors may be relevant for this subsector too, but a consolidated list of relevant subsector-specific indicators in the context of this assignment is not yet available.	▶ Hunting management (e.g. regulations and measures, management plans, establishing, Illegal, Unregulated, Unreported Landings, tagging of species - Governance) ▶ Impact on local biodiversity and ecosystems ▶ Existence and degree of enforcement of regulations to manage collection of shells, corals and other resources of biological origin.

[57] Macreadie, P.I., Anton, A., Raven, J.A. et al. 2019. The future of Blue Carbon science. Nat Commun 10, 3998 doi:10.1038/s41467-019-11693-w

[58] Chun, J.; Kim, C.-K.; Kang, W.; Park, H.; Kim, G.; Lee, W.-K. Sustainable Management of Carbon Sequestration Service in Areas with High Development Pressure: Considering Land Use Changes and Carbon Costs. Sustainability 2019, 11, 5116.

[59] Negra, Christine & Sweedo, Caroline & Cavender-Bares, Kent & O'Malley, Robin. (2008). Indicators of Carbon Storage in U.S. Ecosystems: Baseline for Terrestrial Carbon Accounting. Journal of environmental quality. 37. 1376-82. 10.2134/jeq2007.0290.

SUBSECTOR	DESCRIPTION	POTENTIALLY RELEVANT CRITERIA
BLUE BIO-ECONOMY	These studies and other reviews e.g. on sustainability performance of national bio-economies address the topic in general terms and not specifically in the context of blue bio-economy. The derivation of criteria and indicators specific to blue bio-economy to assess its sustainability from the more general bio-economy frameworks falls outside the scope of this assignment.	▶ Innovation (no. of patents – Governance) ▶ Farm management (Environmental) ▶ Marine genetic resources (e.g. application in pharmaceuticals - Environmental)
TRANSMISSION OF ELECTRICITY AND COMMUNICATIONS	Sustainability indicators are not readily available at this level. To some extent it can be considered as a component of the VCA of Renewable energy generation.	▶ Impact on ecosystems (turbidity, refuge effect – Environmental) ▶ Damage to seabed and seafloor habitats during laying of cables (Environmental)
RESEARCH, SURVEY AND EDUCATIONAL ACTIVITIES	The scope of this subsector in the context of blue economy varies and include many different aspects of sustainability. A consolidated list of relevant subsector-specific indicators in the context of this assignment is not yet available.	▶ Funding (public/private Investment in Research & Development – Economic) ▶ Education (no. of educational programmes, no. of scientific publications – Social) ▶ Research (no. of research surveys – Environmental) ▶ Impact on the species, habitats or ecosystems being surveyed or researched ▶ Number and quantity of supplies and services procured in the local coastal communities nearest the area being surveyed or researched
LAND CLAIM	It is hard to find indicators of sustainability. A consolidated list of relevant subsector-specific indicators in the context of this assignment is not yet available.	▶ Impact on ecosystems (turbidity, refuge effect – Environmental) ▶ Mitigation (compensation of impacted habitats – Environmental) ▶ Stakeholder acceptance/engagement (Social/ Governance) ▶ Damage or loss to marine and coastal habitats, spawning grounds and other ecologically significant areas as result of land reclamation ▶ Changes to offshore currents, erosion and sedimentation as result of the reclamation ▶ Contribution of the land claim in question to local coastal defence and to dampening the effects of climate-related storm surges and sea level rises

PART 5

CASE STUDIES: TESTING THE PROPOSED BLUE ECONOMY SUSTAINABILITY FRAMEWORK

The applicability of the blue economy sustainability criteria and indicators were tested through case studies. At the same time, the experience gained through the case studies helped to shape the final BESF. The case studies cover a selection of activities and practices across different blue economy sectors.

