BLUE GROWTH BOOK

State of the art
assessment and overview
on the most relevant drivers
and opportunities
in the Mediterranean
Blue Economy

Interreg
Mediterranean
MISTRAL

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CREDITS

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SUMMARY

Today, Blue Growth is recognised to be an economic opportunity, source of jobs and driver to sustainable development for Europe. The EU Blue Growth strategy defines and supports actions and framework in order to unlock the potential of seas and oceans and, to address this big challenge, a number of initiatives have been already launched across Europe. According to the Annual Economic Report of Blue Economy (EC, 2018), Mediterranean states account for four of the five largest shares in blue economy.
Nevertheless, the overall potential of Mediterranean Sea could be better exploited in terms of blue growth and jobs. The lack of homogeneity and a poorly managed overall use of diverse and numerous resources - that goes from local biodiversity, tourism, renewable energy production, and so on - represent a major limit to guarantee the long-term capacity to sustain such economic activities. This challenge can only be implemented by the development of a common and shared vision that includes all MED Countries for a sustainable use of sea resources.
This report aims to assess challenges and opportunities within the Blue Growth sector looking at innovation driven actions in order to deliver the highest impact a thus open opportunities for stakeholders. The report not only looks at the well-established sectors in the recent years, but also at those emerging sectors considered to be promising in the future in terms of innovation capacity and potential of investment. An integrated and systemic approach is necessary for the economic growth and innovation exploitation in the BG as part of a process that comprises and involves different attributes and frameworks that may not always be aligned. In this context, an overall benchmark analysis is performed at MED scale and key indicators are taken into account in order to find the drivers for exploitations, the so-called Innovation Potentials. The identification of characteristics and assets of each sector will highlight the implementation scenario (enabler factors) for each innovation potential, as a prerequisite to concentrating clusters, investors and resources around an accomplishment-oriented vision of their exploitation. Long-term impact of this action will result in strengthening the regional innovation systems, orient investment toward sustainable growth, maximising of knowledge transfers within and across Regions and in reducing the lack of homogeneity of innovation along Mediterranean Regions. The report will set the basis for a step forward on Mediterranean growth and for a more sustainable use of sea resources.
The Blue Growth scenario at the Mediterranean level is here described by looking at the most expanding sectors in the recent years and to those emerging sectors considered to be the more promising in the future i.e. Marine Renewable Energy (MRE) - Fishing & Aquaculture (F&A) - Maritime Surveillance (MS) – Blue Biotechnologies (BB) - Coastal and Maritime Tourism (C&MT). After a general overview of Blue Growth size and trends around the Mediterranean Sea, an in-depth descriptive analysis with an assessment of the current status and opportunities is provided by sector as a whole result of data integration on Albania, Cyprus, Croatia, France, Greece, Italy, Spain and Portugal (Countries part of the MISTRAL Interreg MED project). The report gives a cross-sectorial analysis of the entire assessment by highlighting potential synergies among sectors and trying to align enabling factors in order to obtain reference for stakeholders who intend to exploit or invest in the Mediterranean's Blue Economy.

1. INTRODUCTION

FOREWARD

Seas and Oceans represent an incredible resource for human lives. There are more than three billion of people around the World depending on marine and coastal resources for their subsistence. According to the Organisation for Economic Co-operation and Development (OECD 2016), the value of the global ocean economy may be in the order of US$1.5 trillion per annum, contributing approximately 2–3 per cent to the world's gross domestic product (GDP). Globally, Oceans provide goods, services, energy, food, jobs and transports for millions of people. At the same time Oceans regulate the global climate (Paris Agreement, For the first time, the Ocean is a part of a climate agreement which acknowledges its integral role in the climate balance), act as sink for greenhouse gases and also provide us with water and the oxygen we breathe. Due to its intrinsic and global importance, it comes that marine resources have to be kept healthy in order to guarantee their future use.
The international community recognized the importance of Oceans for sustainable development for the first time in occasion of the Rio+20 outcome document, where Member States underlined the importance of "the conservation and sustainable use of the oceans and seas and of their resources for sustainable development,…".
After that, oceans and seas interested a number of goals under the 2030 Agenda for Sustainable Development[1] and are now specifically linked to 10 targets under SDG 14 goal "Life Below Water" which aims to "Conserve and sustainable use the oceans, seas and marine resources for sustainable development". SDG 14 establishes particular emphasis to the reduction of marine pollution, protection of marine and coastal ecosystems, minimization of the impacts of ocean acidification, regulation of fishing activities, conservation of coastal and marine areas, increase and transfer scientific knowledge. Marine technologies and oceans are also mentioned in other goals under the 2030 Agenda for Sustainable Development .
In 2011 the European Commission adopted a Communication on Blue Growth recognizing a great potential for innovation and growth along Europe's coasts, seas and oceans accordingly to the Europe 2020 strategy for smart, sustainable and inclusive growth. Blue Growth is now the long-term strategy that supports sustainable growth in the marine and maritime sectors as drivers for the European economy. Today the EU's "blue" economy represents 5.4 million jobs and a gross added value of just under €500 billion per year. Growth in the blue economy offers new and innovative ways to revamp EU out of its current economic crisis by contributing to the EU's international competitiveness, resource efficiency, job creation and new sources of growth whilst safeguarding biodiversity and protecting the marine environment.
Innovation across all sectors of the blue economy is fundamental for realising its growth and jobs potential. Indeed, innovation is seen as critical issue for achieving the sustainable development goals and therefore bringing significant environmental benefits. Innovation can also help to develop cost-effective marine protection measures that can contribute to the implementation of the Marine Strategy Framework Directive (MSFD)[2].
By monitoring Innovation across EU (Commission Annual Growth Survey for 2014) the Commission found some bottlenecks in the process of transfer research results into goods and services. This was mainly represented by the poor collaboration between the public and private sectors and by the lack of suitable skills. The reference framework was also poor of investment in knowledge, access to finance, reference to clear standards and duplications in research. In order to unlock the potential of the blue economy in Europe, Member States need to put in place policies and local solutions to effectively address these barriers.

IMPLEMENTING BLUE GROWTH IN THE MEDITERRANEAN TROUGH COOPERATION AND INNOVATION

The Mediterranean Sea represents a promising opportunity for Blue Growth. The basin, with its unique cultural heritage and natural patrimony (400 UNESCO sites), local biodiversity and geo-physical characteristics, provides major local opportunities for blue growth and jobs across different sectors. At the same time Mediterranean is subject to environmental constraints related to climate change and pollution, and often suffers of the scarce management of its resource. The blue economy strongly depends on the health and quality of the environment for the sustained supply of goods and services and this is particularly true in the case of a closed Basin as for the Mediterranean Sea. Growing the blue economy in the Mediterranean Basin requires a range of framework conditions to be fulfilled with joint efforts.
Dedicated Actions/Initiatives has been launched by the Commission in order to accomplish the Blue Growth challenge at Mediterranean level. BLUEMED is the research and innovation Initiative aimed at promoting the blue economy through cooperation. It represents the strategy of reference for the Mediterranean countries for a healthy, safe and productive Mediterranean Sea. BLUEMED identified priorities for research and innovation cooperation in a dedicated Strategic Research and Innovation Agenda, the BLUEMED SRIA[3], whose implementation contribute to the creation of new 'blue' jobs, social well-being and a sustainable growth in the marine and maritime sectors. The Initiative is finalised to achieve sustainable growth and job creation for the regions, by capitalizing on achieved results and best practices, removing barriers, reducing fragmentation and promoting integration.
It has been reported that Regional Smart Specialization Strategies (RIS) are valuable instruments for the Blue Growth (BG) implementation . Indeed, BG and RIS share the focus on innovation and see different sectors development through a holistic approach that relies on common skills and shared infrastructure. Building a net for suppliers and enablers will reinforce the BG implementation[4] and the position of Blue Clusters will assume a pivotal role in this direction. In order to enhance the efficiency of the implementation actions, in terms of investments in research innovation and technology, regional systems may count on transnational and interregional cooperation through macro-regional strategies (e.g. INTERREG, Vanguard initiatives) to ensure a stronger planning and impact orientation.

[1]Transforming our World: The 2030 Agenda for Sustainable Development, United Nations 2015
[2]DIRECTIVE 2008/56/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL, 17 June 2008 Establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)
[3]http://www.bluemed-initiative.eu/wp-content/uploads/2017/09/BLUEMED-SRIA_Update_final.pdf
[4]De Vet J-M., Edwards J., Bocci M. (2016), Blue Growth and Smart Specialisation: How to catch maritime growth through 'Value Nets', S3 Policy Brief Series No. 17/2016

LOOKING AT ENABLING CONDITIONS TO SUPPORT BLUE GROWTH IN MED

Blue economy relies on the sustainable utilisation of sea or oceans and, by looking at an exploitation end, many Countries/Regions are now assessing the potential economic value of their resources also with the support from the Commission trough specific financing programme.
The present study has been conducted in the frame of the Interreg MED project MISTRAL, aimed to promoting and implementing transnational BG ecosystem of innovation with the joint effort of Research and Technology Organisations (RTOs), public bodies and Clusters. In accordance with the main objective of the Interreg MED Programme devoted to promote sustainable growth in the Mediterranean and in line with the BLUEMED Initiative, MISTRAL acts to i) limit the fragmentation of actions and regional policies in the sea sector; ii) strengthen the transnational cooperation creating the critical mass for succeeding in the R&D actions; iii) support the development of a favourable ecosystem for a BG governance and common vision; iv) build a competitive, sustainable and innovative maritime economy supported by a new cross sectoral multi-nodal “value-nets” providing high quality jobs.
This report represents the first step of BG implementation process and is aimed at assessing challenges and opportunities within the Blue Growth sector along Mediterranean Sea, by looking at innovation driven actions in order to deliver the highest impact and thus open opportunities for stakeholders. The report not only looks at the well-established sectors in the recent years, but also at those emerging sectors considered to be promising in the future in terms of innovation capacity and potential of investment. In this context, an overall benchmark analysis is performed on the basis of MISTRAL consortium composition that includes EU and non-EU Member States namely Albania, Cyprus, Croatia, France, Greece, Italy, Spain and Portugal (MISTRAL spatial distribution of partners). Countries from the south and east bank are not included in the analysis.

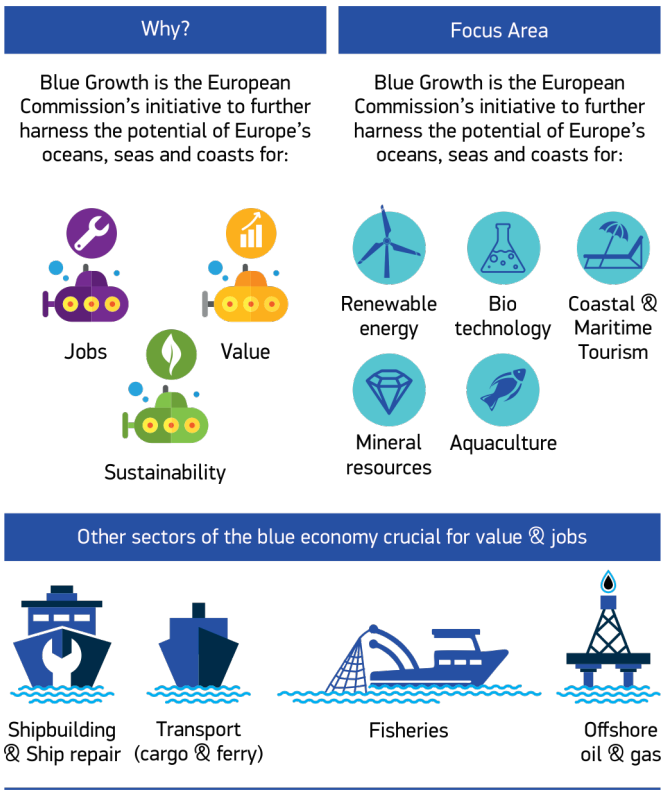
Key indicators are taken into account in order to find the drivers for exploitations, the so-called Innovation Potentials. The identification of characteristics and assets will highlight the implementation scenario (enabler factors) for each innovation potential, as a prerequisite to concentrating clusters, investors and resources around an accomplishment-oriented vision of their exploitation. The report will set the basis for a step forward on Mediterranean growth and for a more sustainable use of sea resources.

2. THE MEDITERRANEAN AND THE BLUE GROWTH

2.1 INTRODUCTION TO BLUE GROWTH IN THE MEDITERRANEAN

EU's Blue Growth strategy aims to bring together economic growth and sustainable ecosystems by improving knowledge, planning and security, providing adequate support with EU funds, and improving cooperation between countries, regions and businesses. After the adoption of the Blue Growth Strategy in 2012, the Commission has launched initiatives in many policy areas related to Europe's oceans, seas and coasts, in order to promote concrete actions at local level. The aim was to bring together business, public authorities and stakeholders to develop a sustainable Blue Economy, terms that includes those activities that interest the sea and land-sea interactions in the context of sustainable development. The Blue Economy represents a big opportunity for growth in Europe and nowadays comprise about 5.4 million jobs with a gross added value of almost €500 billion a year[5]. The potential is based on seas and oceans resources and the challenge is to maintain and make them healthy, safe and sustainably managed.
In this context, the emerging concept of the Blue Economy has gained a pivotal role in the Mediterranean basin also sustained by a number of Initiatives and Strategies (as described in Chap. 1). Key challenges for the Mediterranean including gaps, specific factors enabling the blue growth as well as measures for capacity creation and skills' enhancement have been identified (i.e. BLUEMED SRIA[6]). Sectors recognised to be of interest for the Mediterranean basin include ecosystems, climate change, biotechnologies, aquaculture, fisheries, tourism, shipbuilding, transportation, observing systems, data, offshore platforms, cultural heritage, spatial planning among others (Fig. 2.1).
Mediterranean basin is a unique but also fragile system. Mediterranean Sea represents only the 1% of the global oceanic water with an incredible variety of resources, nevertheless the intense human activities (23 are the Countries that surround the sea), transport and tourism (one third of the global tourism interests the Mediterranean) together with the exploitation of resources too often without an efficient management, caused an increasing degrade of the marine environment. Taking into account the delicate balances between the productive activities and the quality of the sea and therefore of the resources, the concept of the blue economy offers opportunities for economic diversification and growth embedded in the fundamental principles of environmental sustainability. Recognising this potential, MED Countries are looking to their marine resources to discover new opportunities for investment and employment and build competitive advantage in emerging BG sectors.
In 2016-2017, Horizon 2020 has also invested EUR 46 million in research on aquaculture management, spatial planning and diseases and provided access to research infrastructure with a special focus on the Mediterranean. Such funding can de-risk private investment and make investments more attractive. Projects in the next cycle of funding will focus on large-scale demonstration of commercial feasibility for offshore and biorefinery projects.

The Mediterranean Sea has a central role for the economy growth of coastal communities and Countries. The BG sector plays a pivotal role for the region's economy, with huge potential for innovation and for sustainable development. The economic opportunities provided by the Mediterranean Sea need an increased attention for a management that respects its ecosystems and that is able to maintain and increase their value potential. The conversion of economic sectors that in some cases have adversely affected the health of ecosystems into sustainable activities, together with the development of new clean and technologically advanced applications, represents important opportunities for innovation and economic growth across all Mediterranean countries. The sustainable use and conservation of Mediterranean common resource (the sea, sea/land) must to be built in close collaboration between all the Mediterranean countries and their stakeholders at policy, economic and social level.



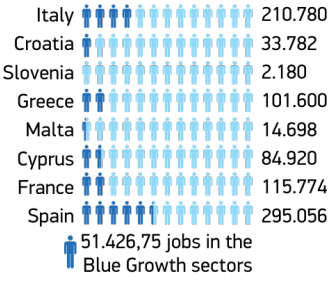
[5]The 2018 Annual Economic Report on Blue Economy, Directorate-General for Maritime Affairs and Fisheries (European Commission), DOI 10.2771/305342.
[6]http://www.bluemed-initiative.eu/wp-content/uploads/2017/09/BLUEMED-SRIA_Update_final.pdf

UK	IE	FR	PT	ES	MT	IT	SI	HR	EL	CY	RO	BG	EE	LV	LT	PL	FI	SE	DK	DE	NL	BE
ATLANTIC OCEAN					MEDITERRANEAN SEA						BLACK SEA		BALTIC SEA								NORTH SEA	

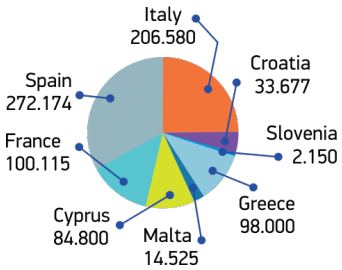
MEDITERRANEAN SEA Blue Growth

JOBS

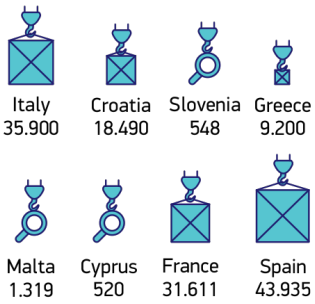
JOBS — Blue Growth Sectors
Total: 858.790 jobs



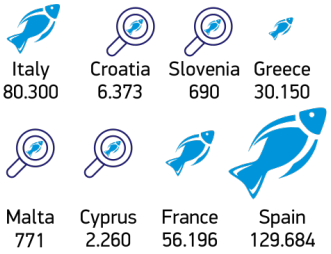
JOBS — Coastal & Maritime Tourism
Total: 812.021 jobs



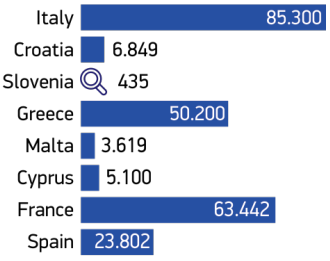
JOBS — Shipbuilding & Ship repair
Total: 141.523 jobs



JOBS — Fisheries
Total: 306.424 jobs



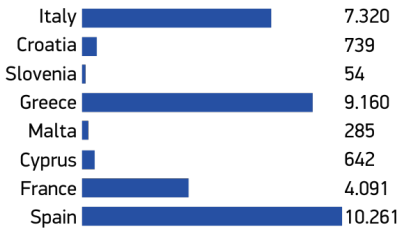
JOBS — Transport
Total: 238.747 jobs



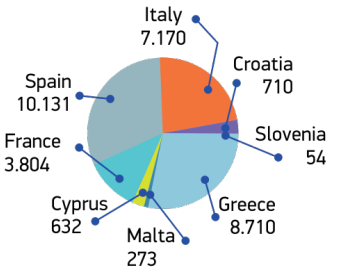
MEDITERRANEAN SEA Blue Growth

VALUE

VALUE — Blue Growth Sectors
Total: 32.552 million €

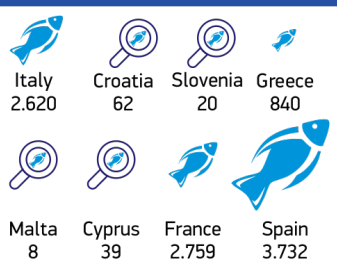


VALUE — Coastal & Maritime Tourism
Total: 31.484 million €

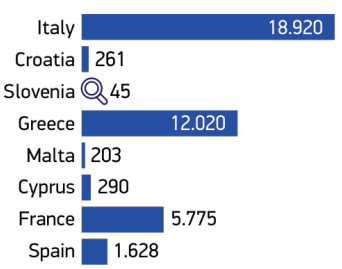


VALUE — Shipbuilding & Ship repair
Total: 6.958 million €

JOBS — Fisheries
Total: 10.080 million €



JOBS — Transport
Total: 39.142 million €



According to **"The 2018 Annual Economic Report on EU Blue Economy"**[7], at Country level the contribution that blue economy sectors represent to national GDP exceeds the EU average for seven out of eight of the Nation represented in MISTRAL consortium. In addition, Mediterranean Member States are responsible for four of the five biggest percentages (Fig. 2.2).

