



Sustainable Sea and Ocean Solutions

Intelligent Technologies for the Blue Economy

White Paper

Editorial Notes

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Executive Summary

Oceans, coastal areas and marine activities play a crucial role now and in the future of the European Union and its citizens [9]. But more than ever, the oceans are under increasing pressure due to overfishing and pollution. Consequently, sustainable development of the oceans is required in order to ensure their health and productiveness.

For that, we – Fraunhofer, SINTEF, VTT, RISE, TNO, Tecalia, +Atlantic CoLAB, AZTI, ENEA and Ifremer – propose in this white paper the Innovation Platform »Sustainable Sea and Ocean Solutions ISSS - Intelligent technologies for the Blue Economy«. Our mission is the responsible utilization of our oceans to harness their potential and to create more value and more jobs in the European Blue Economy. The Innovation Platform »Sustainable Sea and Ocean Solutions ISSS« aims at key enabling technologies for in-depth technological innovations for subsea and marine activities and shared infrastructures through cross-cutting collaboration to ensure healthy and productive oceans. It will focus on European subsea and maritime research activities and cross-link relevant national and European initiatives and stakeholders from research, industry, society and policy to form an integrated whole.

In Chapter 1 we address the need for an Innovation Platform »Sustainable Sea and Ocean Solutions ISSS« in order to push the European Green Deal and the Blue Growth Strategy forward and contribute to the European strategy for data and the European biodiversity strategy, as well as, specifically, to a Horizon Europe mission on healthy oceans, seas, coastal and inland waters. Our objectives are to develop and master digital and key enabling technologies for subsea and maritime applications to provide EU industries the competitive edge they need to become leaders in the global Blue Economy while protecting the ecosystem of our oceans to achieve Sustainable Development Goal (SDG) 14 [17].

Chapter 2 describes our concept for the Innovation Platform »Sustainable Sea and Ocean Solutions ISSS« to master the European green-blue transition: based on joint research activities, we will focus on developing new technologies, such as sensors for autonomous operations and communications, as well as materials for new applications under extreme environmental conditions. We will interlink existing research infrastructures and establish new ones offshore and onshore and launch joint data platforms for interdisciplinary research in Europe to gather, process and provide reliable real-time ocean data. Our aim is the fast transfer of new technologies and innovations into industrial applications within the three central application areas: Aquaculture (marine living resources and blue biotechnology), Ocean Cleaning (cleaning the oceans of plastic waste, microplastics and unexploded ordnance) and Energy and Raw Materials Harvesting (non-living resources, offshore wind and ocean energy).

In Chapter 3 we give an overview of our action plan to establish the Innovation Platform »Sustainable Sea and Ocean Solutions ISSS«. The identified requirements for successful implementation include coordinated investments, enabling policies, broad support for research and development (R&D), and industry, investor and citizen engagement.

Even in the uncertain times of 2020, the momentum for innovation, change and sustainable growth need not be lost [12]. The economic recovery from the COVID-19 pandemic should support growth and employment in the green-blue ocean economy. The key enabler of a sustainable Blue Economy is applied R&D – to boost new digital and biodiversity-friendly technologies and innovation and to capture better data.



1 Pushing the European Green Deal and the Blue Growth Strategy:

In Need for »Sustainable Sea and Ocean Solutions ISSS«

The oceans cover 71% of the planet's surface, and more than 95% of the underwater world remains unexplored. Biologically diverse and highly productive, the oceans provide humanity with considerable economic and ecological resources. As an immense source of materials, energy and ecosystem services, the oceans secure the future supply of resources as well as food and feed while holding great potential for economic growth, employment and innovation. However, the extent of human activities challenges the resilience of the marine and coastal resource base [1] – more than ever, the oceans are under increasing pressure due to overfishing and pollution. Consequently, sustainable development of the oceans is required in order to ensure their health and productivity. Moreover, the oceans play a crucial role in climate change, on the one hand being a victim of the climate crisis, while on the other providing solutions to mitigate climate change by reducing carbon pollution [2]. The oceans are therefore not only the key to achieving climate and societal goals, but also a prerequisite for sustainable development to maintain the right balance between growth and the ocean economy, as well as between health and productivity.

1.1 Goals

The European Green Deal is the flagship agenda to drive Europe's ecological transition to become the world's first climate-neutral continent by 2050. It acknowledges the important role of seas and oceans: "lasting solutions to climate change require greater attention to nature-based solutions, including healthy and resilient seas and oceans" [3]. Seas and oceans are drivers for the European economy and have great potential for technological innovation and sustainable growth [4]. Especially the blue aspects of the Green Deal propose specific actions and targets, such as boosting aquaculture and offshore renewable energy, as well as sustainable seafood production as part of the so-called Farm to Fork strategy. The Green Deal is therefore a relentless push for Europe's long-term Blue Growth strategy, which supports sustainable growth in the marine and maritime sectors as a whole – the Blue Economy.