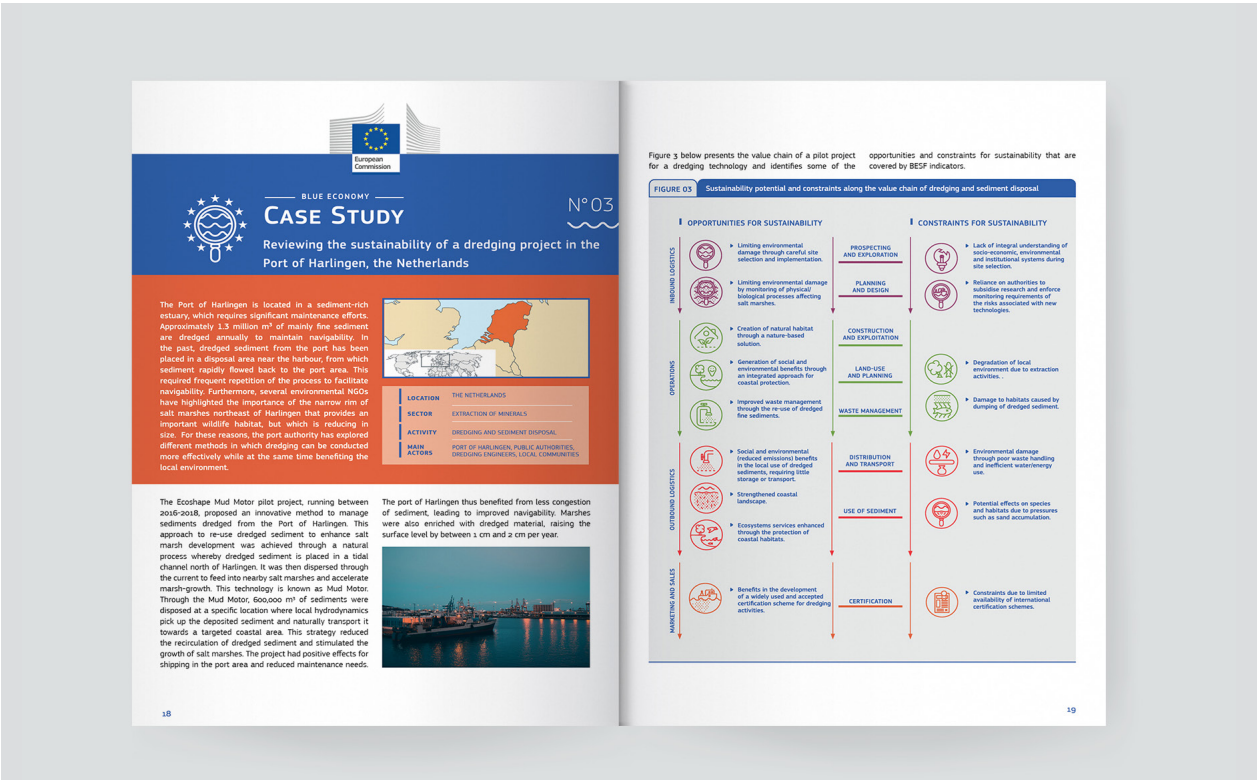
5.1 Coverage of the case studies

The case studies look at different blue economy activities with a broad geographical coverage. The examples were selected to illustrate the benefits of conducting blue economy activities in a sustainable manner and were reviewed against the sustainability dimensions of the BESF.

The practices were selected based on desk research and expert judgment, to find the most suitable cases to test the BESF indicators. The selection took into consideration the following criteria:

- Sectoral coverage across case studies
- Prioritisation of pressing issues in the selected sectors
- Geographical coverage across case studies
- Data availability, to ensure comprehensive case studies

The activities described for each of the case studies listed in Table 21 are examples of best practices within a blue economy subsector.



European Commission

BLUE ECONOMY

CASE STUDY

N°03

Reviewing the sustainability of a dredging project in the Port of Harlingen, the Netherlands

The Port of Harlingen is located in a sediment-rich estuary, which requires significant maintenance efforts. Approximately 1.3 million m³ of mainly fine sediment are dredged annually to maintain navigability. In the past, dredged sediment from the port has been placed in a disposal area near the harbour, from which sediment rapidly flowed back to the port area. This required frequent repetition of the process to facilitate navigability. Furthermore, several environmental NGOs have highlighted the importance of the narrow rim of salt marshes northeast of Harlingen that provides an important wildlife habitat, but which is reducing in size. For these reasons, the port authority has explored different methods in which dredging can be conducted more effectively while at the same time benefiting the local environment.

LOCATION: THE NETHERLANDS
SECTOR: EXTRACTION OF MINERALS
ACTIVITY: DREDGING AND SEDIMENT DISPOSAL
MAIN ACTORS: PORT OF HARLINGEN, PUBLIC AUTHORITIES, DREDGING ENGINEERS, LOCAL COMMUNITIES

The Ecoshape Mud Motor pilot project, running between 2016-2018, proposed an innovative method to manage sediments dredged from the Port of Harlingen. This approach to re-use dredged sediment to enhance salt marsh development was achieved through a natural process whereby dredged sediment is placed in a tidal channel north of Harlingen. It was then dispersed through the current to feed into nearby salt marshes and accelerate marsh-growth. This technology is known as Mud Motor. Through the Mud Motor, 600,000 m³ of sediments were disposed at a specific location where local hydrodynamics pick up the deposited sediment and naturally transport it towards a targeted coastal area. This strategy reduced the recirculation of dredged sediment and stimulated the growth of salt marshes. The project had positive effects for shipping in the port area and reduced maintenance needs.

The port of Harlingen thus benefited from less congestion of sediment, leading to improved navigability. Marshes were also enriched with dredged material, raising the surface level by between 1 cm and 2 cm per year.