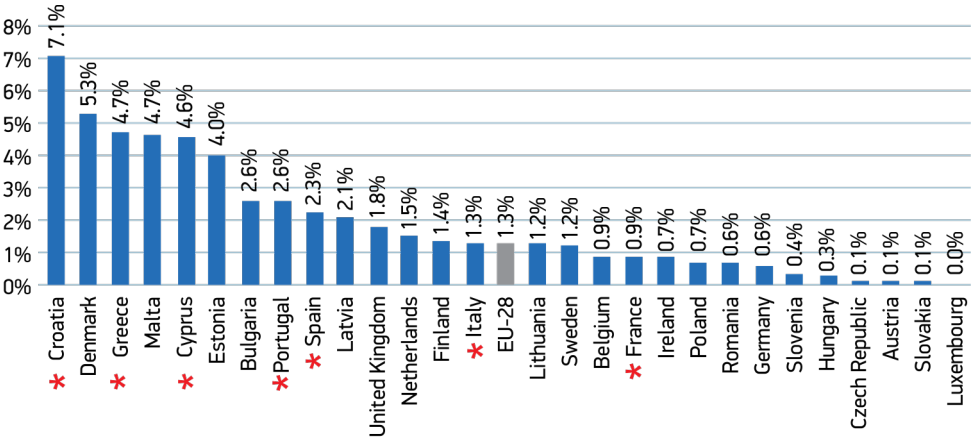


Fig. 2.2 Contribution of blue economy to national GDP (Adapted from2018 EC Report)

This reflects the fact that Mediterranean countries consistently base their economies on Marine resources. Anyway, the overall picture changes when referring to GVA generated in absolute terms. Countries as Croatia and Cyprus lose out while Spain, Italy and France arise among the top five GVA.

According to the 2018 EC Report Spain, Italy and Greece showed top value in terms of jobs with Spain accounting for one fifth of total blue economy-related employment. The Mediterranean loses shift down the ranking when it comes to investments and profit, only Italy and Spain play again a role in this direction.

Fig. 2.3 Picture of blue economy GVAin 2016 (adapted from 2018 EC Report)

[7]The 2018 Annual Economic Report on Blue Economy, Directorate-General for Maritime Affairs and Fisheries (European Commission), DOI 10.2771/305342.

2.2 THE MED AREA. BLUE ECONOMY AND ITS BG SECTORS

There are many different interpretations of Blue Economy definitions and descriptions due to the interpretation of coastal and oceans activities and their direct and indirect impacts. Here in particular three reports (OECD[8], WORLD BANK[9]and the 2018 EC Report[10]) have been considered for the sector description.

According to 2018 EC Report, the blue economy can be distinguished between:

-marine based activities (fisheries and aquaculture, offshore oil and gas, offshore wind energy, ocean energy, desalination, shipping and marine transport, and marine and coastal tourism) and
-marine related activities which use products for the oceans and marine based activities (Seafood processing, marine biotechnology, shipbuilding and repair, port activities, communication and maritime surveillance).

Other approach intends category of blue economy that are linked to the living "renewable" resources of the oceans (such as fisheries) as well as those related to non-living and therefore "non-renewable" resources (including extractive industries, such as dredging, seabed mining, and offshore oil and gas, when undertaken in a manner that does not cause irreversible damage to the ecosystem). It also includes activities relating to commerce and trade, monitoring and surveillance, coastal and marine area management, protection, and restoration.
This definition reflects the definitions adopted by the OECD and the World Bank and it includes also emerging sectors and economic value based on natural capital and non-market goods and services. Blue Economy could be therefore divided between established and emerging sectors.

The established sectors are:
- Extraction of marine living resources
- Offshore oil and natural gas
- Ports warehousing construction of water projects
- Shipbuilding and repair
- Maritime transport
- Coastal tourism

For the emerging sectors:
- Renewable energy
- Blue biotechnology
- Deep-sea mining
- Desalination
- Coastal and environmental protection
- Defence and security
- Marine research and education

Among the established sectors:

- Extraction of marine living resources

Some sectors perform significantly better than others. Marine living resources sector includes harvesting and transformations into gods and products of biological resources from the sea and includes fisheries, aquaculture, fish processing, crustacean and molluscs and whole or retail sail.
Spain, with 22 % of the total jobs and 17 % of the GVA, leads the living resource sector (Fig. 2.4)

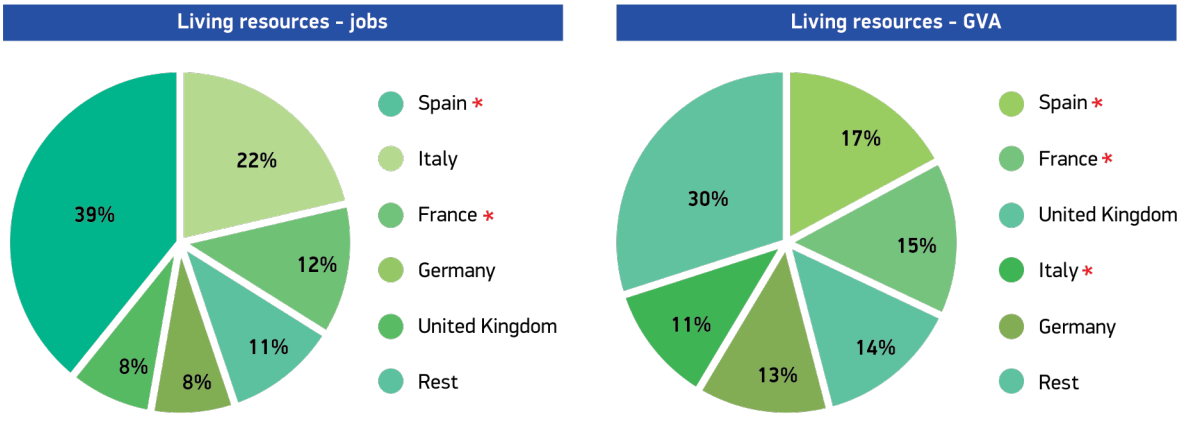


Fig. 2.4Total jobs and GVA of living resources sector. Adapted from 2018 EC Report.

[8]OECD (2016), The Ocean Economy in 2030, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264251724-en
[9]World Bank; United Nations Department of Economic and Social Affairs. 2017. The Potential of the Blue Economy : Increasing Long-term Benefits of the Sustainable Use of Marine Resources for Small Island Developing States and Coastal Least Developed Countries. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/26843 License: CC BY 3.0 IGO."
[10]The 2018 Annual Economic Report on Blue Economy, Directorate-General for Maritime Affairs and Fisheries (European Commission), DOI 10.2771/305342.

Not enough consistent and comparable data for a comprehensive socioeconomic analysis are available. The top 5 members for living resources and share in biological resource fisheries in terms of jobs are all Mediterranean Countries (Spain, Italy, Greece, Portugal and France) and for Aquaculture jobs 4 out of five showing the importance of Living Resources sector for MED economies.

- Offshore oil and natural gas

This sector includes extraction of crude petroleum, extraction of natural gas and support activities. This Sector mainly interests the North and Baltic Sea, with United Kingdom as leader. Mediterranean traditional production areas are located in Spanish Greece Maltese, Italian (Adriatic) and Croatian waters.

- Ports warehousing construction of water projects

Ports play a central role in the development of established and emerging maritime sectors and may include cargo handling; warehousing and storage; construction of water projects; and service activities incidental to water transportation. Mediterranean country (Spain, Italy and France) are included in the top 5 in terms of jobs but only Italy has a significant GVA with respect to port activities. Leaders of the sector are UK and Germany.

- Maritime transport

Important sector for all the human economic activities, Maritime transport assumes an essential role with respect to blue economy. This includes sea and coastal passengers transport as well as inland. In EU Around 235 000 persons were directly employed in the sector (1.2 % less than in 2009). Italy leads in terms of jobs (22% of the total) and also Greece play a role but in terms of GVA again the leadership is to Germany and North European Countries.

- Shipbuilding and repair

Shipbuilding and repair accounted for 7 % of the GVA, 7 % of the jobs and 2 % of the profits of the total EU blue economy in 2016. Global shipyard is focusing attention on new markets and higher technology / high added-value products, such as naval vessels, cruise ships, ferries, mega-yachts, and dredgers. From Med Countries only Italy and France are in the top 5 players in terms of Jobs and GVA.

- Coastal tourism

Spain dominates the EU coastal tourism sector, accounting for 25 % of the jobs and GVA in the total EU blue economy in 2016. Across EU jobs are distributed for 45 % in accommodation, 14 % in transport and 41 % in “other expenditures”. The gross value added is also generated first by accommodation followed by transport. Mediterranean Countries play a central role in this sector with Spain, Italy, France and Greece that are represented among the top five Countries according by their shares of Jobs and GVA by sub-sectors in 2016 (data from 2018 EC Report).
For the emerging sectors is not easy to collect consistent data for a precise description in terms of jobs and growth. The lack of data does not allow the defining of a clear picture, anyway trends and potentials could be identified by alternative indicators to the economic data.

- Renewable energy

Renewable energy includes various forms of ocean energy, offshore wind as well as wave and tidal energy. Currently both are considered in development with a big investment in research and innovation. Clearly, Offshore wind energy is a well establish sector among the emergent ones.

- Blue bioeconomy and biotechnology

Activities in this sector mainly refer to biofuels as an example and to biotechnology use that is characterized to have various applications in different fields. It has to be noted that Bioeconomy has acquired growing

importance since 2012 when Europe launched and adopted the Europe's Bioeconomy Strategy[11] to addresses the production/use of renewable biological resources and convert them into products and bio-energy. There are strategies at national and regional level devoted to boosting the use of renewable biological resources to produce goods, added value products and new jobs. This sector mainly has an impact in the healthcare and pharmaceutical sectors, agriculture, veterinary products and aquaculture, in industrial processes and manufacturing and energy production.

- Deep-sea mining

This sector includes production extraction and processing of non-living resources including mineral and metals. No deep-seabed mining

project has taken place up to now, so the assessment of its socioeconomic potential is difficult.

- Desalination

Seawater desalination includes consumer and commercial use and agriculture irrigation. Spain has invested in the biggest plant in EU and other countries are also investigating possibilities of growth. Anyway, data on desalination are non-existent.

- Coastal and environmental protection

Under this category are included technologies, infrastructures and operational skills to develop supportive mechanisms for European costal area implementing adaptation strategies bound to develop rapidly in the wake of climate change and extreme water condition.
The annual turnover of coastal protection activities is currently roughly estimated at EUR 1 billion to EUR 5 billion per year (Report ECORYS 2012[12]).

- Defence and security

According to OECD definition, Maritime safety and surveillance "describes the economic activity related to products and services in different maritime domains, ranging from pollution and fisheries control to search and rescue, customs and costal defence by government and public or private organisations". There are no economic figures, as some activities have not yet been developed to commercial scale at global level.

[11] A sustainable Bioeconomy for Europe: Strengthening the connection between economy, society and the environment, EC 2018 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0673&from=EN
[12] Study in support of policy measures for maritime and coastal tourism at EU level ECORYS 2012, DG Maritime Affairs & Fisheries

2.3 DEFINING THE SECTORS OF INTEREST IN MISTRAL

The sectors of interest for MISTRAL follow the indication of the Terms of Reference for Integrated Projects of Axis 1, for the sub-thematic focus "Blue Growth" are:

- Marine Renewable Energy (MRE)
- Fishing & Aquaculture (F&A)
- Maritime Surveillance (MS)
- Blue Biotechnologies (BB)
- Coastal and maritime tourism (C&MT)

The selected sectors include both well-established sectors in the recent years (as Tourism and Fishing and Aquaculture) but include also those emerging sectors (Biotech, Renewable energy, Surveillance) considered to be promising in the future in terms of innovation capacity and potential of investment. In Fig. 2.5 and in the following of this section a general description of MISTRAL subsectors is given while the detailed analysis of each sector is object of the next chapter.

Fig. 2.5 The five sectors of the sub-thematic focus "Blue Growth" (Interreg MED TORs for Integrated Projects - Axis 1, February 2017).

BLUE GROWTH

Blue Energy
Our seas and oceans offer a vast renewable energy resource. Technologies are currently being developed to exploit this potential (offshore wind, tidal wave and wave potential as well as differences in temperature and salinity.

Fishing & Aquaculture
In Europe, aquaculture accounts for about 20% of fish production and directly employs some 80.000 people. EU aquaculture is renowned for its high quality, sustainability and consumer protection standards. Furthermore, it opes the door to complementary and hybrid exploitation of instalments (connecting energy and fish production, for example).

Maritime Surveillance
Integrated Maritime Surveillance is about providing authorities interested or active in maritime surveillance with ways to exchange information and data. Sharing data will make surveillance cheaper and more effective, contributing to improve the capacity for response in case of emergencies and increase the economic value of the associated products.

Biotechnologies
Marine life has adapted to thrive in the ambient conditions found in the sea. Blue biotechnology is concerned with the exploration and exploitation of the resulting diverse marine organisms in order to develop new products.

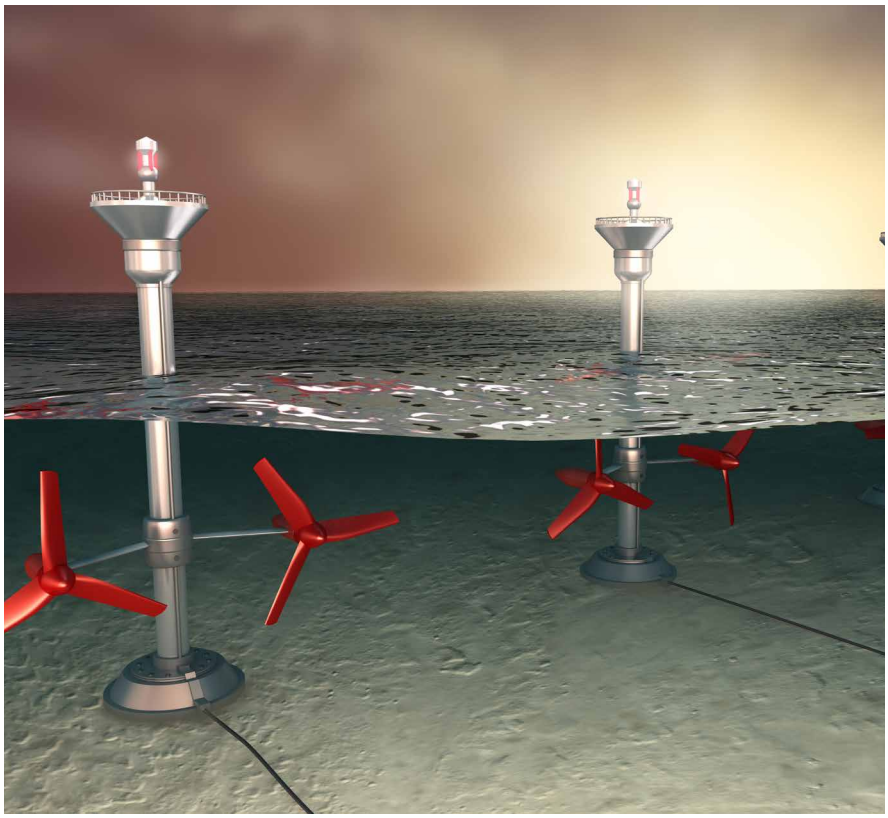
Coastal and maritime tourism
The coastal and maritime tourism sector has been identified as an area with special potential to foster a smart, sustainable and inclusive Europe. It is the biggest maritime sector in terms of gross added value and employment. The EC has started the will to support the development of trans-national and interregional partnerships, networks, clusters and smart specialisation strategies for the specific sector.

- **Blue Energy**

The Blue energy sector has the following six sub-sectors of interest, which quite evidently have a very different level of readiness, economic value and specific potential for the Mediterranean area:

- Offshore Wind Energy (OWE)
- Wave Energy (WE)
- Tidal Energy (TE)
- Sea Water Air Conditioning (SWAC)
- Salinity Gradient Converters (SGC)
- Thermal Energy Converters (OTEC)

Renewable marine energies have the potential to enhance the efficiency of harvesting the European energy resource, minimize land-use requirements of the power sector and reduce the European greenhouse gas emissions (by about 65 Mt CO2 in 2020), in line with main International and EU policies (e.g. COP21 Climate Change (2015), EU Strategy on adaptation to climate change (COM(2013)216), Renewable Energy Directive (2009/28/EC)). As recently stressed in the Communication "Renewable Energy: a major player in the European energy market", further efforts to reinforce research and development in the field of ocean energy are needed. This will help to further reduce costs, lengthen the operating life of



equipment and streamline logistics in technologies that will help to achieve the 2020 targets.
EU industry is a world leader in blue energy and can contribute to reductions in carbon emissions outside Europe through exports. In addition, synergies can also be explored with the offshore conventional energy sector, for example by tackling safety and infrastructure challenges together.

● **Fishing and Aquaculture**
Fishing is defined as the extraction of fish from the oceans for human consumption or use in products. Its value chain includes vessel construction, propulsion and fuels, stock assessment (ecosystem-based fisheries management), fishing systems, distribution and packaging, valorisation of fisheries wastes and by-products.
Aquaculture is defined as the farming of aquatic organisms, usually fish and shellfish (molluscs and crustaceans), primarily for human consumption. The sectors value chain includes hatchery, fish food production, equipment, supply, finance and logistics, marketing and distributions, and processing, valorisation of aquaculture wastes and by-products.
Fish accounts for about 15.7% of the animal protein consumed globally. The UN Food and Agriculture Organisation estimates that aquaculture provides half of this and that by 2030 it will reach 65%[13]. It is currently 25% in the EU. Globally, it has a growth rate of 6.6% per annum, making it the fastest-growing animal-food-producing sector and faster than the 1.8% annual global population increase. It is thus contributing to an overall improvement in human diet. Growth in the aquaculture sector in Asia, which accounts for more than 89% of global production is more than 5% a year, while EU growth in the sector is stagnant. The European Union is the fifth largest producer worldwide with about 4850000 tons of fishery production in 2013, accounting for just over 5% of the capture fishery production worldwide[14]. The contribution of the Mediterranean to this yield is about 8.5% (414000 tons). In the Mediterranean and the Black Sea regions, seven States (Turkey, Italy, Algeria, Spain, Tunisia, Greece, and Ukraine) accounted for more than 80% of total Mediterranean and Black Sea landings in the 2000-2013 period[15]. According to the same study, the total value of fish landings of the Mediterranean and the Black Sea is estimated to reach a minimum of US$ 3.1 billion. Fisheries and aquaculture contribute to the economy of countries bordering the Mediterranean Sea and provide food and employment to coastal communities

employing ca 600000 people: they directly employ 250000 and 123000 people in fisheries and aquaculture, respectively and about 210000 people for secondary sector[16].

● **Maritime Surveillance**
The Mediterranean Sea is one of the most strategic maritime basins. In such a sensitive, unequal and geopolitically unstable region, it is necessary for the Mediterranean States to develop their maritime surveillance. Since 2015, the number of migrants crossing EU external borders doubled compared to previous years. To tackle this unprecedented migrant influx the EU is acting on different fronts of which border security. The Sea is at the heart of international trades which represents 1% of the surface of the seas and concentrates 25% of global traffic and 30% of the world's oil traffic. The Suez Canal plays a decisive role in supplying Europe and the American continent with hydrocarbons through the Straits of Gibraltar. More than 300 ships cross the Strait of Gibraltar every day, 100 the Suez Canal, 50 the Bosphorus Strait, 6 the Strait of Bonifacio, and nearly 2,000 vessels of all sorts are daily present at sea or in harbours. Given the importance of this traffic and the ecological vulnerability of this sea, the Mediterranean Sea has been classified as a special area by the MARPOL 73/78 international convention[17]. Maritime Surveillance (MS) activities are carried out mainly by States and related Authorities. These activities have both national and transnational nature (mostly transnational) and fall under the responsibility of many actors (both at regional, national and transnational level).