According to the European Commission, the Blue Economy provides roughly 5.4 million jobs and generates a gross added value of almost 500 billion euros per year [4].

Further growth is possible in a variety of established sectors as well as in emerging markets of the Blue Economy. The Blue Economy demands considerable innovative, resource- and cost-efficient, robust and reliable technologies as well as advanced materials. Scientific and technological advances are expected to play a crucial role both in addressing several ocean-related environmental challenges and developing Blue Economy activities. In-depth innovations in advanced materials, subsea engineering and technology, sensors and imaging, satellite technologies, digitalization and big data analytics, autonomous systems, biotechnology and nanotechnology are driving development forward – every sector is affected by these technological advances [5]. Today the output of the global ocean economy is estimated at 1.3 trillion euros, and this could more than double by 2030 [6].



Accordingly, several European governments have extended their strategic activities toward marine research and utilization, and various European companies are also becoming increasingly active in this field, as innovation is crucial to maintain Europe's competitive advantage and power in this high-risk market. Looking toward 2030, the OECD predicts that many ocean-based industries have the potential to outperform the global economy as a whole, both in terms of value added and employment.

However, in addition to the existing activities, closer cooperation between European member states, industry and applied research is necessary to respond to the challenges of the Blue Economy effectively and to harness the high potential of value added and employment. Europe must therefore focus on its subsea and blue growth activities and further cross-link relevant national and European initiatives. Increased communication and collaboration between scientists, policy makers, business-people and society at large is of utmost importance.

1.2 Mission

Fraunhofer – together with its partners SINTEF, VTT, RISE, TNO, Tecnalia, +Atlantic CoLAB, AZTI, ENEA and Ifremer – proposes the Innovation Platform »Sustainable Sea and Ocean Solutions ISSS« in order to boost the Green Deal and the Blue Growth in emerging, established and associated Blue Economy sectors. The mission is the responsible utilization of our oceans to harness their potential and create more value and more jobs in the European marine and maritime sectors, within the Blue Economy, by developing and mastering new technologies to ensure European industry leadership in global markets and achieve UN Sustainable Development Goal (SDG) 14 [17].

The Innovation Platform »Sustainable Sea and Ocean Solutions ISSS« is therefore aimed at key enabling technologies for in-depth technological innovations and solutions for subsea and ocean activities, as well as at shared infrastructures and data platforms through cross-cutting collaboration to ensure healthy

and resilient oceans. It will focus on European subsea activities and cross-link relevant national and European initiatives to form an integrated whole to foster technological innovations and applications in the field of e.g. underwater robotics and automation, underwater sensors and actuators, underwater materials, communication and digitalization. This will ensure safe, cost-effective and sustainable offshore operations and provide reliable and accurate data and information on the ocean for better-informed decision-making by policy makers, businesses and investors.

The objectives are to accelerate the development of new technologies and materials as well as their application and fast implementation in industrial processes and adaptation within the Blue Economy sectors. By investing in infrastructure and intelligently networking existing structures, a research and innovation platform for subsea technologies will be the world's most efficient innovation provider for applied R&D. To this end, the Innovation Platform »Sustainable Sea and Ocean Solutions ISSS« addresses entire value chains of the Blue Economy: from building subsea infrastructures to establishing their logistics chains. As a joint European endeavor, the Innovation Platform is aimed at minimizing risks for all partners involved, specifically when addressing complex and high-investment research topics such as automated subsea operation technologies and autonomous platforms that are resource- and cost-efficient and robust. Addressing the relevant technological topics – subsea robotics, subsea communication and navigation, subsea actuators and sensors, subsea manufacturing processes and materials, and artificial intelligence (AI) for optimized process and systems management along the marine value chain – requires a high degree of interdisciplinary, applied R&D in the high-tech fields information technology, electronics, machine engineering, materials and logistics.

1.3 Vision

In 2030, the world population is projected to reach 8.6 billion, compared with its current 7.6 billion. By 2050, the global population will reach approx. 9.8 billion people [7], demanding significant amounts of food and medical supplies, and billions of tons of resources. Climate change and environmental pollution leave humanity coping with its greatest challenge in history – but Europe is prepared:

Healthy and productive oceans with a sustainable and circular European green-blue economy: this vision of Europe in 2030 fueled the motivation to establish an Innovation Platform »Sustainable Subsea Solutions« because it strongly supports the following European strategic goals:

- **Competitiveness:** Since future food and resource supply are known global issues, the competition for marine resources is on, and it is expected to dramatically increase in the near future. This competition can only be won by the player with the most innovative and highly sustainable subsea technologies. Today, Europe's subsea industry is global, but in the race for international leadership in subsea technologies, with the USA in the west and China in the east, Europe risks losing its leadership in subsea technologies.
- **Leadership:** The unique selling point is sustainability, which will enable the EU to take the global leadership in innovative technologies, services and skills for the sustainable use of our oceans – in contrast to the more rigorous and environmentally harmful methods of our global neighbors.
- **Protection:** Tapping the marine resource potential in a sustainable manner is crucial to guarantee the future resource and food sovereignty of the EU.
- **Sovereignty:** Securing the EU's competitiveness, protection and leadership requires supporting infrastructures and highly innovative technologies that are suitable for the tough subsea environment. Such technologies – mostly key technologies in the fields of robotics, sensors and actuators, communications, electronics and materials, as well as data analytics and artificial intelligence – will be researched and developed, providing the EU with a high degree of technological independence.