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Figure 3 below presents the value chain of a pilot project for a dredging technology and identifies some of the opportunities and constraints for sustainability that are covered by BESF indicators.

FIGURE 03 Sustainability potential and constraints along the value chain of dredging and sediment disposal

OPPORTUNITIES FOR SUSTAINABILITY

CONSTRAINTS FOR SUSTAINABILITY

INBOUND LOGISTICS

- Limiting environmental damage through careful site selection and implementation.
- Limiting environmental damage by monitoring of physical/ biological processes affecting salt marshes.

PROSPECTING AND EXPLORATION

PLANNING AND DESIGN

- Lack of integral understanding of socio-economic, environmental and institutional systems during site selection.
- Reliance on authorities to subsidise research and enforce monitoring requirements of the risks associated with new technologies.

OPERATIONS

- Creation of natural habitat through a nature-based solution.
- Generation of social and environmental benefits through an integrated approach for coastal protection.
- Improved waste management through the re-use of dredged fine sediments.

CONSTRUCTION AND EXPLOITATION

LAND-USE AND PLANNING

WASTE MANAGEMENT

- Degradation of local environment due to extraction activities. .
- Damage to habitats caused by dumping of dredged sediment.

OUTBOUND LOGISTICS

- Social and environmental (reduced emissions) benefits in the local use of dredged sediments, requiring little storage or transport.
- Strengthened coastal landscape.
- Ecosystems services enhanced through the protection of coastal habitats.

DISTRIBUTION AND TRANSPORT

USE OF SEDIMENT

- Environmental damage through poor waste handling and inefficient water/energy use.
- Potential effects on species and habitats due to pressures such as sand accumulation.

MARKETING AND SALES

- Benefits in the development of a widely used and accepted certification scheme for dredging activities.

CERTIFICATION

- Constraints due to limited availability of international certification schemes.

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TABLE 21 Overview of the selection of best practices for the case studies

SUBSECTOR	ACTIVITY	LOCATION	DESCRIPTION
EXTRACTION OF WATER	DESALINATION	GRAN CANARIA	In an area where there is not sufficient underground water for agricultural irrigation, a renewable energy-based desalination plant in Gran Canaria, Spain, benefits the local environment and agricultural community and serves as a reference for future developments of SWRO plants in the Canary Islands.
AQUACULTURE	SHRIMP FARMING	VIETNAM, MEKONG DELTA	The example covers (organic) integrated mangrove-shrimp farming in the Mekong Delta, Vietnam. This farming technique is extensive by nature and suggests low maintenance and labor needs as well as low environmental impacts. Local farmers were invited to attend training on climate change adaptation, organic rearing practices, the use of inputs and the importance of mangrove coverage.
EXTRACTION OF MINERALS	DREDGING	NETHERLANDS	A 'building with nature' approach for dredging in the Port of Harlingen, the Netherlands, enriches marshes when sediment is disposed through natural dynamics. The pilot project showed potential in providing economic and ecological benefits of reducing the necessity for dredging, increasing sustainable ecosystem-based coastal protection and conserving valuable habitats for marsh-specific flora and fauna.
AQUACULTURE	SALMON FARMING	NORWAY	A system of 'green licenses' has been introduced in the national sector, whereby farmers have been given the opportunity to expand production on the condition that they adopt solutions that could lead to a reduction of sea lice and escapes - thus mitigating the impact on wild salmon populations. Under this management, local communities are consulted and farms are highly regulated in their efforts to minimize environmental impact.
TRANSPORT INFRASTRUCTURE	PORT EXPANSION	AUSTRALIA	A port capacity project provides an example of how Port of Melbourne has aimed to reduce congestion surrounding the port by expanding container and automotive terminals' capacities. The project was carried out under an Environmental Management Plan, dedicating land as space for public reaction, environmental protection and to serve as 'port buffers'.

The case studies were used to test the draft BESF developed in Task 4. The data collection process allowed for the identification of indicators for which data was available. It also allowed for the adjustment of criteria or units (used to measure the indicators) that needed refining. Annex 7: *Methodology for the development of a set of sustainability criteria and indicators* provides an overview of the process whereby changes were made to the BESF.

Each of these case studies include an introduction to the activity with a Value Chain Analysis of the sector, a review of the activity according to the sustainability dimensions (based on the application of BESF criteria and indicators) and a conclusion and summary of the lessons learned for the particular case study. The Guidelines (provided as an accompanying document to this report) present the data collected for the case study on Salmon Farming in Norway as an example of how the BESF can be applied.