● **Blue Biotechnologies**
Blue Biotechnologies involve the exploitation of living organisms (Algae, microalgae, sponge, bacteria, etc.), in engineering, technology and other fields requiring bio products. Blue biotechnology value chains include research and development, demonstration and test, cultivation and production. Exploration of the sea biodiversity is now helping us understand for example how organisms that can withstand extremes of temperature and pressure and grow without light could be used to develop new industrial enzymes or pharmaceuticals. At the same time, concerns about the land-use impact and the thirst for water of terrestrial crops grown for biofuel are driving efforts to explore the use of algae as a source of biofuels, along with high added-value chemicals and bioactive compounds. While estimated current employment in the sector in Europe is still relatively low, and a gross value added of €0.8 billion, the growth of the sector will offer high-skilled employment, especially if ground-breaking drugs can be developed from marine organisms, and significant downstream opportunities. In the very short term, the sector is expected to emerge as a niche market focused on

[13]FISH TO 2030. Prospects for Fisheries and Aquaculture; www.fao.org/docrep/019/i3640e/i3640e.pdf
[14] Facts and Figures on the Common Fisheries Policy. Publications Office of the European Union, 2016.
[15]FAO (2016) The State of Mediterranean and Black Sea Fisheries. General Fisheries Commission for the Mediterranean. Rome, Italy, available at www.fao.org/3/a-i5496e.pdf
[16]Sacchi J (2011) Analyses des activités économiques en Méditerranée: secteurs pêche-aquaculture, Plan Bleu, Valbonne, available at http://planbleu.org/sites/default/files/publications/analyse_activites_econ_pechefr_1.pdf
[17] PREMAR https://www.premar-mediterranee.gouv.fr/

high-value products for the health, cosmetic and industrial bio-materials sectors. By 2020, it could grow as a medium-sized market, expanding towards the production of metabolites and primary compounds (lipids, sugars, polymers, proteins) as inputs for the food, feed and chemical industries. In a third stage, around 15 years from now and subject to technological breakthroughs, the blue biotechnology sector could become a provider of mass-market products, together with a range of high added value specialised products. Accelerating this process will require a combination of basic research on ocean life and applied research on possible industrial applications with low probabilities but high rewards for success.

● **Coastal and Maritime Tourism**

Coastal refers to land-based tourism activities including swimming, surfing, sunbathing, eco-tourism, cultural tourism and other coastal recreation activities taking place on the coast for which the proximity to the sea is a condition including also their respective services.

Maritime tourism refers to sea-based activities such as boating, yachting, cruising, nautical sports, recreational fishing, diving, underwater cultural heritage as well as their land-based services and infrastructures.

In a communication of 2012, the Commission reported that the extraordinary beauty and diversity of Europe's coasts, as well as the wide range of facilities and activities on offer, make them the preferred holiday destination of 63% of European tourists. The maritime and coastal tourism sub-sector has now become the largest single maritime economic activity, employing 2.35 million people, equivalent to 1.1% of total EU employment. More than 90% of enterprises employ less than 10 people. In some areas, tourism is an additional source of income for coastal communities, but in others it can dominate the local economy[18].

While many of these tourists may not venture far from the shoreline, open-water activities are on the increase. Yachting is expected to grow by 2-3% a year. The cruise industry is also growing. Within Europe it employs nearly 150000 people and generates direct turnover of €14.5 billion[19]. EU shipyards have been successful in serving this specialised market – both with large cruise ships and small leisure vessels.

A healthy environment is fundamental to any form of 'blue' tourism and favours the growth potential of new forms of tourism. High quality bathing waters and pristine coastal and marine habitats have a high recreation value. This increases the attractiveness of coastal areas which in turn increases the growth potential of activities such as nautical tourism and sports, and green tourism such as whale watching. The sheer variety of Europe's tourism means that most growth-generating initiatives will inevitably be on a local or regional scale. Each of Europe's sea-basins presents different challenges and opportunities, requiring tailor-made approaches. Public administrations will need to take a strategic approach to investments in enabling infrastructures such as berthing capacity, port facilities and transport. Higher education courses need to deliver a solid grounding in the specific skills needed to maintain and increase market share in a discerning and competitive global market. This needs to be accompanied by measures that help to improve the tourism offer for low-season tourism and reduce the high carbon footprint and environmental impact of coastal tourism.

Given the sheer magnitude of the activity, the precariousness and low-skill level of much of its current workforce as well as tourism's dominant impact on many European coastal and marine environments, measures at a sea-basin or EU level could have a significant positive impact. Cross-border coordination as part of a sea-basin strategy can contribute to the development of high-value tourism areas.

[18]COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Blue Growth opportunities for marine and maritime sustainable growth; 2012

[19]European Cruise Council (2011)

2.4 MISTRAL METHODOLOGICAL FRAMEWORK

MISTRAL is aimed to fill the gap of transnational and transversal cooperation between the different quadruple helix actors (industry, university, government, and, at a later stage, civil society) in the BG in MED area by unlocking the innovation potential of the coastal and marine ecosystem.
In this regard MISTRAL developed an integrated and comprehensive study defined by a common methodology and aimed to acquire knowledge of the state of the art, key drivers and opportunities for the 5 sectors of BG selected. In particular the analysis is focused on the identification of Innovation Potentials as drivers for exploitation and, consequently, on the description of characteristics and assets (Key Enabling Factors) for their implementation. The analysis looks at the most expanding sectors in the recent years and to those emerging sectors considered to be the more promising in the future i.e. Marine Renewable Energy (MRE) - Fishing & Aquaculture (F&A) - Maritime Surveillance (MS) - Blue Biotechnologies (BB) - Coastal and Maritime Tourism (C&MT). This study is referred to the MED area represented by MISTRAL consortium (see Fig. 2.6) that includes EU and non-EU Member States (Albania, Cyprus, Croatia, France, Greece, Italy, Spain and Portugal). The analysis has been conducted separately at Country/Region level and here is presented as an integrated overview of challenges and enabling conditions per each sector.

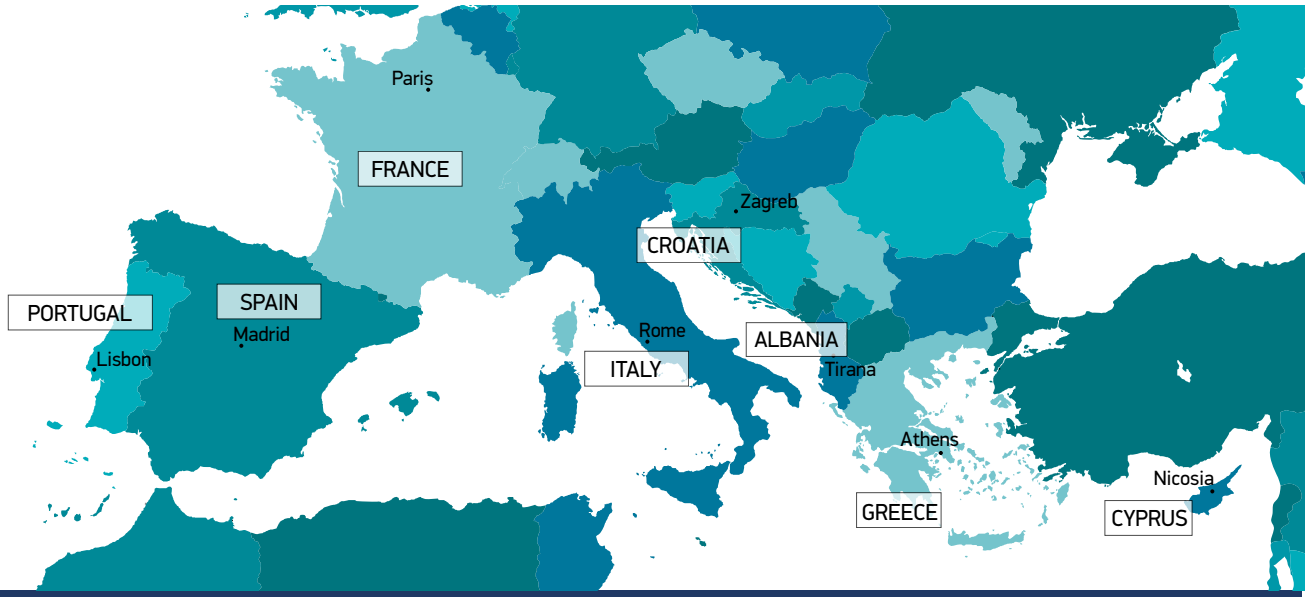


Fig. 2.6 Countries and Regions represented in the MISTRAL Consortium

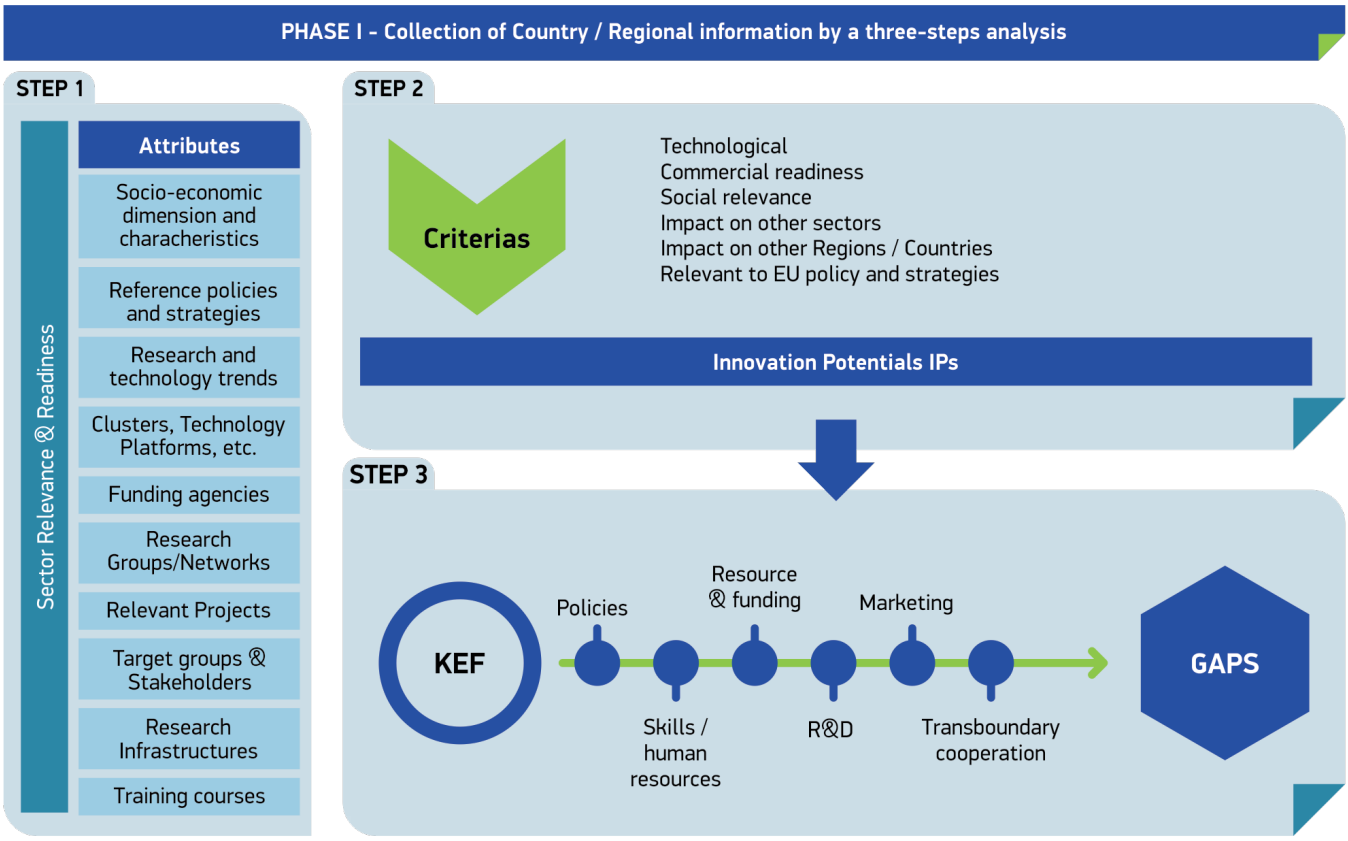
The methodology behind this "Blue Growth Book" consists in a three-phases analysis as shown in Fig. 2.7. In Phase I the collection of the information in terms of state of art, main challenges and opportunities/gaps of the 5 MISTRAL sectors have been performed separately at Country and Regional level. This analysis has been developed following three main steps:

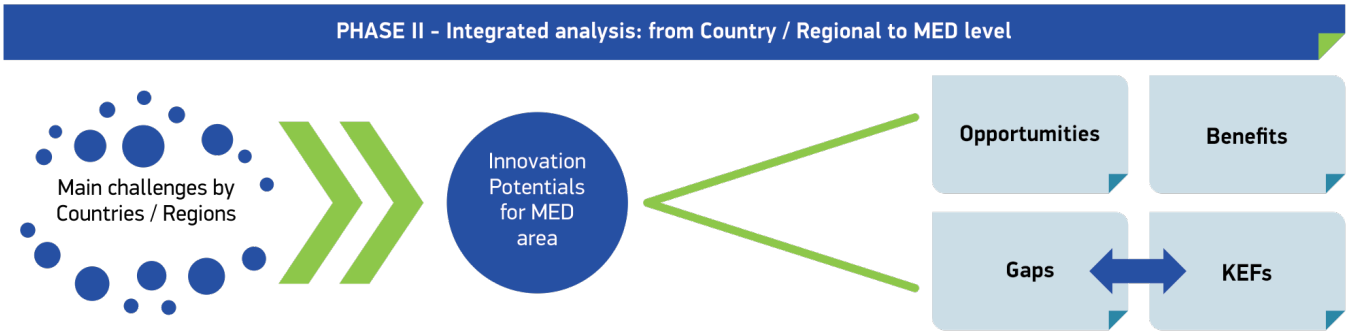
- **Step 1**: A benchmarking is performed at Country/Regional level based on the same attributes to permit a comparative analysis. The methodology included Political, Economic, Social and Technological dimensions and considered cross-cutting issues among a spectrum of characteristics that might bear an impact upon the identification of innovation potentials. The resulting output of this step of analysis is the relevance and readiness level of the sectors for each Countries of the med area.

- **Step 2**: Innovation potentials (IPs) are identified by applying a list of qualitative but common criteria on data gathered in the first step of benchmarking (see Figure 2.7). "Innovation Potentials" are specific actions on sectors and sub-sectors that are considered having high socio-economic potential and impact.

- **Step 3**: On the selected innovation potentials, an analysis of Gaps and Key Enabling Factors (KEFs in Figure 2.7) has been undertaken, by using pre-defined and ad hoc KEFs. All the information have been collected through Country/regional Fiches.

Phase II concerns the integrated analysis of all the information resulting by Phase I on each of the five sectors. At this stage, the common Innovation Potentials proposed for the MED area are defined considering and making an integration between the common challenges resulting by the Country/Regional analysis level.
Five Sector Reports have been produced as Phase II output.
Finally, in Phase III the integrated study between the 5 different sectors is performed by a cross-sectors analysis considering the pool of innovation potentials and the spatial distribution of the defined innovation potentials. The potential conflicts and/or synergies among sectors and the cross-sector study of their key enabling factors are also analysed in this phase of the work.
All country/regional fiches and sector reports at the base of this Blue Book are available on the Mistral website or upon request to the authors. This detailed analysis sets the basis for future implementations and will take into account the analysis of good practices, policies and tools with the specific focus on Country/Regional features in order to boost the Blue Growth.





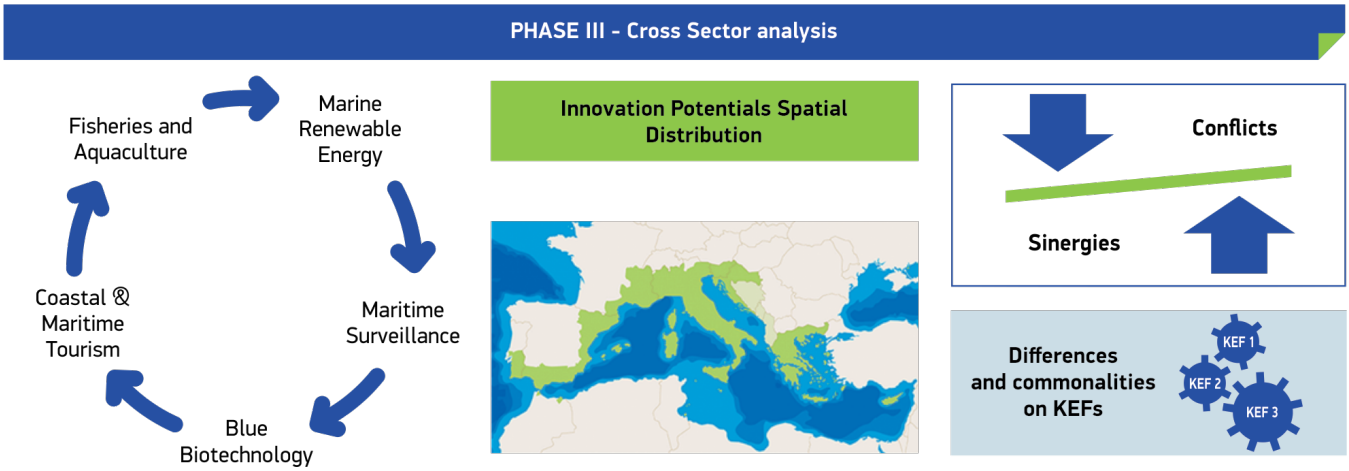


Fig. 2.7 The methodology underthe Mistral Blue Growth Book

3 THE MISTRAL SECTORS

3.1 MARINE RENEWABLE ENERGY

3.1.1 Introducing the sector and its subsectors

The marine renewable energies (MRE) refer to all renewable energies generated from the marine environment. They include energies produced using offshore wind, wave, current, tidal or sea water salinity and temperature. Offshore wind energy is generally differentiated from Ocean Energy (exploiting wave, current, tidal or sea water salinity and temperature). They represent different types of technologies, which are all solutions for diversifying the energy mix from metropolitan to island territories. These MRE have many assets, including: i) high potential of development; ii) high potential of diversification for traditional industrial sectors: carbon energy, metallic construction, naval maintenance; iii) social acceptability relatively higher at sea compared to terrestrial; iv) different types of application from electricity generation to renewable cooling and energy storage; v) synergies with other maritime activities.
Taking into consideration these factors, MRE are an opportunity to be delved to address some of these challenges, even if, at this stage, the different types of MRE are limited or at early stages of development in Mediterranean area.
This development cannot be done without a good knowledge of the natural and environmental conditions with which MRE are directly linked. Though the Mediterranean Sea is a vast territory, several characteristics applies to it as a whole:

- Deep water even close to the shore;
- Very small tidal range and then low tidal currents (accepted in localised corridors);
- Many islands;
- Inhomogeneous winds distribution with localised strong wind areas.

Hence, depending on its territory characteristics, each Mediterranean region will have to conduct an adapted development of MRE.
MRE have the potential to enhance the efficiency of harvesting the European energy resource, minimize land-use requirements of the power sector and reduce the European greenhouse gas emissions, in line with main International and EU policies.
EU industry is a world leader in blue energy and can contribute to reductions in carbon emissions outside Europe through exports. However, as recently stressed in the Communication “Renewable Energy: a major player in the European energy market”, further efforts to reinforce research and development in the field of ocean energy are needed. Indeed, to achieve the 2020 targets, different difficulties in the market development have to be tackled: a) energy production costs; b) operating life of equipment; c) logistics; d) energy storage; e) interconnection with onshore energy grids.
All types of MREs are not adapted/ proven enough to envisage a short- or medium-term deployment in the Mediterranean Sea. The development of MRE in the Mediterranean is by far lower than in the Atlantic area and Northern Europe. The main reasons are related to the natural conditions with lower wind, tide and current as well as higher depths in the Med area. There are less sites for the exploitation of MRE due to the conjunction of these factors. To fill this gap, incentive policies must be put in place, notably through the launching of tenders to finance the construction of MRE parks.
The Mediterranean industry will be able to develop with specific technologies addressing the local context with, for example, the floaters or the anchors; and if the Med countries currently developing pilot projects exchange their experiences.
The principal subsectors related to the marine renewable energy sector are described as follow.
Salinity Gradient Energy: a renewable energy source that can be harnessed from the controlled mixing of two different salt concentration water masses (when a river runs into a sea, the mixing of fresh and seawater occurs). Three potential river mouths located in the Mediterranean Basin have a high extractable energy potential. Among them, two are located on the European soil: the Rhone River in France and Po River in Italy. However, since salinity gradient energy is still a concept under development, further research is needed for this technology to uptake;

Tidal Energy (tidal range and current): tidal range involves installing a barrage dam structure across a river that uses the ebb and flow of the tides to create the height difference essential for generating energy. Although tidal range is a proven technology with long-term viability, the environmental implications of any new scheme are prohibitive in most scenarios. Tidal range structures are also characterized by high investment costs.
Tidal current generation involves installing turbines underwater in fast flowing tidal streams. The technology has been proven technically feasible, although costs must be lowered in order to compete with other renewable energy sources. Tidal energies are not conceivable and adapted to the Mediterranean only in some areas like Dardanelles, Gibraltar and the strait of Messina could have a potential for the exploitation of tidal energy (current). However, some more research and measurement are needed and expected. Non-technological barriers (as permits and heavy maritime traffic) are important notably for Spain where potential exists in the strait of Gibraltar.