The Innovation Platform »Sustainable Sea and Ocean Solutions ISSS« thus strongly supports the European Green Deal Vision 2030. As a global leader in subsea technologies, Europe provides innovative solutions to the world's marine and subsea industry, enabling global and sustainable utilization of our oceans while supporting the agenda of the UN Decade for Ocean Sciences (2021–2030).

Europe in 2050: A climate-neutral continent through a completely green-blue transformed economy and society. During the last thirty years, since 2020, the European countries joined forces to approach the utilization of the global oceans – not only by tapping resources sustainably, but also by tackling marine litter and overacidification. Europe invested significantly in infrastructure and R&D, as well as in education and training, yielding highly innovative and sustainable subsea technologies and strongly supporting cross-border collaboration between research institutions and subsea industries, flanked by regulations to facilitate a single subsea market. Consequently, Europe's marine and subsea business environment – which is fair, competitive and agile – is a healthy network of various strategic value chains.

Europe currently operates a high-tech network of interconnected marine and subsea multipurpose platforms along its coastline, facilitating flexible adaptation to the demands of European society. Aquaculture and offshore energy harvesting are performing at historically high levels, and synergies exploited in technological developments in the subsea sector caused spillover effects in other application fields. Marine litter has been significantly reduced, which not only improves the ecological state, but also supports maritime tourism. The established sustainable green-blue circular economy strongly contributes to saving the ocean ecosystem and mitigating the effects of climate change.



2 Mastering the green-blue Transition: A Concept for »Sustainable Sea and Ocean Solutions ISSS«

The European Green Deal is a response to climate-related and environmental challenges. It is a new growth strategy that aims to transform the EU into a fair and prosperous society with a modern, resource-efficient and competitive economy with zero net emissions of greenhouse gases in 2050 and with economic growth being decoupled from resource use. A sustainable Blue Economy, as part of the Green Deal, will play a central role in alleviating the multiple demands on the EU's land resources and their supply risks, and in tackling climate change. [3]

Overall, the Blue Economy offers enormous potential for sustainable growth in Europe. According to the European Commission and its report on the Blue Economy [8], the established sectors of the EU Blue Economy – maritime living resources, maritime extraction of non-living resources, maritime transport, port activities, shipbuilding and repair, and coastal tourism – directly employed over 4 million people and generated 658 billion euros of turnover and 180 billion euros of gross value added in 2017. In 2018, the contribution of the established Blue Economy sectors to the EU-28 economy was 1.5% in terms of gross value added and 2.2% in terms of employment [9].

The Blue Economy's emerging and innovative sectors, i.e., offshore wind, ocean energy (wave and tidal), offshore aquaculture, and blue bioeconomy and biotechnology, as well as marine minerals, desalination and defense, offer significant potential for growth and jobs, especially in renewable energies – with exponential growth in recent years. The Blue Economy is interconnected with many other activities and its impact goes beyond the sectors mentioned above. The increased added value for Europe's Blue Economy is generated by collaborative research into advanced maritime technologies to enable operations in extreme environments (deep-sea, seabed, saltwater). Being

robust, intelligently networked and life-cycle-cost-optimized, these technologies can facilitate economies at scale.

Numerous national and European research initiatives are already in place in several maritime sectors to tap the potential of the Blue Economy and master the challenges to ensuring healthy and resilient oceans. However, such initiatives are often poorly coordinated and are rarely interlinked with industry activities – the technology transfer into industrial applications has been insufficiently promoted so far. Therefore, coordinated action is required, as most research and innovation efforts in these fields cannot be tackled at the national level.

The Innovation Platform »Sustainable Sea and Ocean Solutions ISSS« will create a critical mass and facilitate precompetitive break-throughs through efficient coordination and collaboration between research, industry, policy and society. Innovation and industry alliances across borders will strengthen Europe's economic position and maintain its competitive edge, for example by connecting and developing infrastructures. The overall concept for the Innovation Platform »Sustainable Sea and Ocean Solutions ISSS« is shown in Figure 1.