5.1 General observations and lessons learned from the case studies

The framework of indicators has enabled the collection of data across different activities, generally providing good coverage of sustainability elements, both in quantitative and qualitative terms. The indicators highlight important sustainability elements of the activities across the four dimensions and allow for a review of the overall sustainability performance of a particular activity or a sector. The following points portray the main lessons learned in the process of using the BESF to develop the case studies:

▸ When applied to the particular example of an activity or a sector, some indicators of the framework allow individual conclusions on certain elements of sustainability to be drawn. This is the case for indicators that reveal a certain activity or sector to be beneficial (e.g. very high percentage for indicators such as *'Financial returns reinvested in local activities'* or *'Energy demand met by renewable energy'*). In cases where the user wishes to determine the relative sustainability performance of a particular activity, a comparison could be made to another similar activity. In making use of each of these approaches, data collected for some indicators must be interpreted in the context of other indicators. For example, it may be necessary to look at *'energy consumption'* along with data collected for economic indicators such as *'Turnover'* or '*Production value'* in order to get a sense of the energy efficiency of a particular process.

▸ The indicators of the framework can be applied to different scales. The case studies have provided examples whereby data has been collected at the national level (i.e. the case study on the salmon farming sector), regional/provincial level (i.e. the case study on shrimp farming sector), company level (i.e. the case study on desalination) and at the level of a particular project (i.e. the case study on dredging). The majority of indicators are flexible and can be applied to various scales. However, there are certain indicators/units that may be interpreted differently when applied to different scales. This is the case for the indicator '*Total revenues generated by local enterprises'* when being applied to the national sector, where the definition of 'local' in this context is to some extent left for the user to determine. From one perspective, this may be beneficial as it allows for data collection to be tailored to the example at hand. However, difficulties may arise when such indicators are interpreted differently in the data collection for two comparative examples. Other examples where indicators may be interpreted differently when applied at different scales include *'indirect employment'* (in terms of what constitutes 'indirect'), *'Emissions of CO_2, SOx, NOx, and P.M.'* (in terms of which activities should be included in the scope of aggregated emission calculation) and *'Level of stakeholder engagement'* (in terms of which actors are determined as a 'stakeholders'). While the Guidelines for the BESF (developed as a separate document) offer suggestions on the application of the indicators as well as definitions on some key concepts, the flexibility of the framework requires the end-user to clearly identify the scale at which the data on the activity is to be collected, and at which level a sustainability assessment is most appropriate.

▸ When applying the BESF, it is necessary to retrieve the correct data as specified by the unit of the indicator at the correct scale (i.e. national, regional/provincial, company or project level). This study involved the use of comparative examples of similar processes in different countries or regions. In doing so, the study team overcame certain challenges in retrieving data for an indicator at the correct scale for both examples – as is required to make a comparison. In some cases (e.g. *'Turnover'* measure in million EUR/year), estimations must be made by using information from different sources to provide data at the correct level (as required by the unit of the indicator). Furthermore, when data is found at the correct scale and the correct unit (as required by the indicator), the methodologies used for the calculation of the data need to be verified to ensure coherence when comparing two examples. The BESF, however, provides enough flexibility to use alternative approaches that can alleviate shortcomings in data comparability (e.g. by adapting the identified data to a comparable scale).

▸ Several aspects need to be taken into account when identifying an activity to serve as a comparative example in the application of the BESF. The study team found that in the process of comparing similar activities in different regions, there were many contextual differences that complicated the interpretation of the data (e.g. important geographical, political or climatic differences). It is therefore recommended that when applying the BESF, comparisons between different activities are conducted on a local basis. Such comparisons could be made between different processes that aim to achieve the same outcome (e.g. produce the same product). Within one of the case studies developed by the project team, an extensive shrimp farming method (with lower stocking densities and – in the example used – organic feed and restrictions on chemical inputs) is considered. The case study makes reference to an intensive method (with higher stocking densities and – in the example used – higher chemical concentrations). If the product produced (i.e. shrimp) are the same and if both examples are local, then this provides an example of where it may be more straightforward to make comparisons between two different processes.[60]

▸ In making local comparisons between alternative processes, it could be useful to focus on the costs of certain practices and to compare them to the sustainability benefits achieved. While developing one of the case studies, the study team looked into different sources of energy that could be used for desalination technologies. While it seemed that wind-energy provided a feasible option for a particular desalination plant, further focus on the operational costs and (environmental) benefits of other viable energy sources (e.g. conventional fossil fuel or alternative renewable energy) used by a plant in *the same* location would have provided a useful comparison. Alternatively, insight could also be drawn on the operational sustainability of a process by monitoring its performance over time – by, for example, comparing dynamic cost data to local environmental/social data. In this context, the maintenance and depreciation costs of equipment will play an important role in determining the sustainability of innovative technologies (and investments there in). In the process of developing the case studies, new indicators have been added to the BESF to capture these elements.[61]

[60] However, the examples used by the study team for the case study on shrimp used different shrimp species – which can yield different market values. Such details must be taken into account when assessing the sustainability performance of an activity – for example when interpreting the economic indicator on the monetary value of 'production farmed fishes (m EUR/year)'.