Ocean Thermal Energy Converter (OTEC): a marine renewable energy technology that harnesses the solar energy absorbed by the oceans to generate electric power. The sun's heat warms the surface water a lot more than the deep ocean water, which creates the ocean's naturally available temperature gradient, or thermal energy. The bigger the temperature difference, the higher the efficiency. The technology is therefore viable primarily in tropical areas where the year-round temperature differential is at least 20°C.

Offshore Wind Energy (OWE): It is an MRE concerns the generation of energy from the wind. According to "The annual economic report on EU Blue Economy 2018", offshore wind is the fastest growing activity in the blue economy. In 2017, the EU has a total installed capacity of 15.8 GW in 10 northern European countries. By 2020, offshore wind is expected to reach a total installed capacity of 25 GW. The geographic configuration (i.e., high depth) of the Med sea gives strong limitations to the application of these technologies. The design of Floating offshore platforms is required to take advantage of this kind of MRE.

Wave Energy (WE): Ocean energy is abundant, geographically diverse and renewable. It could meet 10 % of the European Union's power demand by 2050. Priority will be given to tidal stream as to the generation of energy from the seas' waves (i.e., wave energy), which have a high market potential for Europe and sufficient scale on a European level.

Sea-water air conditioning (SWAC): it is an innovative and environmentally friendly form of air conditioning that uses sea water as a renewable source of cold water located nearby. The cold water being denser than the hot water, it masses deeply while only the surface layers are warmed by the sun. Cold deep-sea water is pumped and passes through a heat exchanger system to cool the water distribution network of the air conditioning. During this stage, the pumped water warms up by a few degrees. It is then discharged into the natural environment at a depth corresponding to its temperature. This technology avoids and replaces conventional electric air conditioning systems. It is already developed in the Mediterranean context especially on the French Mediterranean coast. Island territories are ideal places for the deployment of this technology. This type of energy has been mentioned by the French partner only.

3.1.2 Marine renewable energy in the MED area

In this section the results of the benchmarking analysis are discussed in detail giving an overview of the panorama of the MRE sector in the MED area. The analysis has been done in terms of socio-economic, technical and research aspects for each MED country using specific attributes which have been already discuss in the Methodology chapter (section 2.4).
Next graphs introduce the results of the benchmarking analysis, showing the levels of relevance (Fig. 3.1) and readiness (Fig. 3.2) of the sector in each country, making possible a comparison between the actual situations in the countries in the MED area.

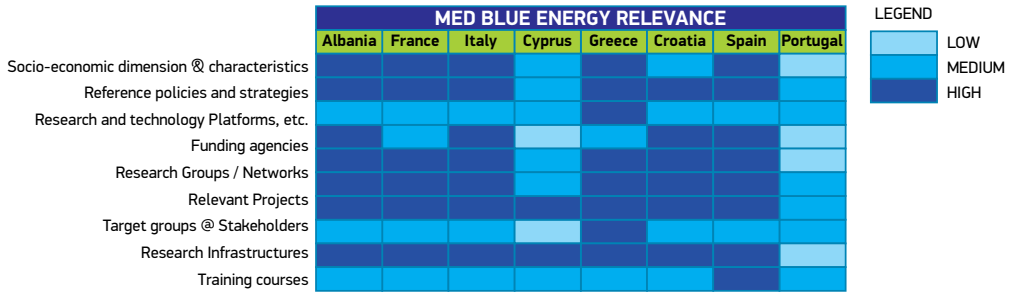


Fig. 3.1 Relevance of MRE sector in MED Countries

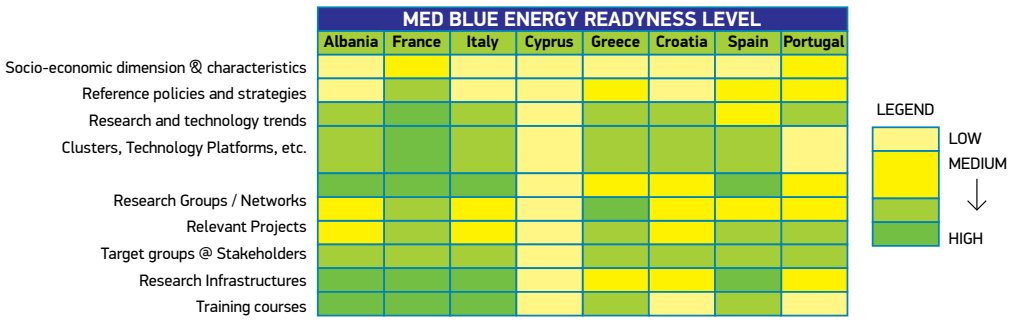


Fig. 3.2 Readiness of MRE sector in MED Countries

The matrices of results show that the MRE sector has been recognized with high relevance for the economic, social, technological and research etc. point of view from most of the MED countries. Moreover, the readiness level of these technologies is not already full developed in all the countries. Cyprus is an example of the country, which presents lowest readiness level of MRE sector for each attribute.

- **Key economic figures**

There is currently no commercial development of MRE in the Mediterranean. Despite the high potential impacts of MRE on socio-economic characteristics, the readiness level is low for most of the studied countries. This is explained by the fact that the MRE sectors in Mediterranean countries are at an early stage of development and R&D activities are expected. Most of the countries perceived the development of MRE as strategic and impacting their economy with the creation of new companies and jobs.

- **Reference policies and strategies**

Existing reference policies and strategies are targeting mostly renewable energies as a whole without making any distinction on the type of energy. There are very few policies specific to MRE at national level. At regional level, we observed that the large majority of the smart specialization strategies are targeting the development of marine renewable energies.
The identified strategies are derived from European plans and strategies which clearly targets the development of MRE as strategic for the European Union. Seas and oceans are considered as drivers for the European economy and have great potential for innovation and growth. We can underline the following strategies and plans: Blue Growth which is the long-term strategy to support sustainable growth in the marine and maritime sectors as a whole has a specific axis on Ocean and Offshore wind energies; The 2030 package Climate & Energy package is a set of binding legislation to ensure the EU meets its climate and energy targets for the year 2030.
The targets were set by EU leaders in 2007 and enacted in legislation in 2009. They are also headline targets of the Europe 2030 strategy for smart, sustainable and inclusive growth. One of the domains concerns the development of renewable energies. The EU member countries have also taken on binding national targets for raising the share of renewables in their energy consumption by 2030, under the Renewable Energy Directive. For 2030, the overall effect will enable the EU as a whole to reach[20]:
(i) a 40% cut in greenhouse gas emissions compared to 1990 levels
(ii) at least a 32% share of renewable energy consumption, with an upward revisions clause for 2023

[20]https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2030-energy-strategy

(iii) indicative target for an improvement in energy efficiency at EU level of at least 32.5%, following on from the existing 20% target for 2020
(iv) support the completion of the internal energy market by achieving the existing electricity interconnection target of 10% by2020, with a view to reaching 15% by 2030
Moreover, by 2050, the EU intends to reduce its emissions considerably, by 80 to 95% compared to 1990. The European Strategic Energy Technology Plan (SET PLAN) aims to accelerate the development and deployment of low-carbon technologies. It seeks to improve new technologies and bring down costs by coordinating national research efforts and helping to finance projects.
Concerning floating offshore wind, the SET Plan targets in its declaration of Intent to "develop cost competitive integrated wind energy systems including substructures which can be used in deeper waters (>50m) at a maximum distance of 50 km from shore with a levelized cost of energy (LCoE) of less than 12 ct€/kWh by 2025 and less than 9 ct€/kWh by 2030, striving towards cost competitiveness[21]". Concerning ocean energies, the plan targets for the levelized cost of energy (LCoE) are: i) for tidal stream energy: reduction to at least 15 ct€/kWh in 2025 and 10 ct€/kWh in 2030; ii) for wave energy technology, it should follow the same pathway through convergence in technology development and reach at least the same cost targets maximum 5 years later than tidal energy: 20 ct€/kWh in 2025, 15 ct€/kWh in 2030 and 10 ct€/kWh in 2035.

COUNTRY	CLUSTERS AND TECHNOLOGY PLATFORMS MENTIONED
ALBANIA	Albany Energy Association
CYPRUS	Blue Energy Cluster – Cyprus Hub (PELAGOS - Marinem)
FRANCE	Pôle Mer Méditerranée
	Pôle Mer Bretagne Atlantique
	French Maritime Cluster
	France Energy Eolienne
	Marine Energy Observatory
	Cap Energies
	DERBI
GREECE	CHORUS
	Blue Energy Cluster – Greek Hub (PELAGOS)
	Blue Growth Strategy of the municipality of Piraeus
ITALY	National Technology Cluster – Blue Italian Growth (BIG)
	Energy Cluster
	Italian Community of the offshore wind
	Blue Energy Cluster – Italian Hub (PELAGOS)
	RON
Portugal	Forum Oceano
SPAIN	APPA Marina
	PAT 18 – ENERMAR
	PTM – Plataforma Marítima Española
	Wave Energy and Offshore Wind Basque Country
	Sea of Innovation Cantabria
	CMC - Clúster Marítimo Canarias
	AVAESEN - Asociación Valenciana de Empresas del Sector de la Energía
European	Waterborne
	ETIP Wind
	ETIP Ocean Energy
	Wind Atlas

Table 3.1 Clusters and technology platforms in MRE sector

[21] https://setis.ec.europa.eu/system/files/setplan_wind_implementationplan_0.pdf

- Clusters, Technology Platforms

Clusters and technology platforms listed in Table 3-1 are seen of medium or high relevance in all MED countries. Except Portugal, which grades the maturity level of its clusters and technology platforms with a low readiness level, all countries think they have a high or almost high readiness level in terms of clusters and technology platforms.

For the countries where the sector is in development (mainly France and Italy), there are some clusters and technology platforms which aim is to create and coordinate a community of actors around the topic. For the countries in which the sector is less developed, such organizations do not exist or are at their first steps (e.g.: PELAGOS hub in Cyprus).

Most clusters mentioned in the country fiches are not focused on Blue Energy but are working on all energies or on Blue Growth. Except for PELAGOS hubs, there is no cluster specialized in marine renewable energies.

Most clusters or technology platforms are dealing with energy as a whole and work partially on marine energies.

The differences between countries and the maturity of clusters depend on the national cluster policy driven in each country. For example, in France, where the cluster policy is quite developed, clusters are then much more organized and oriented on Blue Energies. They play a key role in the sector development. In countries where the sector is less mature, it seems that no cluster were created but professional organizations or networks play that role of structuring the sector.

- Funding Agencies

It appears that the European Union, through its various funding agencies and subsidy programs is a key financing player supporting the development of the marine renewable energy in the Mediterranean area.

In fact, at EU Level, the European Regional Development Fund (ERDF), the Horizon 2020 Funding Program as well as the European Funds for Strategic Investment (EFSI), the European Structural and Investment Fund (ESIF) and the European Maritime and Fishery Fund (EMFF) have a significant financial impact on the development of marine renewable energy. To this list can also be added the European Investment Bank (EIB).

At national level, only France, Greece, Portugal and Spain seem to have a significant national funding scheme focused on the MRE sector. For example, in France the ANR (National Research Agency), ADEME (Energy Management and Environment Agency), BpiFrance (Public Investment Bank) and the FUI (Fonds Unique Interministeriel) are granting funds to support R&D; and renewable energy is one of the key topics on which they focus. In Greece, only the National Fund for Environment through Green Fund programs is an active MRE financing player. In Portugal, the government is financially active through the Portugal 2020 Funding Program, the Fundaçao de Ciênca e Tecnologia Funding Program, the Mar 2020 Funding Program and the Fundo Azul Funding Program. In Spain, there is financing participation at national level through the actions of the CDTI (Centre for the Development of Industrial Technology).

In Cyprus, it is still worth to note the involvement of the state through its Research Promotion Foundation and the Support Scheme for large scale RES plants.

At regional level, all institutional bodies of regions facing the sea in Italy can provide with funding for MRE. In France, the Sud (Provence Alpes Côte d'Azur) and Occitanie regions as well as some regions on the Atlantic coast can also provide with funding. To be noted that these funds arise mainly from European programs (such as ERDF) involving a cascade financing to regional institutions.

- Research Groups, networks and other resources

Research in the MRE sector is very well developed in some of the Mediterranean countries under study in this report, such as France and Greece, and fairly developed in Italy, Portugal and Spain.

However, in Albania and Cyprus there are only very few research groups and networks active in the research field of MRE, and they usually are not specialized in MRE, as they rather deal with broader topics such as geosciences, energy, water, environment and engineering (cf. the Albanian Institute of GeoSciences, Energy, Water and Environment, the Albanian Centre for Energy Regulation and Conservation, a think tank focused on the Albanian en-

ergy market or the Oceanography Centre of the University of Cyprus).
In France, Greece, Italy, Portugal and Spain knowledge and expertise in particular in the offshore wind and wave energy sub-sectors have been acquired over the last decade and many research projects are still ongoing, allowing for more concepts and technologies to be developed and analysed. The organizations, groups and networks active in the field of MRE research in the abovementioned countries are various and they tackle different research needs, from wind and ocean resource assessment to floating concepts, mooring systems, cables, substations, storage and interconnections. Some of them are also involved in research studies related to environment interaction.
There are several types of research groups: state-controlled institutes, laboratories and companies, privately-owned companies and institutes and university departments.
State-controlled institutes and laboratories are the direct consequence of government policy supporting R&D in key sectors. This is the case in France with France Energies Marine, whose role is to foster the French marine renewable energy sector's competitiveness by developing R&D projects, providing support services to MRE companies and facilitating discussions among the sector's stakeholders. Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER), an oceanographic public institution is also deeply involved in MRE. In Greece, the Hellenic Centre for Marine Research (HCMR) is a governmental research organization operating under the supervision of the General Secretariat for Research and Technology (GSRT). They have developed a methodology for identifying potential marine areas for the siting and development of offshore wind and wave parks. Another key public research player in Greece is the CRES (Centre for Renewable Energy Sources and Saving) which was founded in 1987 by Presidential Decree. CRES is active in the field of applied research on new energy technologies and they have for example installed a demonstration Wind Park in the area of Agia Marina in Lavrio-Attica. In Italy, public institutes and organizations active in MRE research and development are the CNR, ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development), IIT (IstitutoItaliano di Tecnologia) and GSE (GestoredeiSistemiEnergetici) a state-owned Italian company that promotes and supports renewable energy sources. In Portugal, the National Laboratory of Energy and Geology (LNEG) and the Instituto Hidrografico, laboratories governed by the Ministry of Economy and the Portuguese Navy, respectively; and INEGI (Institute

of science and innovation in mechanical and industrial engineering), a public institution, are conducting research in the MRE field. Finally, in Spain, CTN (Centro Tecnologico Naval y del Mar) and CTC (Components Technological Centre) are also key public players.
Engineering schools and university departments are also deeply involved in MRE R&D, with for example Centrale Nantes, Centrale Marseille and Aix-Marseille University (with their IRPHE laboratory) in France, the Piraeus University of West Attica (with its Laboratory of soft energy applications and environmental Protection-SEALAB), the Department of Environment of the University of Aegean (with its Energy Management Laboratory), the School of Naval Architecture and Marine Engineering of the National University of Athens (with its Laboratory for Floating Structures and Mooring Systems) in Greece, the Aerospace Department of Politecnico di Milano (and their POLI-Wind group), the University of Campania Luigi Vanvitelli (with its Department of Civil Engineering, Design, Building and Environment), the University of Florence (with its Interuniversity Centre for Building Aerodynamics and Wind Engineering), the University of Calabria, Naples Fedrico II, Padova and Politecnico di Torino and many others in Italy, Instituto SuperioTecnico in Portugal, and the Malaga University (with its Department of Fluids, Systems and Hydrodynamics of Vehicles), Cadiz University (GOFICA research group) or the University of Cantabria (with IH Cantabria) in Spain.
Finally, many private companies have their own dedicated R&D department either to develop their own projects or others'. There are for examples, Eolfi, Ideol and Naval Energies in France, Wave for Energy (Srl) in Italy, WavECOffschore Renewables in Portugal, and Tecnalia (a private applied research centre) in Spain.
All in all, these institutions have a significant amount of past and ongoing MRE research and experimental projects (see Relevant Projects section). Furthermore, some of them are hosting research infrastructures, another key element of R&D.

- Relevant projects

There are currently several ongoing projects that deal with marine renewable energies in the Mediterranean countries under study.

European collaborative projects funded by INTERREG-Med, H2020 or Med-Maritime Integrated programs are very active in these countries. They tackle various relevant challenges linked to promotion, knowledge sharing and key R&D barriers that the marine renewable energy sector is currently facing.

Some of these European collaborative projects have more of a promotinggoal as enlightening economic opportunities, identifying technical and non-technical solutions, creation of cluster in blue energy and sharing of knowledge among scientists encouraging effective measures and investments for the blue growth for example BLUENE, ENERCOAST, PELAGOS, PRISMI and MAESTRALE.

Other European collaborative projects are more R&D-focused: they usually deal with one specific R&D aspect that is key for the future development and commercialization of blue energy technologies. For example, OSMOSE, DREAM and TILOS work on the smart electrical grid needs. Other projects focus on new concepts such as multi-purpose floating offshore systems REPOS, FLOATMASTBLUE.

On their side, MARINET and DTOCEAN PLUS aims at providing easier access to R&D tools, as they respectively target research infrastructure integration and easy access and design tools availability. Other projects concerning big data management should be highlighted too. These projects focus on the observation of social, physical, biological and chemical parameters of Mediterranean seas in order to develop accurate management systems to increase the effectiveness and mitigate potential impacts of offshore renewable energy investments.

European projects via for example its H2020 SME Instrument's project also finances projects as Ideol in France with its Leadfloat project, Nautilus in Spain which both worked on a type of floating foundation for floating offshore wind turbine and iReact project developed by EMTECH Diastimiki.

Although the EU finances many projects linked to the blue energy sector, it is key to point out that several projects are also led at national level only. This is the case for example of E-Wave in Cyprus, a project which was developed by the Oceanography Centre of the University of Cyprus and which studied the wave energy potential. In France, France Energy Marine has launched and managed more than 30 R&D projects since 2012 through 4 research programs.

Another type of projects that cannot be left aside given their significant impact on the blue energy sector development in Europe are demonstration projects and pilot farms.

For what relates to the floating offshore wind sector, there are currently 2 demonstrators in France (in operation) and 1 in Spain (commissioned for 2020), but all of them are located in the Atlantic Ocean. We can also count 4 pilot farms in France, 1 in Italy, 1 in Portugal and 2 in Spain that should be in operation in the coming years. Only 3 of these pilot farms are

located in the Mediterranean Sea (off the French coast). When it comes to the wave and tidal sectors, only France, Portugal and Spain have ongoing demonstrating projects, however all of them are located in the Atlantic Ocean, only Italy has demonstrators in Med area.

- Target groups and stakeholders

Target groups and stakeholders can be classified in different kinds of entities: companies, public authorities, associations, professional organizations and support organizations, which are organizations which help the development of innovation. It is hence a very wide category and the project partners from the Mediterranean countries under study reference heterogeneous actors. However, some tendencies can be highlighted.

Target groups and stakeholders of the Blue Energy are mainly evaluated with medium relevance for the development of the sector and a medium-high readiness level. These actors have an important role to play in the innovation in this area.

Apart from companies, the mentioned organizations are not exclusively linked to marine renewable energies but are working on energy issues at a whole or on renewable energies. For some countries, ministry and public institutions working on environment or related topics are included in stakeholders.

Countries with a less maturity level in the sector (Albania and Cyprus notably) include more public authorities in their stakeholders, whereas countries with a higher maturity level (France, Italy, Greece, Spain) mention more private entities, such as companies and professional networks/associations. It is a good projection of the market maturity and potential: in countries where there are less opportunities, private entity did not yet seize markets.

- Research Infrastructures

Research infrastructures are present in four countries, namely France, Greece, Italy and Spain whilst none has been pointed out in Albania, Cyprus or Portugal.