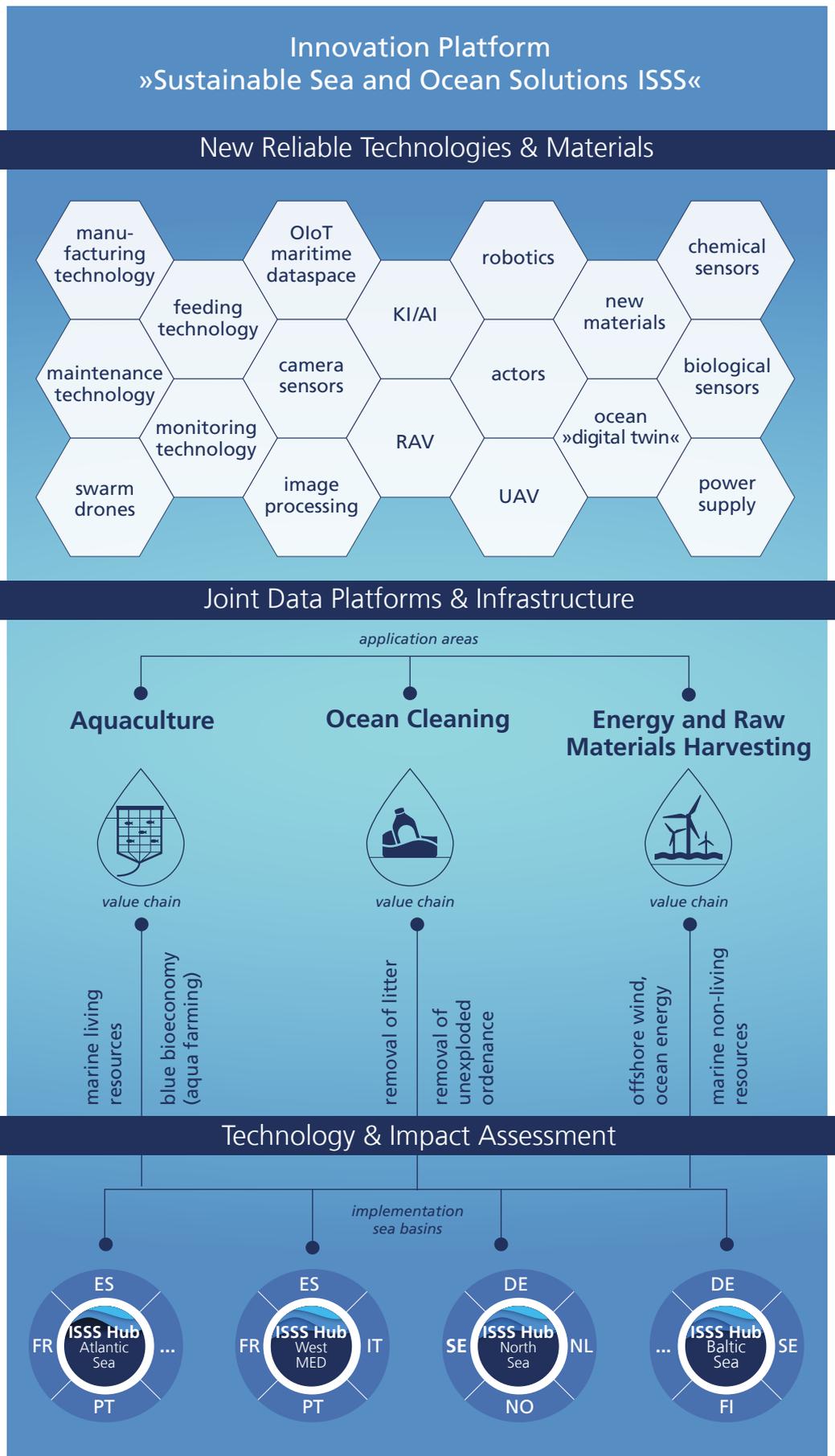


Figure 1: Concept for the Innovation Platform »Sustainable Sea and Ocean Solutions ISSS«

2.1 Technologies

In collaboration with the relevant stakeholders in research, industry and policy, the joint research activities of the Innovation Platform »Sustainable Sea and Ocean Solutions ISSS« will focus on the development and qualification of new technologies for autonomous operations, such as communication, navigation and information technologies and material and production technologies for extreme environments, including cross-cutting digitalization techniques. Such technologies include, for example:

- subsea robotics and vehicles
- subsea communications
- subsea sensors and actuators
- subsea-robust materials and systems
- subsea logistics
- subsea signal processing and data analysis

All these technologies should be able to efficiently and effectively build up marine and subsea structures, operate and maintain them as efficiently as possible, and eventually decommission them sustainably and automatically.