[61] Including for example the common indictor 'maintenance costs' in the Environmental dimension. A database providing an overview of the development of indicators is provided in Annex 10.

▸ The process of collecting data for the case studies (i.e. through literature reviews or gathering feedback from experts) has provided additional insight on aspects that might influence the sustainability of a particular activity or sector and which may fall outside of the scope of the indicators applied through the BESF. Specifically, the VCA has helped to identify potential bottlenecks or externalities (both positive and negative) that provide important context to the data collected through the BESF. For example, stages that occur later in the value chain of the case study activity may provide important incentives for sustainable operations (e.g. profitability of the activity may depend on consumer demand on international markets). The VCA approach was thus found to be an important and useful complementary approach to the application of the BESF. Furthermore, the application of the indicators through the case studies has led to a further fine-tuning of the BESF indicator set. A database providing an overview of the development of indicators is provided in Annex 10: *Comprehensive database of blue economy criteria and indicators.*

▸ Some BESF indicators require a certain value to be attributed to a particular activity or sector. It can be challenging to identify exactly how much of an aggregated value (e.g. the total budget of a public fund) is dedicated to a particular activity. On the other hand, in some contexts it can be difficult to determine if the data collected is exhaustive for the activity or sector to which the indicators are being applied. For example, in the economic dimension, while it may be possible to identify various sources of public funds or private investments, it might not be straightforward to ascertain whether these values combined provide the total amounts dedicated to a particular activity or sector. In many cases, this understanding of the completeness of available data relies on the reporting standards at a national level (when considering sectors) or at an entity level (when considering the activities of a company).

▸ It is critical to identify reliable and recent data to support a sound judgement on the sustainability performance of an activity or sector. More commonly, there was a lack of available data for indicators in the social dimension (e.g. *'average wage of employees'* and the *'employment rate of vulnerable groups'*). Overall data gaps (including those in the other dimensions) relate to a lack of standardised data collection methodology at the national or international scale or in developing regions/countries where activities are not well documented or language barriers exist when reviewing literature). The quality of data collection may also depend on the existence of previous research and related studies or reports. This may be difficult where regulation, control and monitoring of (illegal) activities are weak and for which transparency of the activities of the sector is an issue. At the company level, limited national reporting requirements for companies of specific sectors and industries can result in a lack of data. At the project level, information may be scarce if the technology being implemented is at the pilot stage.

The general observations for data collection indicate the issue of retrieving very specific data at the specific or individual level (e.g. local or company specific). During the Lot 2 Peer Review Group Webinar on March 17, 2020, participants confirmed that overly specific indicators can impact the applicability and usability of the framework, furthermore indicating that it can reduce the willingness of stakeholders as data collection becomes too complex. An outcome of this discussion was the development of a set of 20 key criteria and indicators to provide the most essential and required minimum information for conducting a review of the sustainability of a given activity.

PART 6

RECOMMENDATIONS

A set of recommendations has been developed based on the outcomes of the research steps of the study. These recommendations are aimed at economic operators, investors and policymakers at the international level. Furthermore, several sources of expert input have served for the development of these; namely, the Members of the Peer Review Groups, via virtual meetings and individual interviews, input and lessons learned from the process of applying the developed BESF to different case studies, and the review of the BESF by industry stakeholders.

First, based on the lessons learned from the application of the BESF in case studies, recommendations are developed to support the use of the framework. These are relevant to anyone that wishes to apply the framework criteria and therefore target economic operators, investors and policymakers alike.

COMPARISONS BETWEEN DIFFERENT PRACTICES THROUGH THE APPLICATION OF THE BLUE ECONOMY SUSTAINABILITY FRAMEWORK ARE ENHANCED WHEN ACTIVITIES ARE SET IN COMPARABLE ECONOMIC, SOCIAL AND GOVERNANCE CONTEXTS AND AT A SIMILAR SCALE.

The case studies show that it is important **to consider the general and specific context in which an existing or proposed blue economy activity is set.** This is true whether two approaches of the same activity are looked at in the same area or country, or activities are compared in different regions of the world. Applying the BESF to activities within the same area or country is more straightforward, as the overall context (primarily legal, but also social, environmental, political, etc.) will to a large extent be the same. The relative homogeneity of European countries facilitates comparability of activities when applying the BESF. The context, however, is likely to differ if similar activities are considered across different regions or countries of the world. When the general and specific environment of two or more activities are not the same, it becomes very difficult to make quantifiable comparisons between them.