There are various types of research infrastructures: offshore marine test sites, tanks and channels, and observation buoys.

Both France and Spain have offshore marine test sites however only one is located in the Mediterranean Sea: the Mistral offshore test site, located in the Fos Gulf. It creates the opportunity for various parties working in the blue energy industry to carry on research and experiments in real conditions. The 4 other marine test sites are located in the Atlantic Ocean: two are located off the Spanish coast in the Basque country (BIMEP and HARSHLAB), one in the Canary Islands (PIOCAN) and one off the French coast (SEM-REV).

There are onshore test facilities in Spain, Italy, Greece and France, operated either by public institutions (such as the IFREMER water tanks in France or the CNR water tanks and wind tunnel in Italy), by schools and universities (such as the SeaLab of the University of West Attica in Greece, the IRPHE swell and hydraulic canal in France, the Cantabria Coastal and Ocean Bassin or the Natural Wave Energy Lab in Napoli, Italy) or by private entities (such as the Oceanide test facilities in France).

These facilities allow different structures to be tested in their environment of use and is key for R&D advancement.

Observation buoys have been set in France and in Greece. In France, the project is called MemoFlow and has been installed on the Mistral marine test site. In Greece, the Poseidon System-Long variability monitoring infrastructure, operated by HCMR is an operational monitoring, forecasting and information system for marine environmental conditions that works thanks to a network of observation buoys enabling to collect various types of data.

- Training Courses

There are no or very few training courses focusing on marine renewable energies themselves all over the MED area (see Table 3-2). It could be explained by the fact that marine energy is a sector under development and that the skills assessment is still under evaluation in order to know which competences are needed and missing in comparison with the existing trainings in other domains. For the time being, most countries propose general engineering trainings, probably because no specific needs and competences have been identified yet by the economic actors of the domain. The only courses specialized in marine energy are professional courses. For the moment, only very few trainings exist for qualified workers in that field.

It should be interesting for the innovation enhancement, to rely on workers highly-qualified in one or several marine energies. Moreover, that could answer to the need of diversification for workers. Competences from other sectors of activity such as offshore Oil & Gas are transferable to marine energy sector. The adaptation and conversion of competences from other sectors and the creation of new trainings to the specific needs of MRE will be crucial for the sector long term development.

For a majority of MED countries, except for Cyprus, Portugal and Spain, training courses is not deemed of high relevance for innovation. However, in most countries training is evaluated at a high readiness level, except for Greece and Portugal in which training courses are graded of medium readiness level.

COUNTRY	TYPE OF TRAINING AVAILABLE
ALBANIA	Several training (university or professional) but mainly in engineering. All trainings are completed today.
CYPRUS	No courses on blue energy but some programmes on energy more globally. However, the Cyprus authorities have identified the needs for qualifications in Blue growth sectors.
FRANCE	All courses are ongoing, except one which is expected in the future. The majority are dealing with engineering and marine energies as a whole but a few of them are dedicated to MRE.
GREECE	Several training courses on going, and one completed which will happen in the future again (Seminar). On-going courses are engineering ones with a marine and/or energy dimension.
ITALY	General engineering trainings and management or innovation courses are set up in universities. Specific trainings on energy types are available but are professional courses.
PORTUGAL	Very few and very general courses on renewable energies.
SPAIN	Very few and very general courses on energies or renewable energies.

Table 3.2 List of available training courses in MRE sector

3.1.3 Identifying innovation potentials and key enabling factors

3.1.3.1 Opportunities and benefits

Two main blue energies have been selected and identified as main innovation potentials by all the MED countries from the Country fiches, which are:

Floating Offshore Wind Energy (FOWE): floating offshore wind is a breakthrough innovation market, as opposed to offshore wind with fixed foundations, whose development potential is limited mainly by the bathymetry of the oceans and seas - 40-50 meters deep being the threshold commonly accepted by the players of the market. As floating wind farms can be deployed in deeper waters, it permits to exploit areas further offshore which offer better wind resources (offshore wind corridors being more productive) and to improve the social acceptability of the location of farms projects.
It is particularly adapted to the Mediterranean as practically no important installations of wind turbines with fixed foundations are possible (continental shelf and deep water even in coastal areas). The development of floating offshore wind turbine market responds on the one hand to specific characteristics arising from the technologies currently being developed and, on the other hand, to the market potential of the offshore wind laid on sea floor, which is technologically more mature and therefore in the short term economically more attractive. As already specified in introduction, offshore wind is the fastest growing activity in the blue economy in Europe with a total installed capacity of 15.8 GW in 2017 and an estimation of 25 GW installed in 2020. Among it, the floating offshore wind energy is emerging. In 2018, the state of the art in Europe is the following
While FOWE technology was previously confined to R&D, it has developed to such an extent that the focus is now moving into the mainstream power supply.
The floating offshore wind turbine appears to be the blue energy offering the strongest market potential in the short and medium term. It is particularly adapted to the Mediterranean but obviously if the potential sites are windy.
While FOWE technology was previously confined to R&D, it has developed to such

COUNTRY	FLOATING OFFSHORE FARM
FRANCE	- 4 pilot farms projects ongoing (1 on Atlantic and 3 on Mediterranean coasts) with a capacity of 24MW each, composed either of 3 turbines of 8 MW or 4 turbines of 6 MW. Commissioning expected for 2021. Objective to launch thereafter industrial farms of 500MW each;
	- 2 test floating offshore turbines (Floatgen and Eolink) already in operation;
PORTUGAL	Installation in 2018 of a 25 MW wind farm consisting of WindFloat systems off Viana do Castelo (WindFloat prototype completed with success a five-year testing phase at the end of 2016);
SPAIN	- 2 pilot farms projects ongoing (on Atlantic coast) with a capacity of 5 and 25 Mwand an expected commissioning in 2020;
	- 1 test floating offshore turbine (DemoSATH) expected in operation in 2020.

Table 3 3 List of Floating Offshore MED Farms

an extent that the focus is now moving into the mainstream power supply.
The floating offshore wind turbine appears to be the blue energy offering the strongest market potential in the short and medium term. It is particularly adapted to the Mediterranean but obviously if the potential sites are windy.

Wave Energy & Tidal Energy: technology in wave energy is still being proven. The optimum technological model is yet to be defined. Several pioneering players have built up prominent positions while new entrants are arriving to the market. The segment is regarded by the European Commission as entering the introductory market stage.
Waves are formed by winds blowing over the surface of the sea. The size of the waves generated will depend upon the wind speed, its duration, and the distance of water over which it blows (the fetch), bathymetry of the seafloor (which can focus or disperse the energy of the waves) and currents. The resultant movement of water carries kinetic energy which can be harnessed by wave energy devices.
The potential is however very limited in the Mediterranean.
During the last decade important progress has been achieved as regards wave energy development especially in Italy. A (near) full-scale demonstration project where a full-scale Inertial Sea Wave Energy Converter (ISWEC) prototype has been developed and tested in Pantelleria and its impact on Posidonia Oceanica meadows has been assessed as well as another plant in Lampedusa (Sicily). The rated power of ISWEC was 100 kW, and the mooring took place at 800 meters from the coast in a water depth of 35 meters. The principle of operation of ISWEC consists in the interaction of sea waves with the hull of the device and the gyroscopic system. Moreover, a prototype Overtopping BReakwater for wave Energy Conversion (OBREC) has been implemented and tested at the Port of Naples. The principle of operation of OBREC is based on the difference between the water levels in the reservoir and the sea water level that can be exploited through low head turbines[22].
Next scheme shows the geo localization of the IPs as emerging from the Country fiches. We chose to perform the following analysis only for the IPs commonly defined by all the MED countries.

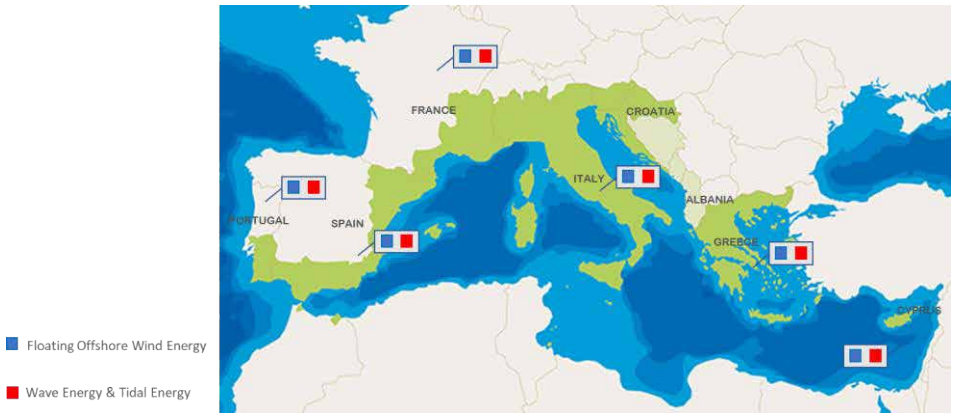


Fig. 3.3 Geo localization of innovation potentials MED request as emerging from the Country Fiches

Most of the MED countries identified the two innovation potential, Floating Offshore Wind Energy and Wave Energy & Tidal Energy, as principal challenges for the development of MRE. Except Croatia and Albania which have not competence and developed technologies in the MRE field. Greece identified also other main challenges as innovation potential: Smart Microgrid Systems, Provision of research services and facilities which are fundamental parallel aspects for the development of the two principal IPs. Also, Italy identified as IP the concept of integrated technologies energy island. The energy island concept or "energy archipelago" is not completely new but can be seen as a particular specification of the well-known multipurpose offshore platform concept specialized for energy purpose.
The main idea is to combine different kind of renewable sources of renewable energy: wind, waves but also solar and geothermal in order to guarantee a continuous production of energy from different sources. Moreover, this concept also includes the local storage of the energy produced and the possibility to produce energy that can be fed directly into the grid or used locally to produce hydrogen (ships can in the future use these islands as a supporting infrastructure) or to sustain desalinization processes or aquaculture activities.
The energy archipelago is not presented in the report as a subsector or an innovation potential even if it is considered as a viable option for the deployment of MRE in the Mediterranean area.
In this Section the benefits and the opportunities related to each innovation potentials are discussed in detail with reference to the actual situation of the MED countries. The analysis has done for each defined KEF. In particular, the two IPs have been analysed separately for the technological aspect moreover, for other KEF the situation of the different IPs is common and discuss in a unique description.
The scheme below (see Table 3-4) introduces the results of the analysis in terms of opportunities and benefits defined for each innovation potentials chosen.

FLOATING OFFSHORE WIND ENERGY	WAVES&TIDAL ENERGY
R&D Demonstration projects Correlation between EU and national policies Human skills Funding at EU level	R&D and technical knowledge Existing technological prototype Correlation between EU and national policies Human skills Funding at EU level

Table 3.4 Lists of benefits for the innovation potentials in MRE sector

[22]Marine Renewable Energy in the Mediterranean Sea: Status and Perspectives_Energies 2017 Takvor H. Soukissian ID, Dimitra Denaxa 1, Flora Karathanasi, Aristides Prospathopoulos, Konstantinos Sarantakos, Athanasia Iona Konstantinos Georgantas 1and Spyridon Mavrakos.

As already mentioned, the blue energy sub-sectors that constitute a real opportunity for the Mediterranean Sea are the floating offshore wind and to a lesser extent the wave and tidal energies. Their technological and commercial readiness varies from one country to another, as detailed below. That being said, the current context (in terms of policies, HR, funding and R&D) in Europe in general and in some of these countries in particular creates a breeding ground for further development of these energy sources. This context is an opportunity that has to be seized given the several benefits that further advancement in the blue energy sector would bring to Europe.

Floating Offshore Wind Energy

If research and development activities in the field of floating offshore wind are not carried out in countries such as Albania and Cyprus, however, in the other countries under analysis here, R&D activities are currently performed with various levels of intensity in this field. Greece and France present the high wind energy potential.

In Italy, France, Portugal and Spain demonstration projects are currently running and/or are being developed (with pilot farms capacity in the range of up to 24MW each). This has created a real dynamic in terms of R&D. Several technologies are tested, notably concerning the floating devices. Various actors as research platforms, labs, multinationals and SMEs are involved in those projects. Nevertheless, R&D effort are still expected to identify areas to reduce the cost of the energy (Processes and means of installation, Underwater electric architecture, Submarine cables, Performance of production systems, Operation and maintenance the stability simulation of floating wind turbines, wind turbine size and embodied energy, moorings, etc.).

We can finally highlight that in most of the countries under study here, the onshore wind energy sector is developed which can favour the emergence of the offshore wind energy through technology transfer.

There is no commercial deployment of floating offshore wind farms in the Mediterranean. France is the most advanced country in that field because the government has defined through a consultation process the areas where the commercial FOWE farms will be deployed. Most of the studied countries (except Albania and Cyprus) estimate that they gather many actors (large enterprises, Labs and SMEs) with large business experience in the com-

mercial exploitation of energy projects and expertise to address the technological and non-technological stakes.

Wave and tidal energy
Apart from Albania, the different countries are currently performing prototyping and for some of them demonstration projects. A wave plant and a tidal current project are currently in operation in the Atlantic Ocean (waves in Spain and tidal in France). Italy has also plants in Pantelleria and Lampedusa. Most of the countries underlined the important R&D activities for wave technologies with patents and significant technical and scientific expertise in wave energy, as well as in the modelling / prediction of conditions.
Wave power is an emerging technology but there are no developed systems under commercial operation. These innovations are either not ready for commercial development or limited to very particular sites. We can point out that Italy have many companies involved in the production of buoy, turbines and related technologies used for the extraction of energy from waves and currents.

The benefits and opportunities in terms of the other KEFs (except for the technological point of view) are common for both the defined IPs so they are discussed together in the following section.

Floating Offshore Wind Energy & Wave and tidal energy
The current political context in Europe and in most of the countries under study here is encouraging. In fact, both European and national policies already exist to foster the development of RES. This is a first step towards further policies vote and implementation, which will hopefully one day be more specific on MRE.
For example, Cyprus has announced in 2017 a Support Scheme for large scale RES plants. It aims at increasing the share of RES in the country's energy consumption. France has numerous policies that aims at accelerating the transition to an eco-friendlier economy and its Multi-Annual Energy Plan (PPE – Programmation-pluriannuelle de l'énergie) now includes different renewable energy sources, out of which marine renewable energy and in particular offshore wind energy. Similar examples exist for all the Mediterranean countries under study here. The EU as previously mentioned influences significantly these national policies.
This constitutes a suitable context and it could pave the way for further political implication, without which it will be extremely difficult to turn the ongoing MRE research projects and demonstrations to full-scale and commercially viable operations (see below Gaps to address).
Highly-specialised scientists and engi-

neers are adequately provided in the countries under study. Skills for welders or electricians needed for constructing or maintaining reliable and safe floating, offshore and underwater machinery, require specific training. The technical expertise and technologies derived from the general offshore field, mechanical engineering, and robotics (etc.) are available in the area, and this constitutes a real chance for the MRE sector.

The main human resource is correlated to the maintenance of the systems and the grid connection. This kind of skills already exists in other marine applications which constitute an opportunity for the overall sector development.

Adequate experiences, scientific know-how, knowledge sharing and skilled human resources as well as longstanding University education on the exploitation of MRE and sustainable management of ports is however needed.

In a minority of countries, specific funds are active and currently allow for MRE projects financing. We can also underline the existence of other funds which are not directly dedicated to MRE but that can impact it positively. For instance, in Greece, a special fund for ports infrastructures may be thought of in order to finance the specific infrastructures needed for FOWE.

But in majority, there are no dedicated funding programs at national level.

European funding at centralised level with notably Horizon 2020 and at regional level with the European Regional Development Fund (ERDF) play a key role in the development of MRE across the EU. These funds are very helpful for R&D activities. According to “The annual economic report on EU Blue Economy 2018”, around 320 organisations operate in the ocean energy sector across Europe, of which 140 participate in the European Commission’s research programme Horizon 2020.

The support from the EU is a real opportunity for MRE and this domain is fully in line with the European current strategies. In fact, it is one of the domains targeted by the EU Blue Growth strategy and it is also fully in line with “EC perspectives for Offshore Wind Energy: Action needed to deliver on the Energy Policy Objectives for 2020 and beyond”.

In addition, the MRE sector should feature in the National Energy and Climate Plan to 2030. All the support schemes are expected to continue with a mid- to long-term vision.

However, an increased public support at national level could leverage the private investment for the development of MRE projects. This is for instance the case for the FOWE demonstration projects that are under development in France where the investment is shared: 35% of the financing comes from public sources with the 65% remaining being private.

As highlighted in the above sections related to research and ongoing projects, the R&D activity around MRE is well developed in most of the Mediterranean countries under study.

The knowledge for this sector is relatively high and prototypes of offshore energy technologies are being developed by academic institutions, laboratories and private entities. These technologies can be tested in “real” conditions thanks to facilities such as marine test sites, water tanks, wind channel etc.

This flourishing R&D context is a real opportunity for the blue energy sector. Now the main challenge consists in integrating all these singular projects and favouring knowledge sharing, while focusing on technical and non-technical barriers to the development of MRE that could be solved through additional R&D research.

In addition, the emphasis must be put on the transition from fundamental research to economically-viable applications and in some countries, synergies must be created between all parties, with companies on-boarded as stakeholders.

3.1.3.2
Gaps and enabling factors to address

Based on the above-described situation of MRE advancement in Europe, the main gaps currently constituting a barrier to further and smoother development of the blue energy sectors can be identified. In order to address these gaps, some recommendations can be offered. Table 3-5 introduces the results of the analysis in terms of gaps defined for each innovation potentials chosen.

FLOATING OFFSHORE WIND ENERGY & WAVE AND TIDAL ENERGY
Coordination of governments schedules of deployment and supporting policies for MRE in order to maximise regional cooperation also with stakeholders for increase investments Additional funding instruments to provide access to low cost financing for pilot projects and increase the funding to research and innovation focused on cost-competitiveness Training courses for specialized skills Soft competences to enable the dialogue between the stakeholders and facilitate the decision to implement MRE project Public funds also to improve the public acceptance as well tax incentives Reinforce of R&D for specific topics Lack of marketing actions in the different countries and a lack of awareness about MRE

Table 3 5 Lists of Gaps of the IPs in MRE

The gaps in terms of the other KEFs are common for both the defined IPs so they are discussed together in the following section.

Floating Offshore Wind Energy & Wave and tidal energy

In order to reinforce investors' confidence and allow stakeholders of the blue energy value chain to keep committing to this sector, governments should provide a clear view on their capacity ambition, project pipeline and supporting policies in their National Energy and Climate Plans (NECPs) to 2030. This would provide regulatory certainty concerning planning, design criteria and characterization of concession areas.

In the most mature countries, such as France where bids for offshore wind commercial and pilot farms have already been launched, the government should publish a long-term calendar of the next calls for bids, which should present a significant number of coming bids, well spread in time, with sufficient capacity requirement to optimize connection grid and enable stakeholders to make out future economies of scale.

In countries where the blue energy sector is not as mature, it is key that governments show their will to evaluate available marine renewable resources, proceed with mapping and characterisation of concessions areas as this would be a good start to boost the blue energy sector.

Furthermore, the governments should coordinate their schedules of deployment and supporting policies for MRE in order to maximise regional cooperation in the development of a European supply chain.

All these policy measures would allow operators and manufacturers to consider positioning themselves, plan for investments and size their production tool accordingly. Electricity distributors could also anticipate grid connection investments.

It will also be key that governments work to improve public perception about the growing share of renewable energies in household's electricity bills and justify the fact they bid on renewable energies, which currently remain more expensive than other sources of energy such a nuclear energy in France.

The national and European regulators could also work on defining ways of solving potential conflicts about use of maritime space.

Finally, at European level, additional funding instruments should be earmarked to provide access to low cost financing for pilot projects and increase the funding to research and innovation focused on cost-competitiveness. Some already exist, as for example the NER 300 European programme, which is endowed with 300M€ and targets demonstrators. It has granted Floatgen in France and Windfloat Atlantic in Portugal.

Despite the fact that different training courses exist with competences and expertise already available, there are gaps to address. As seen in the previous section, they are few training courses available that are fully dedicated to MRE sector.