Collaborative research and partnerships across sectors create scale economies and require a long-term approach to cross-sectoral technological cooperation in R&D to implement robust, reliable and sustainable technologies. The Innovation Platform will interlink existing research infrastructures and establish new ones offshore and onshore, as well as establish joint data platforms across Europe for interdisciplinary research to reduce the risk of costly, unplanned and unnecessarily complex rulings being issued to responsible business operations. Each activity within the application areas will be accompanied by a technology assessment to evaluate its impact on the environment, society and the economy in its regional sea basin implementation area.

With a strong emphasis on digitalization, innovation activities will focus on the development of:

- new sensors for monitoring physical, chemical and biological parameters
- robust and reliable power supply for subsea technologies
- autonomous systems for inspection, intervention, monitoring and control, maintenance and decommissioning
- technologies for navigation and communication
- command and control methodologies for subsea navigation, communication, mission adaptation and cooperation
- technologies for removal of marine pollution and detection and removal of unexploded ordnance
- technologies for detection and prevention of CO₂ and hydrocarbon releases from sediments, e.g. in marine research, and for monitoring technical underwater installations
- new materials for extreme environmental conditions

It will also focus on creating and developing the following research infrastructures (for research and industry):

- European network of research and testing facilities
- European network of multipurpose platforms (e.g. energy harvesting and aquaculture)
- Maritime Data Space and Ocean Internet of Things
- European Network for Modular Underwater Robotics
- satellite network for affordable broadband communication
- offshore European power grid
- marine observatory for environmental aspects, including Copernicus and Ocean Research Infrastructures
- innovative port infrastructure
- research vessels for rapid response missions
- civil subsea monitoring network
- education and training network for subsea technologies

The aim is fast transfer into industrial applications within the following three central application areas and its implementation areas of Europe's sea basins.



2.2 Applications

Achieving the sustainable utilization of our oceans requires innovative technologies as described in Section 2.1. The following paragraphs describe the application areas for these innovative technologies.

- Aquaculture

This application area Aquaculture comprises all value chains related to the extraction of marine living resources, such as sustainable fisheries or seaweed harvesting, with the goal of expanding blue biotechnology.

Food supply will have to increase 60% by 2050 to meet the demands of a projected population of 9 billion [5]. Sustainable food and feed production is key to meeting the Green Deal goals within the Farm-to-Fork strategy. Therefore, new technologies and strategies for food/feed production systems are required in order to respond to pressures on food webs resulting from climate change, physical degradation, competing uses and fisheries-induced evolution.

The blue bioeconomy therefore has great potential for growth. The market potential for aquaculture is enormous. It was valued at 169 billion US dollars in 2015 and, with an anticipated growth rate of 5.3%, is set to reach 242 billion US dollars by 2022. Technologies for the circular aquaculture economy include solutions for cage maintenance, e.g. cleaning and repairing, aquaculture monitoring and data analytics to improve cultivation efficiency and effectivity.

New blue biotechnologies may provide a more sustainable way to produce food, feed, nutraceuticals, cosmeceuticals, biomedical, biopolymers and enzymes by using renewable genetic marine resources. This will also entail an increasing need for tools and knowledge to sustainably develop marine-based products with industrial applications.

- Energy and Raw Materials Harvesting

This application area Energy and Raw Materials Harvesting comprises all value chains related to renewable energy, such as offshore wind and ocean energy, as well as the extraction of marine non-living resources.

The ocean will play a key role in the transition to a sustainable global energy system, while the established extraction of minerals, oil and gas is mostly in decline due to decreasing production and increasing costs; projections suggest significant growth by 2050 [5]. The raw materials policy, reinforced in the context of the EU Industrial Policy Strategy, positions critical raw materials (with high supply risk, high economic importance and lack of substitutes) as key elements for the industrial value chains [5]. Marine minerals could be a future supply source when extracted with environmentally friendly practices.

EU offshore wind energy had grown to a capacity of 18.5 GW by the end of 2018 [8]. Europe's offshore wind industry continues to lead the sector, driven by a strong home market, and European offshore wind accounts for 91% of worldwide deployed capacity [10]. Studies providing detailed scenario trajectories for offshore wind show moderate growth towards an installed capacity below 40 GW in 2050. More ambitious scenarios foresee for offshore wind an installed capacity ranging from about 70 GW to 240 GW in 2050 [10]. But additional space for offshore wind farms in European waters is needed. The European Commission's Long-Term Strategy assumes 400 to 450 GW of offshore wind capacity by 2050 in connection with their net-zero decarbonization scenarios [11]. Wave and tidal-stream energy generation have also risen over the past decade. The main challenge here, however, remains the further reduction of technology costs so these sources can compete with other renewable-energy technologies [12]. Nevertheless, offshore energy has high potential for integration with other industries, such as green hydrogen applications.



A green-blue transition is possible and essential«

- Ocean Cleaning

This application area Ocean Cleaning comprises all value chains related to the removal of marine litter, such as plastic waste (micro- and macroplastics) and removal of unexploded ordnance.