Next to the limitations related to comparing activities set within the realities of different regions and countries, **the scale at which an activity is carried out is an important factor.** This can relate to **geographic scope**, i.e. national, regional, local or company-level. It also applies to **the industry**, namely, looking at the industry as a whole, a specific activity within it, or location within which an activity of that industry is set. Outcomes of the BESF are difficult to compare if one considers activities at different scales. This issue can be addressed in either of two approaches: **1)** efforts made to obtain information from activities of comparable scale (e.g. compare at similar company level) or **2)** adapt the indicators to a common comparable format (by measuring the indicator per unit of output – e.g. *emissions per ton of* CO_2).

The BESF is applicable to a specific geographic context and activity scale and frame. This needs to be credited for each activity that is being analyzed. Therefore, in cases where the framework is applied to make comparisons (e.g. between different projects), it is recommended to identify activities **that are set within similar political, economic, social and governance contexts, and implemented at similar scale, to increase the comparability of their sustainability aspects.**

THE COLLECTION AND AVAILABILITY OF DATA SHOULD BE IMPROVED TO FOSTER THE APPLICABILITY OF THE BLUE ECONOMY SUSTAINABILITY FRAMEWORK.

One of the main findings of the case studies is the large variation in the existence and quality of available data across the activities and countries/regions examined. Many data were either not publicly available or not collected at all. When information is available, it can also be outdated or provided in a form which is not usable or comparable (e.g. aggregated to a higher level, or combined with information for other activities, for example, employment data may be found for a sector, but not the subsector which is the focus of the activity under examination). Measurement

units may not be the same and some adaptation may be needed if comparisons are to be made. If possible, and depending on the nature of the activity examined, alternative indicators may be considered. This would be for the analyst to decide on a case by case basis. Lack of data and their quality challenges are known in many fields. The general recommendation one encounters is to increase the collection and availability of primary data.

In addition to the BESF criteria and indicators, **a value-chain analysis** was applied to the case studies. The value-chain analysis **provides a horizontal qualitative narrative of generic sustainability aspects** in all the segments of the value chain of a blue economy sector and its activities. The research team found that this horizontal and generic approach is complementary to the in-depth, quantitative approach of the BESF. The value-chain analysis provides important and relevant insights into different sustainability opportunities and shortcomings, which can complement the quantitative approach that the BESF offers.

We echo the general recommendation to **increase the collection of primary data**, though understand its limitations and the need for a more practical approach. The **value-chain analysis** applied to the case studies **enables the identification and collection of further contextual/qualitative information, and complements the data identified through the BESF.** This complementary approach allows the analyst to reach the best possible conclusion.

THE IDENTIFICATION OF KEY SUSTAINABILITY ASPECTS SHOULD BE BASED ON LOCAL CHALLENGES AND NEEDS.

The case studies indicate a strong focus on environmental sustainability – a possible result of the prominence of frameworks focusing on environmental sustainability in the recent years. Such trade-offs between sustainability dimensions appear rather common, though it may also result from lacking appreciation of sustainability requirements in general. An activity may appear less economically sustainable when, for example, public support is needed. However, public funding can play a strategic role for the development of sustainable blue economy activities and may be essential in the outset stages or piloting phases of innovative activities.

A blue economy activity is unlikely to support all four sustainability aspects equally. Rather, **the specific context within which an activity is implemented or shall be implemented needs detailed consideration.** Whilst a push for activities that provide sustainability improvements in all aspects is recommended, it can be argued that the focus remains on the sustainability aspects where improvements are urgently needed. Thus, **when considering the sustainability aspects of an existing or proposed activity, it is recommended to frame it against the range and magnitude of the sustainability challenges it will address.**

THE BLUE ECONOMY SUSTAINABILITY FRAMEWORK NEEDS TO BE DYNAMIC AND SHOULD BE PERIODICALLY UPDATED TO MAINTAIN THE RELEVANCE OF ITS SUSTAINABILITY CRITERIA AND INDICATORS.

The BESF is a comprehensive framework which provides a broad understanding of issues in sustainability in maritime environments. Sustainability evaluations are part of a dynamic learning process to attain sustainable systems (Sala et al., 2012)[62]. The BESF is in fact rooted in the contemporary understanding of what is

[62] Sala, S., Farioli, F., & Zamagni, A. (2012). Progress in sustainability science: Lessons learnt from current methodologies for sustainability assessment: Part 1. The International Journal of Life Cycle Assessment, 18(9), 1653-1672. doi:10.1007/s11367-012-0508-6Found at: https://link.springer.com/article/10.1007/s11367-012-0508-6

and is not sustainable. It follows that some of the criteria and indicators in the framework that are currently deemed as an appropriate unit to measure sustainability may cease to be later on. 'Energy consumption', for instance, is currently a relevant indicator of unsustainability when energy predominantly originates from fossil sources (coal, oil, etc.). If the approach of 'green' infrastructure[63] is further promoted and standardised, reducing overall energy consumption and promoting an increase in the use of renewable energy sources, the indicator may lose relevance compared to its counterpart on 'renewable energy consumption'. Lastly, some indicators may be relevant to assess sustainability, but do not have a suitable unit that is commonly accepted (e.g. underwater noise or marine litter). As such, the BESF is based on a temporary landscape of major sustainability themes (e.g. energy, income inequality, land-use, etc.) and can provide a snapshot of the current sustainability discourse.