MRE training courses are needed to convert these previous skills to the requirements of MRE projects and to acquire specialised skills that are needed for those specific technologies and

infrastructures.
Concerning professional lifelong learning, there is a lack of professional courses and qualifications (no high-degree but more technicians and qualified workers). We can also underline specific needs concerning skilled welders and electrician workers for offshore platform.
A dedicated competence & training centre at EU level to support the development of marine energies could be envisioned to have shared qualifications.
Finally, skills and an exchange of experience is required for the development of soft competences to enable the dialogue between the stakeholders and facilitate the decision to implement MRE project.
Despite the strong commitment of the EU through its funding programs and the investment of some countries, there is a lack of funding for Blue Energies.
It is needed to have public funds targeting the economic development and sustainability of the technologies, in order for them to become cost-competitive.
In fact, it is key to note that the current scheme of national financing of commercial plants, such as offshore wind energy commercial plants in France, is controversial.
Consequently, public national financing should grand projects working on cost-reduction and cost-competitiveness of MRE, otherwise the subsidy bill for commercial plants (once in operation) will be tremendous. By enabling MRE to become cheaper, through innovation and economies of scale, funding of new commercial plants will be more affordable.
There is also a need for funding in order to assess the environment interaction and impact of MRE to improve public acceptance. A need for new and adapted infrastructures to the development of MRE has been expressed (for ports especially).
There are still many topics on which research must be done and for which innovation must be developed. Some of these R&D needs are technological but a number of them are not.
The main technological stakes are: a) an overall cost reduction; b) connection to the electricity grid, electricity system flexibility and storage; c) suitability of the anchors and foundations to the surrounding environment: to reduce the cost of anchoring and maintaining MRE systems; d) performance of production systems; e) resistance of MRE systems in rough marine conditions: materials must be adapted to resist against corrosion and marine biofouling; and f) the adaptation of shipyards and ports.
Moreover, the main non-technological stakes are the estimation of exploitable resources and predictability of electricity production, the environmental impacts and interaction, the socio-economic impacts and cross-sectorial interaction and safety and security of construction, installation, maintenance and dismantling procedures.
Given the technologies adapted to the Mediterranean context are still at early stage of development, R&D is still a key enabling driver of their further advancement and commercialisation.
The emphasis must also be made on demonstration projects, which enables to anticipate potential challenges and to involve additional players in the game while constituting a showcase for the industry.
There is a lack of marketing actions in the different countries and a lack of awareness about Marine Renewable energies in general and this concerns the different stakeholders: Industries, Research and academics actors, Policy makers and the civil society.
To cover this gap, significant communication campaigns are needed to increase public understanding and facilitate the acceptance of MRE projects. Research results regarding MRE industry impacts on the environment should be notably published in order to facilitate acceptance by local communities.
Marketing, communication to public authorities and publicity are indicated as very influential and impactful factors for future developments in MRE.

3.1.4
Outlook and expected trends

The Mediterranean European countries are more and more focused on RES as a solution to “decarbonise” energy producing. It mainly concerns solar and onshore wind energy.
For what relates to MRE, in general, the Mediterranean Sea has less potential than the Atlantic Ocean, the English Channel or the North Sea. Areas benefiting from strong and regular wind are limited (Lion Gulf, Aegean Sea and very specific areas). Areas with strong tidal current are limited to deep straits. Wave energy is inconstant and can be considered only for specific areas (such as islands or coastal facilities integration). Thermal energy can be of interest for most of the Mediterranean coasts but only to produce air conditioning (cold & heat) as no electricity could be produced from it in the Mediterranean Sea.
During consultations organised to define the suitable areas for MRE, many questions have been asked by professional stakeholders, mainly the fishermen, and by the environmentalist about interactions between MRE (mainly offshore wind turbines) and marine ecosystems and avifauna. Although many data have been collected on these ecosystems (via scientific campaigns, fishermen observations, environmental associations observations...), it is not possible yet to present tangible answers to these questions. Statistic data exists (fishing stock for example) but the behaviour of mobile species that would interact with MRE infrastructure does not. On this topic, high frequency observatory projects related to floating offshore wind farms have been proposed in France.
Given the current situation of MRE in the Mediterranean Sea, there are very few published and planned strategies in the Mediterranean European countries. However, France recently decided (November 2018) to go for such a strategy, in the context of its Multi-Annual Energy Plan (PPE). The objectives (beyond the 4 pilot farms, out of which 3 are located in the Lion Gulf, which will have a capacity of 24MW each and become operational in 2021) set are 250MW launched through bid offers in 2022, then 1 000MW launched through various bid offers starting from 2025.
In Portugal, a 25MW pilot farm project is ongoing. In Italy, a 30MW farm is being considered in Taranto. No wind farm development strategy has been clearly decided in Greece or Spain.
For other MRE sources (tidal and wave energy), there are many research projects and a few prototypes that are being developed in the context of national or European projects.
SWAC facilities are mature and they are being installed little by little, at a relatively slow pace.
What proposals could be made at European level to encourage MRE development in the Mediterranean Sea?

- Exchange feedbacks on floating offshore wind pilot farms (France / Portugal) with all interested countries. This could start soon, i.e. before these pilot farms become operational as there is already much to learn about the consultation phase and about these energy infrastructure integration into marine activities spatial planning;
- Invite companies coming from these various countries to participate to these feedback sessions as they could want to position themselves along the value chain;
- Fill the knowledge gap about fishing and environment with European programs about interactions between offshore wind infrastructure and marine ecosystems and avifauna, in order to answer environmental associations and stakeholders from the fishing business;
- Analyse co-activities: fishing and aquaculture;
- SWAC: spread knowledge about SWAC technologies and provide feedbacks.

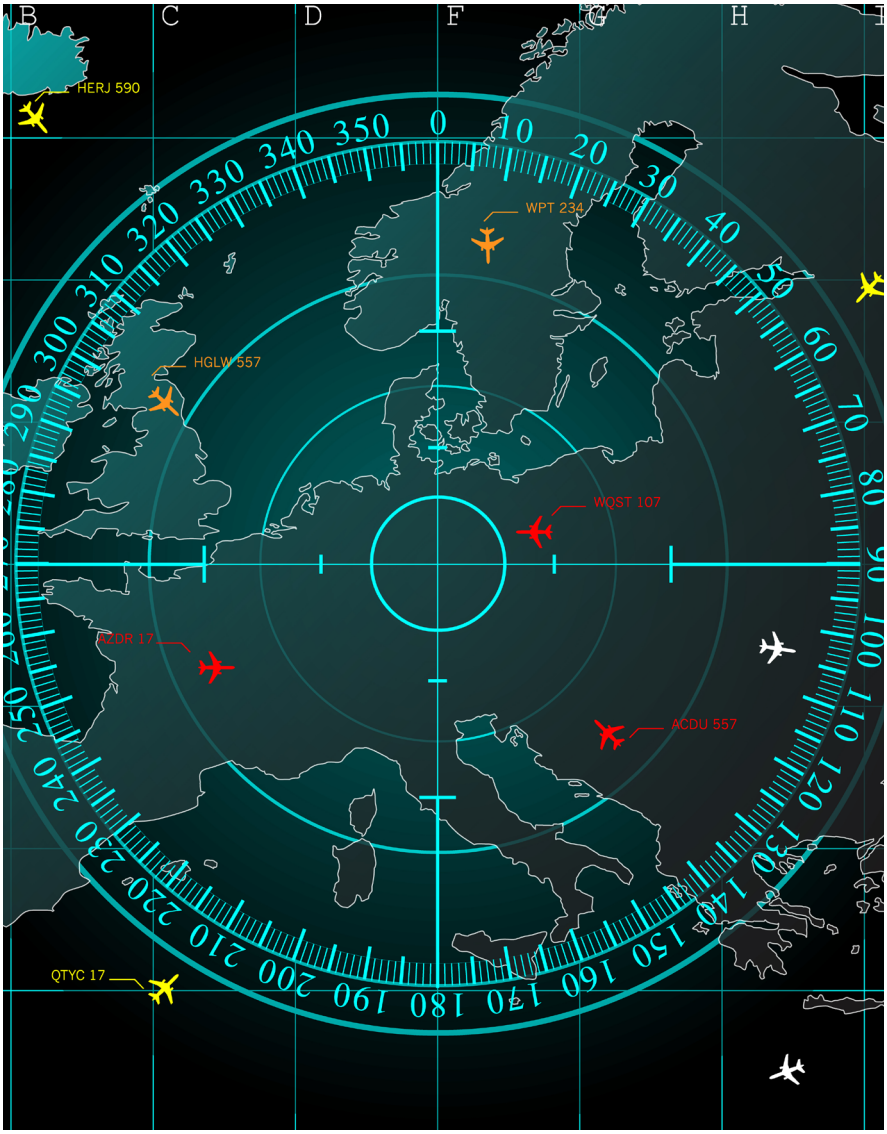
3.2 MARITIME SURVEILLANCE

3.2.1 Introducing the sector and its subsectors

The Mediterranean Sea is one of the most strategic maritime basins. Improving co-operation among European public authorities responsible for carrying out various control activities to detect and react to illegal or dangerous activities at sea has been a goal of the European maritime policy from its outset in 2007[23].
Initial work focused on information exchange. Although communication channels between authorities from different countries were in some cases already in place, those authorities responsible for different activities (fisheries and cargo transport for example) were using mutually incompatible systems that ruled out any useful collaboration. Work started on defining a Common Information Sharing Environment (CISE) that would allow information to flow smoothly between the different authorities while respecting rules on protection of personal data and commercial confidentiality. The EU Maritime Security Strategy adopted in June 2014 and its action plan adopted in December of the same year represented a quantum leap in the commitment of Member States. The Union developed them to address maritime security challenges effectively and comprehensively using all relevant international, EU and national instruments. It covers cooperation in a range of activities including and beyond surveillance and in waters outside Europe.
The Sea is at the heart of international trades too which represents 1% of the surface of the seas and concentrates 25% of global traffic and 30% of the world's oil traffic. Given the importance of this traffic and the ecological vulnerability of this sea, the Mediterranean Sea has been classified as a special area by the MARPOL 73/78 international convention.
Maritime Surveillance (MS) activities are carried out mainly by States and related Authorities. These activities have both national and transnational nature (mostly transnational) and fall under the responsibility of many actors (both at regional, national and transnational level).
The Maritime Surveillance sector has been divided in the following six sub-sectors of interest, which are all very relevant for the Mediterranean area, and whose relevance is in fact extended through the whole basin:

- Transport Safety (T&S)
- Maritime Traffic Support (MTS)
- Maritime Security, Border Control and Migration (MS&BC&M)
- Illegal Fishery Control (IFC)
- Preparedness and Response to Marine Pollution (P&RMP)
- Observing Systems for the Marine Environment (OSME)

These subsectors refer to three main drivers: maritime transport aid and safety (T&S and MTS), control of legal and illegal activities in the sea, including safety and rescue (MS&BC&M and IFC), observing of the marine environment to understand its behaviour and evolution, to protect it from land and sea based pollution sources, to provide data and services to different sectors of the sea economy (P&RMP and OSME).
The relevance of all the Maritime Surveillance subsectors for most Mediterranean countries is demonstrated by the presence of specific national strategies and funding, the large participation of companies, research organizations and public bodies in different EU projects and by the significant number of stakeholders. The sector is a little less developed in Croatia where the attention is now very focused on shipping. Further back is Portugal which has no policies in this regard.



[23]Report on the Blue Growth Strategy Towards more sustainable growth and jobs in the blue economy, Commission Staff Working Document, 2017

Maritime surveillance is overseen by governments through different ministries (typically the ministry of transportation, defence and environment) the operations are carried out by coast guards, navies, and port or sea police. In Italy there is a significant number of large companies dealing with Maritime Surveillance in all its aspects together with smaller companies, the same happens in Spain and in France which is in this context represented by the SUD PACA and Occitanie region. In Greece there are many companies that deal with ICT. In Albania and Portugal, stakeholders are basically ministries and governmental organizations, in Cyprus and in Croatia they belong mainly to the shipping sector.
A detailed description of the identified subsectors is given below.

Transport Safety (T&S) and Maritime Traffic Support:
to efficiently manage maritime traffic and all the activities carried out in the Mediterranean, advanced monitoring capabilities are needed. All Med countries paid attention to transport safety and maritime traffic issues since maritime transport is for all one of the main economic drivers. Specific national policies and strategies have been put in place by the governments following EU directives in the past and supporting infrastructures have been created. Several Vessel Traffic Services (VTS) Centres are present in the Mediterranean of which 12 located in Italy, 6 in Greece and 2 in Albania.
Technology for safety includes also the development of new sensors and tools to help identifying potential threats, the nature of the seafloors, floating objects, sea state etc.

Maritime Security, Border Control and Migration (MS&BC&M):
Maritime Situational Awareness i.e. the capability of public authorities responsible for security issues (mainly border control, law enforcement, transport, illegal immigration and activities) to be aware of what is happening in the MED basin, represents a prerequisite to provide prompt reactions to security threats, to efficiently respond to safety and pollution incidents and to protect the economic interests of the member states generated by the many maritime activities. Representatives of many MED countries are often partner and/or coordinators of these projects.

Illegal Fishery Control (IFC):
although SSF is the major part of the fishing activity, is uncharted and the main source of illegal fishing. Control and monitoring of SSF activities is of vital importance for the assessment of the corresponding fishing effort that by now is totally unreported. The traceability of SSF vessels can be achieved using technologies/methodologies developed, or under-development, for large-scale fisheries based on radio frequencies, satellites and/or internet applications, as well as methodologies for data gathering and manipulation. The possibility however of producing cheaper, even if less powerful, instruments needs to be evaluated as their cost is generally high. Mapping of fishing activities will empower MSP implementation and the tracing of the illegal catches will improve sustainable use of fishing resources.
The EU Common Fisheries Policy (CFP) is a set of rules for managing European fishing fleets and to ensure that fish stocks are sustainable in the long term.
According to EU fisheries controls (08/2017), many Member States did not yet have a sufficiently effective system for fisheries controls to support the success of the CFP.

Preparedness and Response to Marine Pollution (P&RMP) and Observing Systems for the Marine Environment (OSME): as already stated, the Mediterranean is characterized by an intense traffic of ships transporting hydrocarbons and chemical, toxic-harmful substances and by several offshore oil installations (platforms and pipelines) that represent a constant potential risk for the environment. In terms of prevention and identification of illegal activities that can potentially cause marine pollution, routinely oil spill detection monitoring of the sea basin has a deterrent action against those vessel owners who operate tankers' illegal washing. When vessels identification systems data are available, a cross check of the routes followed by the vessels sailing the area affected by the oil spill is done. Moreover, routinely oil spill detection and monitoring of offshore oil rigs and pipelines is required to prevent coastal environment pollution and support emergency recovery actions, while monitoring critical infrastructures. The specific tool created by EMSA to detect illicit oil spills is CleanSeaNet.

3.2.2 Maritime Surveillance in the MED area

In this section the results of the benchmarking analysis are discussed in detail giving an overview of the panorama of the MS sector in the MED area. The analysis has been done in terms of socio-economic, technical and research aspects for each MED country using specific attributes which have been already discuss in the Methodology chapter (section 2.4).
Next graphs introduce the results of the benchmarking analysis, showing the levels of relevance (Fig. 3.4) and readiness (Fig. 3.5) of the sector in each country, making possible a comparison between the actual situation in the countries in the MED area.

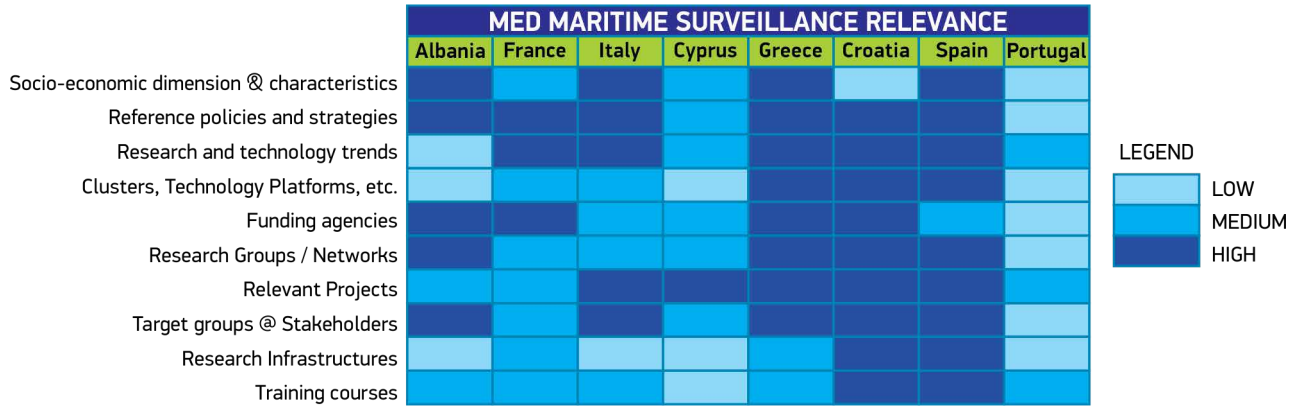


Fig. 3.4 Relevance of Maritime Surveillance sector in MED Countries

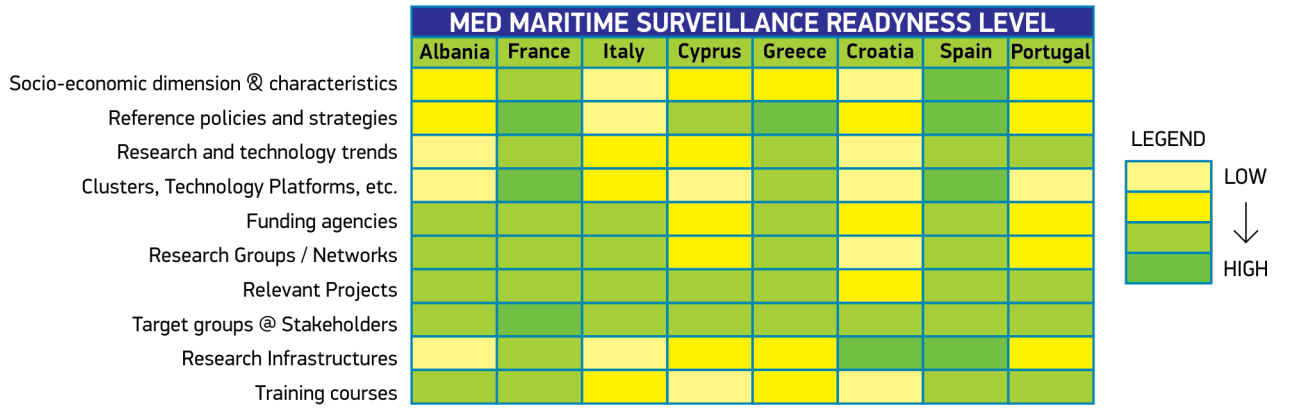


Fig. 3.5 Readiness of Maritime Surveillance sector in MED Countries

The matrices of results show that the MS sector has been recognized with high relevance for the economic, social, technological and research etc. point of view from most of the MED countries. Moreover, the level of maturity (readiness) of the sector is not already full developed in all the countries. Portugal, Croatia are examples of countries which present the lowest readiness level of MS sector for each attribute.

- Key economic figures

The principal actors driven the market of the Maritime Surveillance sector in the Mediterranean area are the companies involved in the development of technologies and services for the monitoring of the traffic, illegal actions and the environment in general. In fact, there are not economic figures which interest is specifically focused on the maritime applications, but they concern an extended concept of surveillance actions. Among them the principals are LEONARDO, e-GEOS, THALES, Aster, AIRBUS and SAFRAN.

- Reference policies and strategies

Many policies and strategies for maritime surveillance are developed in the EU panorama.

Among the EU strategies, the European Security Strategy (2003) is not high relevant, however it mentions the threat of maritime piracy.The EUROSUR border surveillance program is a multipurpose system for cooperation between the EU Member States and Frontex in order to improve situational awareness and increase reaction capability at external borders. The aim is to prevent cross-border crime and irregular migration and contribute to protecting migrants' lives.

The European Union Maritime Security Strategy (EUMSS) adopted in 2014 is the major comprehensive EU Strategic Framework providing the context and coherence for the EU's diverse and wide array of sector-specific maritime policies and strategies. The EU's maritime security strategy action plan was first adopted on 16 December 2014 to help safeguard the interests of the EU and protect its member states and citizens and revised on 26 June 2018 for a more focused reporting process to enhance awareness and better follow-up to the strategy.