Cleaning the oceans of plastic waste is crucial to strengthening the coastal and environmental protection sectors. There are between around 100 and 142 million tons of waste in the oceans [13]. In addition, an estimated 8 million tons of plastic waste and 1.5 million tons of microplastics enter the oceans every year [14]. According to the United Nations Environment Programme (UNEP), an average of 13,000 plastic waste particles now float on every square kilometer of sea surface.

A further very important aspect for healthy and secure oceans and coastlines is the removal of unexploded ordnance. Approximately 1 million tons of bombs, 1.6 million tons of conventional warfare agents and 0.25 million tons of chemical warfare agents pollute the North and the Baltic Sea alone [18], and they increasingly represent a danger in the sea and on the coastlines.

Although the market for plastic recycling has an annual growth rate of 6.5% and is expected to reach revenues of 37 billion US dollars in 2024, the economics of marine litter focus mainly on reducing costs. In aquaculture, for example, marine litter results in revenue losses of more than 100 million US dollars per year due to reductions in fish catch or contamination, cage clearance, fouled propellers and intakes, etc. Marine litter also negatively affects tourism, yielding an annual loss of 25 million US dollars. Health-related issues are not accounted for at all. The cost of cleaning up the global coastlines (34 million km) is estimated to be as high as 50 billion euros per year – no estimates exist for the cost of cleaning up the oceans. In addition, the degradation products of plastic in the water accelerate and promote acidification over the long term.

Gases such as methane and ethylene are known as “climate killers” and are also released during further degradation, especially of LDPE – the smaller the plastic particles, the higher their reactivity. Future scenarios therefore assess microplastics as a borderline ecological hazard, and not preventing it will have far-reaching ecological consequences.

Within these three application areas, the added value for established and emerging Blue Economy sectors will be investigated. The aim is to increase their economic potential by networking the sectors and sharing infrastructures to develop robust and reliable technologies for common application problems. The application areas are linked to the implementation areas via the value chains by researching and applying the technologies and infrastructures within the sea basins of the four planned »Sustainable Sea and Ocean Solutions ISSS« Hubs, as shown in Figure 1. The activities and strategies for the application areas of the Hubs will be carried out in accordance with the respective regional sea basin strategies laid out in the integrated maritime policy of the European Commission [15], as each sea region is unique and merits a tailor-made strategy.

The Innovation Platform »Sustainable Sea and Ocean Solutions ISSS« facilitates Europe’s technological independence particularly in subsea technologies, but also in all related cross-cutting technologies. Coastal regions are ideal for marine technologies and often represent, in an economic sense, less developed regions of EU countries. The placement and development of specific subsea technologies and competencies in these regions will reduce economic inequality in and among EU member states, thus stabilizing societies and helping to reduce dependence on such industries as fishery and tourism.

The ocean cleaning application area in particular has an enormous social dimension, as it tackles a key issue of humanity: marine litter, such as plastic litter and unexploded ordnance, strongly affects our ecosystem and threatens our health and society’s safety and security.