This framework should therefore not be used in a static manner but rather **needs to adapt to developments in the notions of sustainability and its criteria and indicators.**

THE BLUE ECONOMY SUSTAINABILITY FRAMEWORK SHOULD BE APPLIED OVER TIME TO UNDERSTAND THE DIRECTION AND MAGNITUDE OF CHANGE.

Integrated within indicators themselves is a set of scoring methods, such as multiple choice (1 to 3), closed questions (yes/no) or quantitative totals (m EUR/year; percentages). While these providesome insight into sustainability criteria, it is unclear what the effect of a different outcome would mean (e.g. on the impact on the environment). If used sporadically, it provides little insight into the benefits or costs that marginal changes may bring. It is therefore essential to use **the BESF in a systematic manner, to be able to measure the incremental changes being achieved through time** – it is only through this way that the use of the proposed framework will enable an intelligible understanding of the magnitude and direction of change towards a sustainable blue economy. In this respect, **interested parties may consider the periodical uptake of a weighting system, relevant to their specific sector and/or subsector, to increase the precision in their sustainability revisions through time.**

A TAILORED MONITORING SYSTEM SHOULD BE APPLIED TO MEASURE THE (UN)SUSTAINABILITY OF BLUE ECONOMY ACTIVITIES.

Monitoring systems require accuracy and credibility and need to be balanced and objective, clear and accessible, comparable and consistent, and complete and timely. In the conclusions of the case studies, some lessons learned for the application of the BESF provide suggestions to ensure such preconditions for a monitoring system. Findings on the performance of blue economy activities, technological and innovation developments and needs, as well as actual or potential impacts, in terms of socio-economic, ecosystem and biodiversity health, climate change adaptation/ mitigation effects, can then be collected and shared. The criteria, metrics and indicators of the BESF can provide a framework for the development of monitoring systems for blue economy activities. To allow for a consistent global monitoring of a sector's performance, **the capacity for the adoption of sustainable blue economy indicators needs to be developed.** To assess the different areas of performance of the blue economy and related activities, a longlist of sustainability criteria and resulting **key performance indicators** should be shared amongst key players at a global scale. Risk categorisation needs to be agreed upon based

[63] For example, EC Green Infrastructure in the Energy Sector: https://ec.europa.eu/environment/nature/ecosystems/pdf/Green%20Infrastructure/GI_energy.pdf

on a framework at the international level. To do so, it **is essential to foster synergies between the various tools and systems** currently in place and under discussion in the area of sustainable development monitoring (taxonomies, etc.).

The EU taxonomy for sustainable activities, first published in 2019, provides indicators to assess the level of harm done to the environment by certain economic activities.[64] At the current stage of development, the taxonomy does not specifically target the blue economy (although sectors such as production of electricity through wind power, ocean energy and hydropower are included). The BESF can provide **an evidence-based approach to support the further development of the taxonomy** regarding blue economy sectors, but synergies should be strengthened.

6.2 Recommendations to facilitate the uptake of sustainability criteria and to promote a sustainable blue economy investment framework

Based on the lessons learned from the application of the BESF, a set of recommendations have been developed that shall support the utilisation of the framework to support the shift towards sustainable blue economy investments. These are mainly targeted at policymakers and investors.

THE INDICATORS PROVIDE A BASIS FOR MORE RIGOROUS EVIDENCE TO UNDERPIN POLICY AND INVESTMENT DECISIONS.

The Blue Economy Sustainability Framework can support and inform policy levers and actions to secure and promote sustainable investment in the blue economy, and to give investors a sense of their overall longer-term potential financial returns (combined to the assessment of ecosystem value put at risk)[65]

A common tool applied in politics and environmental management is the **application of '(environmental) cost benefit analysis' (CBA)**. CBAs allow for an improved understanding of impacts, by evaluating and comparing status quo and intervening options, often by monetizing environmental impacts. More recently, the concept of "value at risk"[66] has been developed to imply and assess the financial consequences for investors of unsustainable practices being supported – this aspect is further discussed in the parallel study on "Unsustainable Finance in the Blue Economy: Where Does the Money Come From?" (Ecorys 2020). Combining the approach of CBA and the value at risk assessment to the proposed framework could make the BESF a valuable tool for assessing financial sustainability (across all dimensions).