The EUMSS strengthens the link between internal and external security, and couples the overall European Security Strategy with an Integrated Maritime Policy (IMP) created in 2007 to enhance the sustainable development of the European maritime economy and to better protect the marine environment by facilitating the cooperation of all maritime players across sectors and borders. It seeks to coordinate, not to replace policies on specific maritime sectors. Specifically, it covers these cross-cutting policies: (i) blue growth, (ii) marine data and knowledge, (iii) maritime spatial planning and (iv) integrated maritime surveillance.

The national strategies mentioned by the partners countries is the adoption of the EU Maritime Security Strategy that constitutes a major achievement because the concept of maritime security has significantly been widened to interest areas beyond the national defence, including economic growth, employment, energy preservation and life security. The development of a common information sharing environment for the EU maritime domain (Maritime CISE) is one of the key strategic objectives of the Union under this Strategy. CISE is currently being developed jointly by the European Commission and EU/EEA member states. It will integrate existing surveillance systems and networks and give all concerned authorities access to the information they need for their missions at sea. CISE will make different systems interoperable so that data and other information can be exchanged easily through the use of modern technologies. CISE is an ongoing collaborative process which already has been the subject of three Communications by the Commission in 2009, 2010 and 2014 [COM (2009) 538 final, COM (2010) 584 final and COM (2014) 451 final].

Among the regional strategies the RAMOGEPOL Plan which is an instrument of scientific, technical, legal and administrative cooperation with which the French, Monegasque and Italian governments implement integrated coastal manage-

ment actions and Prevention and the fight against polluting events. The Smart Specialization Strategy is an innovative approach that aims to boost growth and jobs in Europe, by enabling each region to identify and develop its own competitive advantages. Through its partnership and bottom-up approach, smart specialization brings together local authorities, academia, business spheres and the civil society, working for the implementation of long-term growth strategies supported by EU funds.
Moreover, for the search and rescue Maritime and also Air actions the European Search and Rescue Plan (EUR SAR Plan) has been developed at the EU level.
Other EU strategies on the maritime surveillance concern the Blue Growth strategy. Blue Growth is the long-term strategy to support sustainable growth in the marine and maritime sectors. Seas and oceans are drivers for the European economy and have great potential for innovation and growth. It is the maritime contribution to achieving the goals of the Europe 2020 strategy for smart, sustainable and inclusive growth. The maritime surveillance sector does not belong directly to the main blue economic sector which are: aquaculture, coastal tourism, marine biotechnology, ocean energy and seabed mining. Moreover, the maritime surveillance with the marine knowledge and maritime spatial planning are transversal essential components to provide knowledge, legal certainty and security in the blue economy. Among the Blue Growth strategies, BlueMed and Westmed are the principal.
Specific general national strategies on the maritime surveillance already exist and they are shown in the next Table 3-6 for each MED country.

COUNTRY	NATIONAL STRATEGY
Greece	Marine Strategy for the Protection and Management of Marine Waters; National Contingency Plan for dealing with pollution incidents from oil and other harmful substances; Greek Law 4037/2012 on ship-source pollution and on the introduction of penalties for infringements; Transport Development Strategy; Operational Program for Extension, Upgrading, and Modernization Program of the National VTMIS System.
Italy	National Program of Maritime Security, NationalPlan of Maritime Search and Rescue, National program for the collection of fishery data, National Strategic Plan “Space Economy” and ItalGovSatCom.
Spain	National Maritime Security Strategy, National Security Strategy, Spanish Strategy for Science and Technology and Innovation, National Maritime Plan of response to pollution of the marine environment.
France	The national strategy for the safety of maritime areas
Croatia	Sustainable Development Strategy
Albania	Sectorial strategy of transport and action plan 2016-2020

Table 3 6 Lists of MED National Strategies

- Clusters, Technology Platforms
In general, in the EU area there are not principal clusters involved in the MS sector.
However, the Proteus Interreg Med project that will be ending in the end of the 2019 includes a pilot action for the creation of a EU cluster regarding the MS sector. Most of the MED countries are involved in the current Proteus initiative as Italy, Spain, France, Portugal, Greece and Cyprus. The main actors in MS sector can be found in Spain with the technological platform of the Spanish maritime sector, the Spanish maritime cluster SMC, the maritime cluster of the Balearic island and Maritime Cluster of Andalusian. In France, Pôle Mer Méditerranée, which covers the different sector of the blue economy, has a specific axis of development on Maritime surveillance where many of its members are involved.
Moreover, the Technology Platform are totally absent for maritime surveillance applications. In fact, in this Section we also reported all the EU infrastructures composed by systems used for the earth monitoring and observation. These infrastructures reported which are the only one in EU employed for maritime surveillance applications, offer also services to sharing the available data to the clients.
Regarding the specific subsectors of the MS sector, specific clusters and infrastructures can be found in each MED country. In the Table below has been shown a resume of them.

COUNTRY	NAME	MS SUBSECTOR
EU	Copernicus security service (EU platform), EURO-ARGO ERIC (EU consortium), EMSO ERIC (EU technology platform), Mediterranean Operational Network for the Global Ocean Observing System (MONGOOS) which is promoting partnerships and capacity building for Global Ocean Observing System (GOOS) in the Mediterranean Sea. The Integrated platform for maritime surveillance has been developed as part of the ESA (European Safety Agency) Space Program and the Fusion Technology Transfer Action. participating countries are also among partners, Italy, Portugal, Greece, Spain, France	OBSERVATION AND MONITORING SYSTEM
France	Aerospace valley, MEDTRIX	
Italy	Seonse, Cosmo-skymed, Long range tracking and identification (LRIT) system, Navigational text message (NAVTEX)	
Greece	Hellenic space technologies and applications cluster (si-cluster)	
Spain	MARITIME OPERATION CENTER - MOC	
EU	SafeSeaNet	
Italy	Vessel traffic service (VTS), Vessel traffic management & information systems (VTMIS)	VESSEL TRAFFIC MONITORING AND INFORMATION SYSTEMS
Greece	METIS platform is a big knowledge technology platform developed in Greece assisting though the global maritime domain., Vessel traffic management & information systems (VTMIS)	
Albania	Marine traffic AIS receiving stations	
France	Pôle Mer Méditerranée, Safe, Eden, System factory and Sealab innovation center	
		MARITIME SECURITY
Spain	Salvamento Maritimo	POLLUTION CONTROL
Spain	SIGO: Integrated Operational Management System for the Spanish Maritime Search-and Rescue Society, Salvamento Marítimo (SASEMAR): search and rescue services.	SEARCH AND RESCUE

Table 3 7 Lists of Clusters and Technology Platform

- Funding Agencies

The European Union, through its various funds and funding schemes is the key funding provider supporting the maritime surveillance sector. European Structural and Investment Funds, i.e. five main Funds working together to support economic development across all EU countries, in line with the objectives of the Europe 2020 strategy: European Regional Development Fund (ERDF), European Social Fund (ESF), Cohesion Fund (CF), European Agricultural Fund for Rural Development (EAFRD) and European Maritime and Fisheries Fund (EMFF). Others are: the EU R&D /PADR Funds, the European Maritime and Fishery Fund (EMFF) The European Internal Security Fund (ex EBF) mainly implemented by EU participating countries through shared management and also through EU direct management. The European Investment Bank (EIB) backed by the European Fund for Strategic Investment (EFSI), International Monetary Fund (IMF), The EU Research and Innovation 7 years (2014-2020) program, Horizon 2020 and its BES / SEC axis as well as the quiet new European Defence Fund which directly financing competitive and collaborative research projects, as well complementing Member States' investment by co-financing the costs for prototype development and the ensuing certification and testing requirements. Moreover, there are the ERDF, Cohesion Fund, NATO, IPA.

More specifically a list of the principal national or regional funding agencies of each EU country, is reported in Table 3-8.

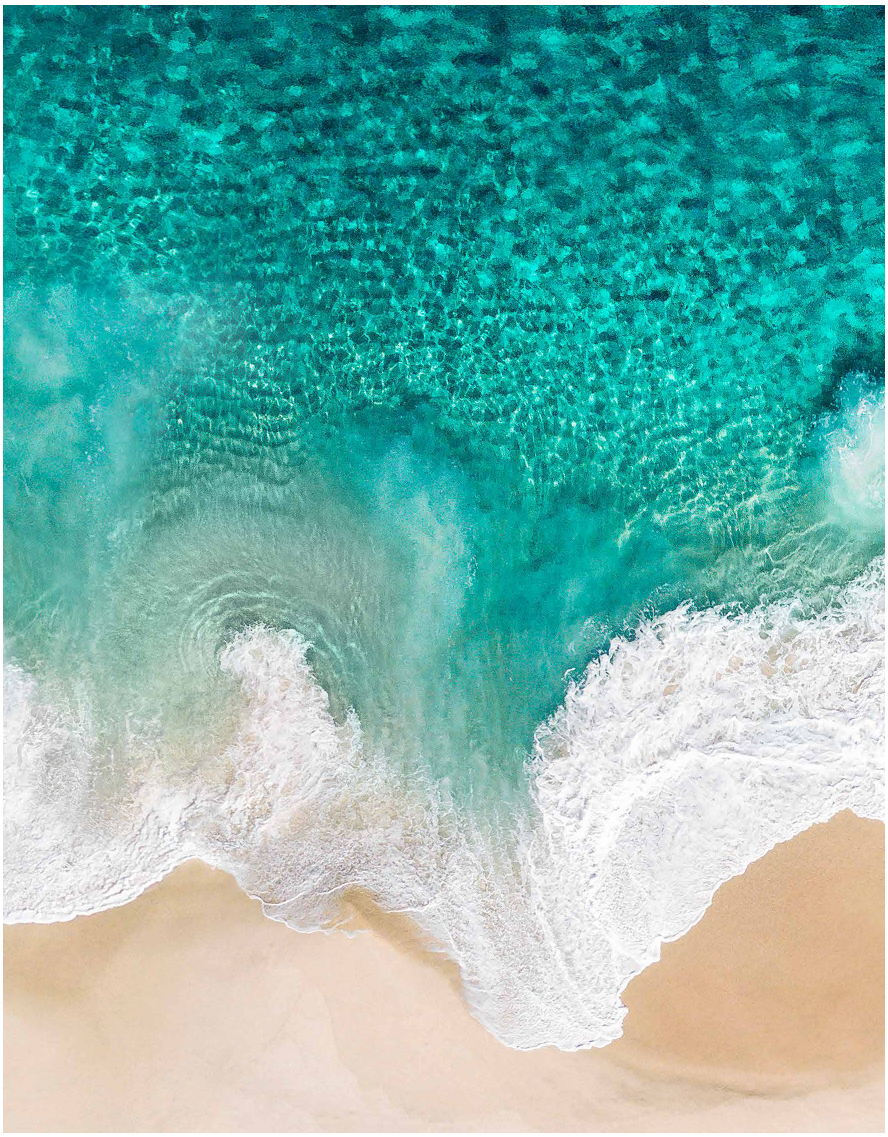
COUNTRY	FUNDING AGENCIES
Italy	Ministry of Defence, Ministry of Transport and Infrastructures, Ministry of Economic Development, Ministry of Environment, Ministry of Education University and Research, Italian Ministry of the environment and protection of the territory and the sea and Ministry of Agricultural food, Forestry and Tourism policies.
Greece	Ministry of Agriculture and Food (Data collection), Ministry of Development and Competitiveness (State Aid), Ministry of Shipping and Island Policy (Surveillance systems), General Secretary of Public Investment (NSRF) and General Secretariat for Research and Technology (R&D).
France	DGA "Direction Générale de l'Armement", Directorate General of Enterprises, Ministries and Regions with the FUI (Interministerial fund), ANR "Agence Nationale de la Recherche".
Albania	Ministry of Infrastructure and Energy, Ministry of Environment, Institute for Nature Conservation in Albania, UNDP Albania and Albanian Association of Urban Transport.
Croatia	Croatian Science Foundation, Ministry of Sea, Transportation and Infrastructure.
Spain	MICINN (Government of Spain), ERDF, Government of the Balearic Islands, Ministry of Defense (Government of Spain), Private investment funds by companies.

Table 3 8 Lists of MED Funding Agencies in MS sector

- Research Groups, networks and other resources

There are many groups involved in research in the maritime surveillance sector all over EU. As already explain in "research and technology trends" section of this report, very different research topics are analysed by researcher of the MED area.

The principal research topics can be classified following the subsector division of the MS sector.First above all the development of observing and monitoring services. In Italy the CNR-ISMAR institute is very active in the study of this fundamental field, in Greece the Hellenic Centre for Marine Research, the Remote Sensing Laboratory-University of Aegean, the Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing-National Observatory of Athens are the main actors. Moreover, France is also one of the most active country in this field of study with the institutes IFREMER "Institutfrançais de recherche pour l'exploitation de la mer" and CNES "Centre National d'EtudesSpatiales". Regarding the development of Radar & Surveillance Systems, Multimedia Communications and multi-sensors system of maritime surveillance applications: these applications have been object of study in Italy of the National, Inter-University Consortium for Telecommunications (CNIT), the DIET department of Sapienza University of Rome, the Institute of Machines of University of Catania, the Armed Forces Communications and Electronics Association (AFCEA) and of the CNR-IREA. In France there is also the ONERA "L'Office national d'étudeset de recherchesaérospatiales" who collaborates with many French majors compagnies in several sectors and in particular in new technologies in radar domain. For the Autonomous systems for marine surveillance, the principal actors are CMRE - NATO of La Spezia in Italy, the Laboratory of Fluid Mechanics & Turbomachinery-Aristotle University of Thessaloniki in Greece, in France the COSMER Laboratory of University of Toulon and in Cyprus the Marine Environment Division (MED) of the Department of Fisheries and Marine Research (DFMR). Computer science studies for Database and Information Systems for integrated maritime surveillance and data management is also one of the main topics in the research field of the sector. In Greece we found the Computer Science Division of the Electrical and Computer Engineering School-National Technical University of Athens (NTUA), the Centre for Research and Technology Hellas (CERTH), the Institute of Informatics & Telecommunications of the NCSR Demokritos and the Center for Security Studies (KEMEA). The Hellenic Ministry of Defence, the Hellenic Coast Guard and NCSR Demokritos



worked together to deliver an integrated national maritime surveillance environment with enhanced cross-sector and cross border information exchange capabilities. In France, the INRIA "Institut National de Recherche en Informatique et Automatique" and CNRS "Centre National de RechercheScientifique" are the main actors. Moreover, also Cyprus participates with the Oceanography Center of the University of Cyprus. The Spanish research in marine sciences is currently capitalized by two Public Research Organizations that are the Spanish Institute of Oceanography (IEO) and the Higher Council for Scientific Research (CSIC). There is also a Coordination and Monitoring Commission for the Activities of Oceanographic Ships (COCSABO) in Spain, which coordinates and optimizes the use of the Spanish oceanographic fleet which is on its way to becoming one of the most important in the world, being the Hespérides, the only Spanish vessel built on purpose for multidisciplinary scientific research in any sea or ocean. The Jaume Ferrer Research Station of Menorca in the Balearic Islands is also of fundamental importance for the sector.

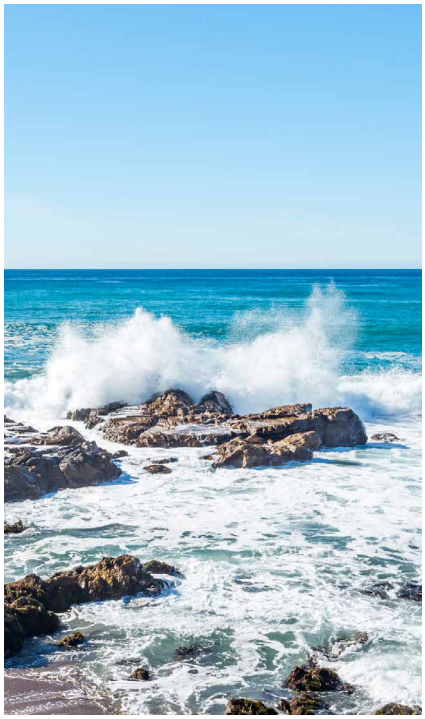
In the case Greece, the Marine Environment Protection Directorate of the Hellenic Coast Guard is responsible for monitoring and coordinating the Port Authorities to implement existing legislation in the fields of prevention and control of marine and coastal pollution. At the same time, it aims to strengthen and modernize the available pollution control instruments and materials at the Port Authorities and the Regional Pollution Prevention Stations. The Hellenic Centre for Marine Research (HCMR) is a governmental research organization under the supervision of the General Secretariat for Research and Technology (GSRT), that contacts research reports on marine pollution.

- Relevant projects

Several projects deal with the Maritime

Surveillance sector are promoted by Europe in which most of the MED countries are involved.
Many projects related to the Blue Growth are aimed to improve the development of the MS sector sharing information on marine environment between the MED countries. Among this kind of project an example is the EUropean test bed for the maritime Common Information Sharing Environment in the 2020 perspective (CISE) in which Greece, Italy, Spain, Cyprus, Portugal and France are the participants countries. Other examples are: Services Activations for GRowingEurosur's Success-SAGRES project, Maritime Integrated Surveillance Awareness-MARISA and Upgrade of Maritime Surveillance. In all the projects listed above most of the MED countries are involved as Croatia, Cyprus, France, Greece, Italy, Portugal and Spain, except Albania.
Other many EU projects make use of the Automation technologies and of the unmanned vehicle for maritime surveillance applications as Perseus, Deployable SAR Integrated Chain with Unmanned Systems DARIUS and OCEAN2020. Marine robotics found its application also in the Tracking Oil Spills in the MED sea and the projects regarding this topic are TESSA Tracking Oil Spills & Coastal Awareness network (TOSCA) and Expanded underwater robotics ready for oil spills in which France, Italy, Greece and Spain are involved.
The RANGER, CLOSEYE, spyGLASS, ODYSSEA, COMMON SENSE, Bridging Innovative Downstream Earth Observation and Copernicus enabled Services for Integrated maritime environment, surveillance and security- MARINE-EO, MARine monitoring system of the Hellenic Seas using REmote sensing-MARRE and Joint European Research Infrastructure network for Coastal Observatory – Novel European eXpertise for coastal observaTories-JERICO-NEXT projects deal with the Observation and monitoring systems for Maritime Surveillance among countries.
The last typology of EU projects concerns the Safe and Security plan in MS sector, the most important are: Promoting security and safety by creating a Mediterranean cluster on maritime surveillance-PROTEUS, MEDESS-4MS Mediterranean decision support system for marine safety and "MARINE environmental in situ Assessment and monitoring tool BOX" (MARIABOX).
For detailed information on these projects please see all the country fiches of each MED partners.
Few MED countries developed not many research projects in maritime surveillance field by using national private/public funds. In Greece Installation of a maritime surveillance system in the Northern Aegean Sea, Development of the National Integrated Maritime Surveillance System (NIMSS), JASON Project, AeRial System and AntipiRacy System and Advanced Coordination CenteR Information Technologies & Applications for Border Surveillance (ACRITAS) are the principal.
Sea4am, AIRMES and DroneSeastem are national protects developed by France and in ItalySos-Bocche Di Bonifacio is the only one.

- Target groups and stakeholders
The EU leader in the maritime surveillance industry and development in general of related technologies and services in this field are:LEONARDO, e-GEOS, THALES, Aster, NEXEYA, AIRBUS, ATOS, SAFRAN, ECA GROUP which are mainly involved in the development of observing and monitoring system of the space and marine environment. For each EU countries the principal actors are also the coast guards, Military Marines, Space Agencies (e.g. Italy ASI), European Space Agency (ESA), Maritime Prefectures, Inter-ministerial Committee, National Ministries, Port Authorities, Vessel Traffic Monitoring Directorates, Maritime Gendarmeries, Chambers of Commerce and Industry as well as Chambers of Shipping and Associations of Passenger Ships.
Specifically, the national actors in the most active MED country in MS sector are reported in Table 3-9.