3 Boosting sustainable growth, employment and healthy oceans:

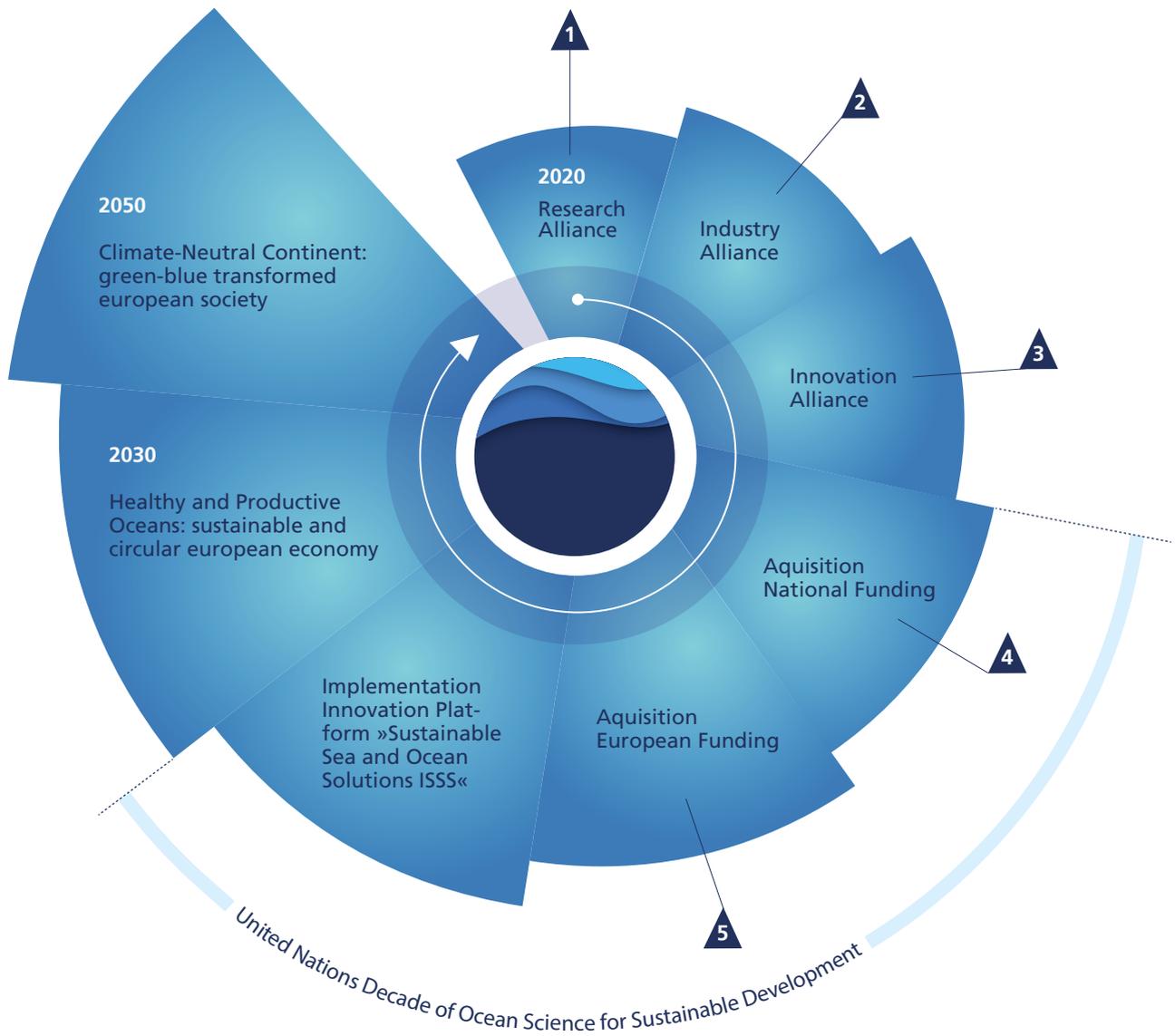
An Action Plan for »Sustainable Sea and Ocean Solutions ISSS«

“Action is required in 2020, the crucial year for our oceans, with deadlines on biodiversity protection, sustainable fisheries and achievement of Good Environmental Status in all European seas.” [6] According to an assessment of the World Wide Fund for Nature (WWF), the EU is failing to progress on Sustainable Development Goal 14 “Life Below Water” of the United Nations’ 2030 Agenda. Specifically, three of the four SDG14 targets due in 2020 will be missed, with the fourth target being only partly achieved. The ten SDG14 targets collectively aim to secure ocean resilience through robust protection of its diverse ecosystems by 2030 [16]. Accordingly, ocean actions have to be stressed as an integral component of the European Green Deal [7], with the Blue Economy as an integral part. Even in the uncertain times of 2020, the momentum for innovation, change for healthy oceans and sustainable growth needs to be preserved [12].

A green-blue transition is possible and essential. Therefore, the Innovation Platform »Sustainable Sea and Ocean Solutions ISSS« will create added value through in-depth technological innovation for subsea and ocean activities, and implement shared infrastructures through cross-cutting collaboration to ensure healthy and resilient oceans. It will cross-link relevant national and European initiatives to form an integrated whole, and propose measures in the maritime sector to establish ways to manage the maritime space more sustainably.

To establish the Innovation Platform »Sustainable Sea and Ocean Solutions ISSS« and to generate added value in the Blue Economy sectors, the consortium will pursue the action plan shown in Figure 2. The milestones include the establishment of research, industry and innovation alliances as well as the acquisition of national and European funding to facilitate a joint research agenda and national resource mobilization plans. Goal is the implementation of the Innovation Platform »Sustainable Sea and Ocean Solutions ISSS«

Action Plan Innovation Platform »Sustainable Sea and Ocean Solutions ISSS«



- 1 Research Alliance: networking research to create a joint research agenda
- 2 Industry Alliance: networking research and industry to meet market needs and create joint research agenda
- 3 Innovation Alliance: networking research, industry, politics, NGOs, associations and citizens to present and adjust the joint research agenda at national and european level
- 4 Aquisition National Funding: financing the joint research agenda and creating national ressource mobilisation plans
- 5 Aquisition European Funding: financing joint research agenda to create added value on european level

Figure 2: Action Plan Innovation Platform »Sustainable Sea and Ocean Solutions ISSS«

The milestones focus on the joint actions to implement the Innovation Platform »Sustainable Sea and Ocean Solutions ISSS«. This requires:

- **Coordinated investments:** The European coastal states already operate various but distinct marine and subsea facilities. Coordinated investments should connect these facilities and enable cross-border collaboration.