However, the proposed sustainability criteria enable one to appreciate the impact of financing a particular activity across the various dimensions (be it economic, social, environmental or governance). **Specific screening and proofing standards and requirements can be determined,** and a risk categorisation process provided, by which financing projects are categorised based on their potential negative impact. **A common sustainability scoreboard for a blue economy investment,** building on the indicators defined in the BESF, could provide an overview of potential investors' social and environmental performance, highlighting strengths and weaknesses of an investment project.

[Eu]ropean Commission (2020). EU taxonomy for sustainable activities. Retrieved from https://ec.europa.eu/info/publications/sustainable-finance-teg-taxonomy_en on 01-07-2020.

[65] WWF, Metabolic, Value at Risk in the Blue Economy – Piloting a Systems Modeling Approach to Explore Sustainability Pressures and Financial Risk, 2019, https://d2ouvy59p0dg6k.cloudfront.net/downloads/metabolic_wwf_value_at_risk_in_the_blue_economy_29112019_lr.pdf. .

[66] Ibid.

A systematic scoreboard, to be financially meaningful, should be based on a number of dimensions and trade-offs:

X. A first dimension is that of the **economic, environmental, social and governance impacts of investments** (basically building and expanding on the ESG approach currently adopted by various financing actors, but transformed into ESG – hence including economic returns as well as the other more 'standard' ESG criteria).

Y. A second relevant dimension to be considered, as previously discussed, is that of the actual **timeframe considered for the investment and the meaningful impacts expected** (positive or negative) – hence the extent to which relevant longer-terms benefits are expected (e.g. future generations vs current ones).

Z. Last, but certainly not least, the transformation that investments are expected to have on local (sustainable) value chains and economic ecosystems should be assessed – hence the local capacity generated to sustain further local streams of revenues, etc. beyond the initial investments.

Assessment of possible trade-offs in the level of sustainability can emerge within and across the three dimensions identified and depending on the level of sophistication and overall ambition of investors and local actors (including policymakers) in scrutinising the practices. The sophistication of the assessment provided may also depend on the level of experience with (and feasibility of) such a tool/process – e.g. based on the level of data available at the business and economic value-chain level, the level of engagement and transparency of investors and financing bodies involved, as well as the magnitude and strategic level of the investments or financing practices considered.

Importantly, the **indicators proposed for the BESF are currently addressing all of the four "dimensions"**, as they are clearly targeting the Environmental / Economic / Governance / Social - E2SG **(X)** aspects, but can easily include different timeframe horizons **(Y)** and are already incorporating elements of capacity and local "transformational" potentials **(Z)** – including local skills, local business creation, level of returns reinvested in local activities, etc. As indicated, indicators and metrics can be expanded through time and based on the confidence and expertise of the parties involved.

THE COLLECTION OF INFORMATION SHOULD BE STANDARDISED AND MORE SYSTEMATICALLY IMPLEMENTED BY PUBLIC AND PRIVATE FUNDING INSTITUTIONS.

Building on the outcome of the case studies, indicating large variations in the existence and quality of available data, **public or private funding institutions interested in examining the sustainability aspects of blue economy activities have the potential to gradually build the necessary level of knowledge and expertise.** Such framework of indicators is **essential to assess very different – but equally relevant – practices:** local/regional blue economy development (Authorities, etc.); specific policies and expected impacts/results (Ministries, etc.); projects portfolios for large financing operations (e.g. Development Banks); and individual investments for private investors (e.g. Financing Sector, Investment Approval Authorities); etc. It can also **potentially serve different types of assessments for the investment/financing practices:** ex-ante, monitoring, and ex-post. Again, greater **synergies should be fostered with other similar practices and tools** that exist at the international level.

Indeed, a funding/financing institution could

request the necessary information related to the BESF criteria from the potential beneficiaries, which could then be updated at a later stage. A request to **provide follow-up information could be included in the funding agreements.** Such requests to the beneficiaries could help to collect pertinent data on a specific activity over time. The special knowledge of the institution is thus increased, enabling it to make future funding decisions based on an extensive database. An additional impact is that, as the use of the BESF criteria and indicators becomes more widespread, more companies/associations will begin to collect/report these data. Further analysis and recommendations in this respect can be found in the parallel study on **"Unsustainable Finance in the Blue Economy: Where Does the Money Come From?" (Ecorys 2020)**[67].

[67] This study is available from the EU Publications Office: https://op.europa.eu

BLUE ECONOMY

SUSTAINABILITY CRITERIA FOR THE BLUE ECONOMY - FINAL REPORT

CLIENT: EUROPEAN CLIMATE, INFRASTRUCTURE AND NETWORKS EXECUTIVE AGENCY (CINEA)

PROJECT CONTRACTORS

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