This requires a decentralized marine and subsea infrastructure, multipurpose platforms for flexible operations, solutions for subsea positioning, and a marine data space for joint data analyses and AI systems.

- **Enabling policies:** The EU single market rules should be fully applied to the marine/subsea sector to facilitate uniform and effective development of industrial value chains, thus guaranteeing a single market without barriers. Accordingly, a coherent framework for a joint European marine policy is required, specifically addressing subsea demands. In addition, excellence in education and training for marine/subsea aspects should be included in the EU's strategic policies.

- **Broad support for research and development:** Particularly when sustainability is required, subsea technologies demand a high degree of innovation and therefore broad support for R&D actions. Such actions should intensify:

1.) applied research in the application areas Aquaculture, Energy and Raw Materials Harvesting, and Ocean Cleaning, including cross-cutting technologies such as subsea robotics, sensors and actuators, subsea communication, and subsea materials and logistics;

2.) the development of sustainable methods and technologies to increase production efficiency and effectivity while maintaining environmental compatibility;

3.) the consolidation of fundamental research and applied R&D to meet the requirements of the maritime/subsea industry.

- **Investor and citizen engagement:** Investors need to channel capital away from damaging activities and toward opportunities in sustainable solutions [12]. To achieve our common goals, the UN Decade of Ocean Science for Sustainable Development (2021-2030) must be used to mobilize all stakeholders for sustainable European Blue Growth in line with the European Green Deal.

Even in the uncertain times of 2020, the momentum for innovation, change to healthy oceans and sustainable growth need not be lost [12]. The economic recovery from the COVID-19 pandemic should support growth and employment in the green-blue ocean economy. Key enablers of a sustainable Blue Economy with responsible utilization of our oceans are applied research and technology development – to boost new digital and biodiversity-friendly technologies and innovation and to capture better data.

References

- [1] European Commission, Directorate-General for Maritime Affairs and Fisheries (2018): The 2018 annual economic report on the EU blue economy.
- [2] IPCC (2019): Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press.
- [3] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions – The European Green Deal (COM/2019/640 final).
- [4] European Commission, Maritime Affairs, Integrated maritime policy: Blue growth. Available online: https://ec.europa.eu/maritimeaffairs/policy/blue_growth_en (accessed on March 1, 2020).
- [5] OECD (2016): The Ocean Economy in 2030, OECD Publishing, Paris. <http://dx.doi.org/10.1787/9789264251724-en>.
- [6] Commission staff working document – Report on the Blue Growth Strategy, Towards more sustainable growth and jobs in the blue economy SWD(2017)128 final.
- [7] UN Department of Economic and Social Affairs. News: World population projected to reach 9.8 billion in 2050, and 11.2 billion in 2100. Available online: https://ec.europa.eu/maritimeaffairs/policy/blue_growth_en (accessed on May 15, 2020).
- [8] European Commission (2019): The EU Blue Economy Report. 2019. Publications Office of the European Union. Luxembourg.
- [9] European Commission (2020): The EU Blue Economy Report 2020. Publications Office of the European Union. Luxembourg.
- [10] Telsnig, T.; Vazquez Hernandez, C., (2019): Wind Energy Technology Market Report, European Commission, Luxembourg, doi:10.2760/223306.
- [11] Agora Energiewende, Agora Verkehrswende, Technical University of Denmark and Max Planck Institute for Biogeochemistry (2020): Making the Most of Offshore Wind: Re-Evaluating the Potential of Offshore Wind in the German North Sea.
- [12] The Economist Group Limited (2020): A sustainable ocean economy in 2030: Opportunities and challenges. World Ocean Initiative, London.
- [13] Umweltbundesamt (2017): Welche Abfallmengen befinden sich in den Meeren? Available online: <https://www.umweltbundesamt.de/service/uba-fragen/welche-abfallmengen-befinden-sich-in-den-meeren> (accessed on July 22, 2020).
- [14] European Investment Bank (2019): The Clean Oceans Initiative. Available online: <https://www.eib.org/en/publications/the-clean-ocean-initiative> (accessed on July 22, 2020).
- [15] European Commission (EC), Sea basin regional strategies. Available online: https://ec.europa.eu/maritimeaffairs/policy/sea_basins_en (accessed on May 14, 2020).
- [16] WWF (2020): Improving international ocean governance for life below water. Report. <https://www.wwf.eu/?uNewsID=360392> (accessed on May 14, 2020).
- [17] United Nations (2020): Department of Economic and Social Affairs, Sustainable Development Goals, 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development. Available online: <https://sdgs.un.org/goals/goal14> (accessed on September 8, 2020).
- [18] Fraunhofer-Gesellschaft (2018): Hazardous contaminated sites in the North and the Baltic Sea. Available online: <https://www.fraunhofer.de/en/press/research-news/2018/august/robotic-salvage-and-disposal-system-RoBEMM.html> (accessed on September 8, 2020).