COUNTRY	NATIONAL ACTORS
Italy	FEDERPESCA
	LEGAPESCA
Greece	SPACE HELLAS A.E
	TERRA SPATIUM
	Hellenic Marine Environment Protection Association - HELMEPA
	Hellenic Medium Fishing Association
	METIS CYBERSPACE TECHNOLOGY SA.
	Union of Greek Shipowners (UGS)
	Greek Tug owners
	Greek Shipping Co-operation Commitee.
Spain	CEPESCA SPANISH FISHING CONFEDERATION
	Fisheries Tracking Center (CSP)
	Technological Center Naval and Sea – Murcia
France	CROSS Operational Regional Center for Surveillance and Rescue

Table 3 9 National Target Groups in MS sector

- Research Infrastructures
There are no research infrastructures dedicated to the maritime surveillance domain in the MED countries except for Spain which has the PLOCAN platform (the Oceanic Platform of the Canary Islands). PLOCAN is a Unique Scientific and Technological Infrastructure (ICTS). Spain also has a principal role with the Balearic Islands Coastal Observation and Forecasting System (SOCIB) in the Balearic Island that is an ICTS too. The development of this kind of infrastructures is a real need for industry players to benefit from test facilities and dedicated areas to perform the test of their technologies already available in the EU market.In Greece, there is POSEIDON System-Long term (climatic) variability monitoring is targeted to end user needs such as maritime energy, transport, fisheries, tourism, as well as environment and climate monitoring.

- Training Courses
In the EU panorama there are not specific courses to form technical and scientific profiles working in maritime surveillance sector. Instead, many transversal courses already exist in almost all the MED countries (especially in Italy, France and Greece, less in Albania and Spain). These courses made by EU Universities or research Institutes are focused on: naval, defence and security sciences, ports logistic, development of monitoring sensors, engineering and electronic technologies and applications, automation, remote sensing, and cyber security. Other courses imply the study of business law and Maritime Security. The development of specialized training courses in future will increase the growth of the marine surveillance sector as it will discuss in Section 2 of this report.
In Table 3-10 the principal type of training courses available in the MED countries.

COUNTRY	TYPE OF TRAINING AVAILABLE
ALBANIA	General management courses are set up in universities. Specific trainings on maritime transport
CYPRUS	No courses on MS sector but some programs on maritime sector more globally, especially in shipping and naval field
FRANCE	Many engineering trainings and or innovation courses are set up in universities. Specific trainings on cyber security, safety of maritime activities and marine robotics are available. There is also military training for Maritime defense
GREECE	Some training courses on maritime security, defense system and automatic control. There are also courses on shipping and marine transport
ITALY	General engineering trainings and management or innovation courses are set up in universities. Specific trainings on communication systems are available but are professional courses
PORTUGAL	No specific courses on maritime surveillance
SPAIN	General engineering trainings and management on naval, marine transport and safety. There are also courses for pollution control and Protection of the Marine Environment in general

Table 3 10 List of training courses in MS sector

3.2.3 Identifying innovation potentials and key enabling factors

3.2.3.1 Opportunities and benefits

Five principal innovation potentials have been identified among the subsectors of the maritime surveillance sector as emerging from the Country fiches. In fact, during this step of the analysis has been chosen to consider as main challenges the common IPs defined by all the country integrating this information with the definition of new IPs at MED level without loss the information from the single partner.

The defined innovation potentials are:

1. **Integrated and interoperable maritime situational awareness platforms and services**
2. **Interactive and Dynamic Atlas of Maritime Risk Maps**
3. **Operative system for Search and Rescue Planning**
4. **Development of Intelligent Vessels Monitoring Systems**
5. **Specialized Social Networking Services for Maritime Crisis Management**

Next Fig. 3.6 shows the geo localization of the IPs as emerging from the Country fiches.

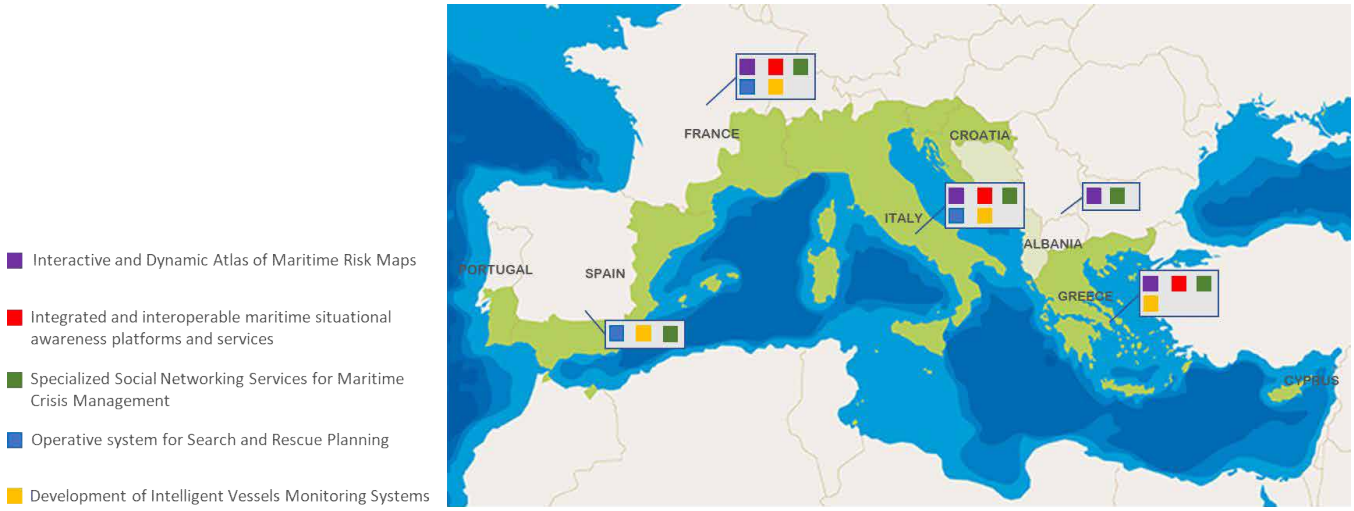
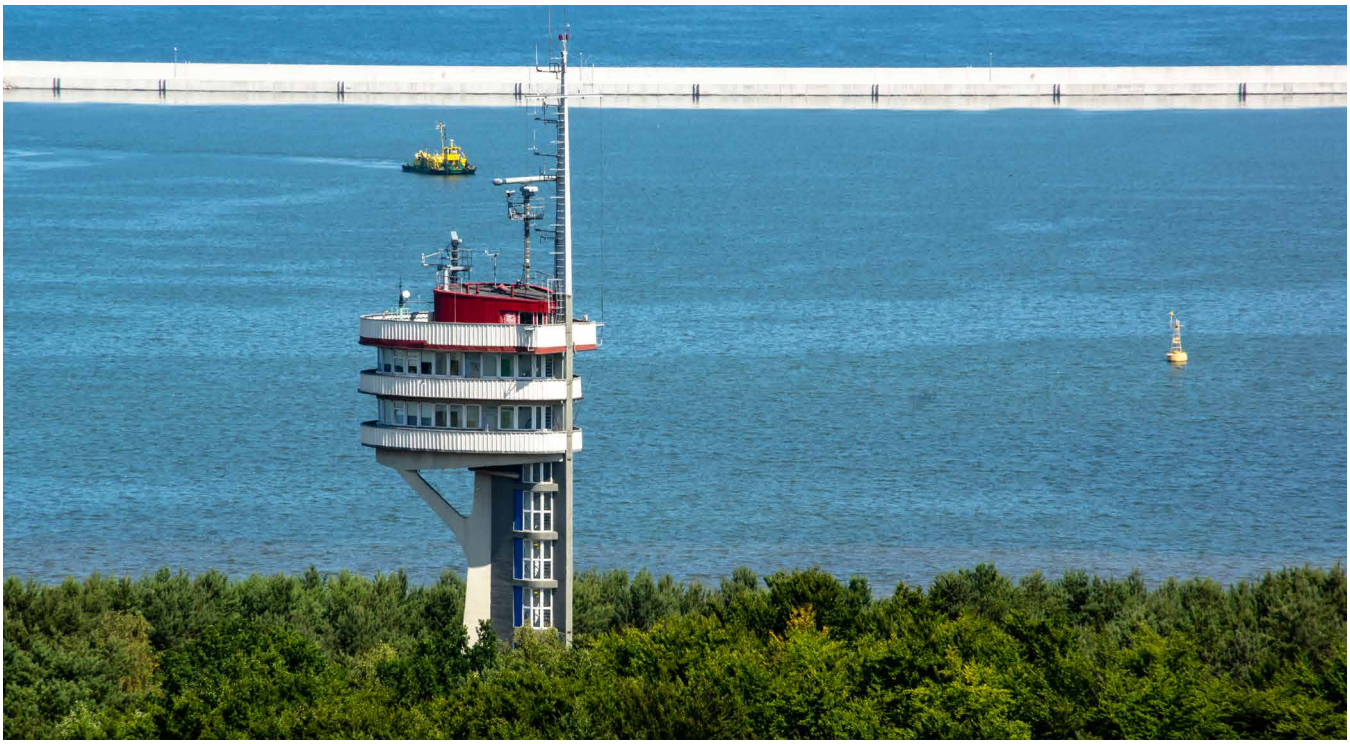


Fig. 3.6 Geo localization of innovation potentials MED request as emerging from the Country Fiches



The innovations with high potential in the MED country manly concern the monitoring system for different solutions in the frame of MS, the creation of common database/maps and other integrated technology/platform to improve the sharing of data among the countries. In this section the benefits and the gaps related to each innovation potentials are discussed in detail with reference to the actual situation, in term of KEFs, of the MED countries.
Table 3-11 introduces the results of the analysis in terms of opportunities and benefits defined for each innovation potentials chosen.

Intergrated and interoperable maritime situational awarness platforms and services	Interactive and Dynamic Atlas of Maritime Risk Maps	Operative system for Search and Rescue Planning	Development of Intelligent Vessels Monitoring Systems	Specialized Social Networking Services for Maritime Crisis Management
• Control for security reasons • Many EU and national Strategies • Technologie • Markets, many industrial partners • Skills in Big data e sybersecurity • EU and national funding agencies • R&D experience and protoype	• Interest in oil spill control • Operational EU and national networks • Social and economic relevance • Transnational sharing	• Social relevance • Economic relevance • EU policy	• Advanced - level Research • High technology trends • Knowledge in big data, machine learning ad AI • Commercial deployment (VMS radar) • Social impact of AI and economic growth	• Advanced - level Research • High technology trends • Knowledge in big data, machine learning ad AI • Commercial deployment (VMS radar) • Social impact of AI and economic growth

Table 3 11 Benefits of each innovation potential in MS sector

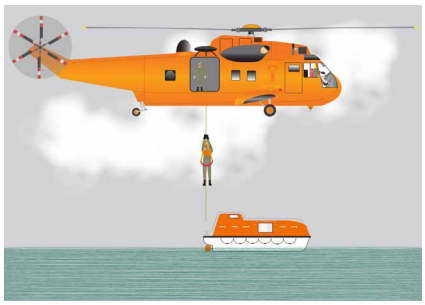
Integrated and interoperable maritime situational awareness platforms and services

The need of monitoring the marine environment is fundamental for the maritime surveillance sector development in order to control all the flux in MED area in term of traffic, migration and illegal actions for security reasons.
The integration of platforms and services for maritime surveillance is one of the basic steps towards the Common Information Sharing Environment (CISE) promoted by EU. This action requires the sharing of data between the existing EU platforms in order to better monitoring the maritime information covering all the aspects of this sector: data on traffic, risks, illegal actions and migration.
Many EU strategies finalized mainly to the integration of different systems. National strategies are also needed to improve the communications between this information at EU level. This aspect of the maritime surveillance sector has been recognized as innovation potential especially by France, Italy and Greece. Greece proposed the creation of a specialized Social Networking Services for Maritime Crisis Management in which the Big and smart data processing and social networking exploitation are combined to operate crisis detection algorithms and management systems.
The principal national strategies are already actuated mainly in France, Italy, Spain and Greece (see section 1.2 and their correlated country fiches).
It is expected that in the next few years new skills able to interact with new systems for the management of platforms, services and emergencies will be

necessary for the operators of this sector. Concerning high educational level, specific expertise in cybersecurity, virtual reality and BIG data management are and will be requested.
Moreover, funding strategies are active at national, regional and EU level. Many Ministries and other public administrations are directly involved in the financing on this topic, especially for Italy and France (see section 1.2 and their correlated country fiches).
There are some available technologies ready to be applied for the development of these sharing platforms. Especially in France, Italy and Greece that have a strong knowledge in radar, sonar technologies and handling and storage of big data.
In addition to these technologies are also use of satellites and other observing systems for land/space and maritime surveillance applications (see section 1.2 and their correlated country fiches).
Many national and EU strategies finalized mainly to the integration of different systems (reported in Section 1.2). There are several funds from EU programs which encourage the development of this system in the maritime sector. Also, national public funds are available in Italy, France and Greece. There is a very good knowledge on the monitoring and observation systems from the R&D point of view for France, Italy, Spain and Greece. Also prototypes of new technologies are developed from many research groups in University and Research Institutes, especially for Italy and France. Cyprus has a strong experience in term of research on monitoring of biodiversity and maritime ecosystem even if the country is not involved in specific studies applied to maritime surveillance. Also, Albania country has a great knowledge in big data, machine learning and automatic identification of system (AIS) even if only on the R&D level and at this moment no specific technologies exists in the country.
The industrial EU partners are large groups and some SMEs are very active in the market of maritime surveillance. The principal actors are in France, Italy and Greece as Leonardo, e-Geos, Thales, Space Hellas, Epos, Terra Spatium, Airbus, Safran etc.

Interactive and Dynamic Atlas of Maritime Risk Maps

The creation of an interactive MED Atlas is fundamental to map all the risks in the maritime environment, especially related to the oil spill control. Other principal examples are the transboundary plants like the Trans Adriatic Pipeline (construction budget of the pipeline in Greece is about 1.7 billion€), which is going to transport natural gas from the Caspian Sea through Greece and Albania and across the Adriatic Sea to Italy the agreement to extend the territorial waters to 19 kilometers in the Ionian Sea should be considered in order to strengthen maritime surveillance systems in order to avoid illegal tapping, leak detection, and sabotage.
The development of an integrated Geographic Information System (GIS) for planning and visualizing the structural information in Maritime Surveillance is a fundamental aspect. The development of modern information systems and e-services will upgrade speed, range and security for data transmission particularly for e-navigation that helps to directly serve businesses and citizens and avoid land-use conflicts, boosting the country's economy.
The risks connected to maritime accidents can impact either the coastal and the offshore areas. It corresponds to the multiplication between the dangerousness (intrinsic propriety of the area) and probable damage (the consequence of a probable danger). The state of the art about the matter consists in the maps of dangerousness, methodologies and common evaluation protocols, management tools limiting impacts, but the risk analysis is completely missing in EU panorama. It would prevent the impact effects, reducing the intervention time and limiting the damages. The implementation of an atlas of risk maps, periodically (daily, weekly) upgraded, can permit to end user to know in near real time the impact of a probable accident in a specified marine area,



according to forecasting of the sea state. This would allow planning intervention protocols in advance; for this reason, it can be an important prevention tool. Some operational EU networks exist already (e.g. ClearSeaNet), that are the basis of the Atlas of Risk maps. National systems are ready to be applied as for Italy, France and Greece. Greece recognized this need as potential for the future development of the MS sector. In fact, a core focus of research on the efficient integration of Maritime Surveillance Systems is the development of Integrated GIS Technologies for planning and visualizing the structural information in Maritime Surveillance.
The use of SCADA Systems operations can provide an integrated approach that combines also real-time process data with geo-coded maps. Real-time satellite imageries can be assessed in order to locate and track vessels, monitor beaches and ports, and detect unlicensed fishing and illicit oil discharges. Sea climate monitoring and forecasting systems can also be integrated in order to provide services like automate early warning solutions informing for extreme weather conditions.
The socio-economic relevance is high because it permits to preserve the marine resources, controlling pollution and preserving biodiversity with positive impact on fisheries and tourism activities.
It is possible to exploit maritime big data and turn them into elements that can be useful to policy makers. The development of integrated information systems and e-services helps to detect and prevent immediately different conflicts and threats, protecting national and international interests.
Considering the transnational character of maritime surveillance this product can be shared with other countries that do not have the same prevention system (Portugal, Croatia) or with countries that must enforce their knowledge in this field (Cyprus, Albania and Spain). In fact, the integration between EU nations is one of the basic steps towards the Common Information Sharing Environment (CISE) promoted by EU. Since 2008 The European Directive obliges the member States the overlook the same marine region to elaborate together plans finalized to guarantee the good ecological state of the own sea area.

Operative system for Search and Rescue Planning

It includes the implementation of new algorithms providing rapid and accurate predictions about tracking/backtracking of drifting objects and missing persons at sea. It is the first step to realize a plug and play platform able to support the decision making in the planning of Search and Rescue operations. It also is the first

step to design an information flow management tool that is activated when the Search and Rescue operation starts.
The social relevance is connected to the safeguard of the life and facilities at sea, meanwhile, the economic relevance is connected to optimization of the search time and means used for the operations.
It is relevant respect the EU policy about the operations of Search and Rescue in the Mediterranean Sea. All coastal States are obliged to provide a search and rescue service according to Hamburg Convention. The European Agency Frontex coordinates the patrol system and play a strategic role in almost all humanitarian SAR operations. Specific national policies are already actuated in Spain, France and Italy (see section 1.2 and their related country fiches).

Development of Intelligent Vessels Monitoring Systems

This innovation potential presents an advanced-level Research and technology trends. An array of well-known and established research interacts with stakeholders in production system support the development of an innovative and competitive sector in maritime security through artificial intelligence and machine learning applications for enhanced monitoring performance of VMS radars.
It is possible to exploit maritime big data to create an Automatic Identification System (AIS) that be used for more accurate and constant analysis in maritime surveillance that detects any anomaly in the environment providing control actions to in order inform immediately any interested party.
Artificial intelligence and machine learning applications in order to enhance monitoring performance of VMS radars are ready for commercial deployment especially in France and Greece (see section 1.2 and their related country fiches). Although Spain does not manufacture them, it uses these technologies through purchase from suppliers.
Artificial intelligence can effectively

contribute to addressing many social challenges. There is now an urgent need to find solutions to prevent marine pollution and tackle illegal fishing that ensures sustainable development in the country. Society must make provision for new issues arising from the emergence of artificial intelligence market. According to EC many jobs will be created, but others will disappear, and most will be transformed. The AI systems can increase the pace of economic growth in shipping and fishery preventing environmental costs and increasing productivity. The development of Intelligent Vessels Monitoring Systems will help to avoid land-use conflicts among neighbouring countries, especially near maritime boundaries. Positive impacts on international shipping and trade are expected through the enhanced vessel traffic management.
Actions undertaken in the context of a wider European Maritime Policy Plan. The above is relevant to the EU strategy for Integrated Maritime Security. In addition, they are relevant to the measures presented by EC, which aim to put an artificial intelligence (AI) in the service of European citizens.

Specialized Social Networking Services for Maritime Crisis Management

Robust digital service sector and internet infrastructure. Big and smart data processing and social networking exploitation are combined to operate crisis detection algorithms and management systems. Many scientific teams, new businesses and start-up companies develop software applications to address these markets with a range of innovative solutions. The development of Specialized Social Networking Services is most of significance for public safety and security. Through the direct communication offered by online services for social networking, citizens will be able to be informed about avoiding and dealing with imminent risks. The immediate information about natural disasters, preventing measures could be organized better ensuring resources safety. Positive impacts on maritime transport, health, security, tourism, fisheries and aquaculture, trade, marine protection. Better inclusiveness (extent to which specific target groups and different stakeholders interact) and use of systemic trans-sectoral along with transboundary approaches further elucidate the multi-dimensional and multi-level and enhance the innovativeness of the endeavor. The above is relevant to the Common Information Sharing Environment (CISE) policy for the EU Maritime Domain.

3.2.3.2
Gaps and enabling factors to address

Table 3-12 introduces the results of the analysis in terms of gaps defined for each innovation potentials chosen.

Intergrated and interoperable maritime situational awarness platforms and services	Interactive and Dynamic Atlas of Maritime Risk Maps	Operative system for Search and Rescue Planning	Development of Intelligent Vessels Monitoring Systems	Specialized Social Networking Services for Maritime Crisis Management
• National policies • Technical skills • Training courses • Gap between technologies and real platforms • Encrease of R&D • Investments for the creation of technical and professional figures • Research project	• Funding strategies at national level • Skills and training courses • R&D and related project	• Funding strategies at national level • Skills and training courses • Marketing • Technologies	• Human skills • Technologies	• Lack of Strategic planning • Research and technology trends • Funding • Market

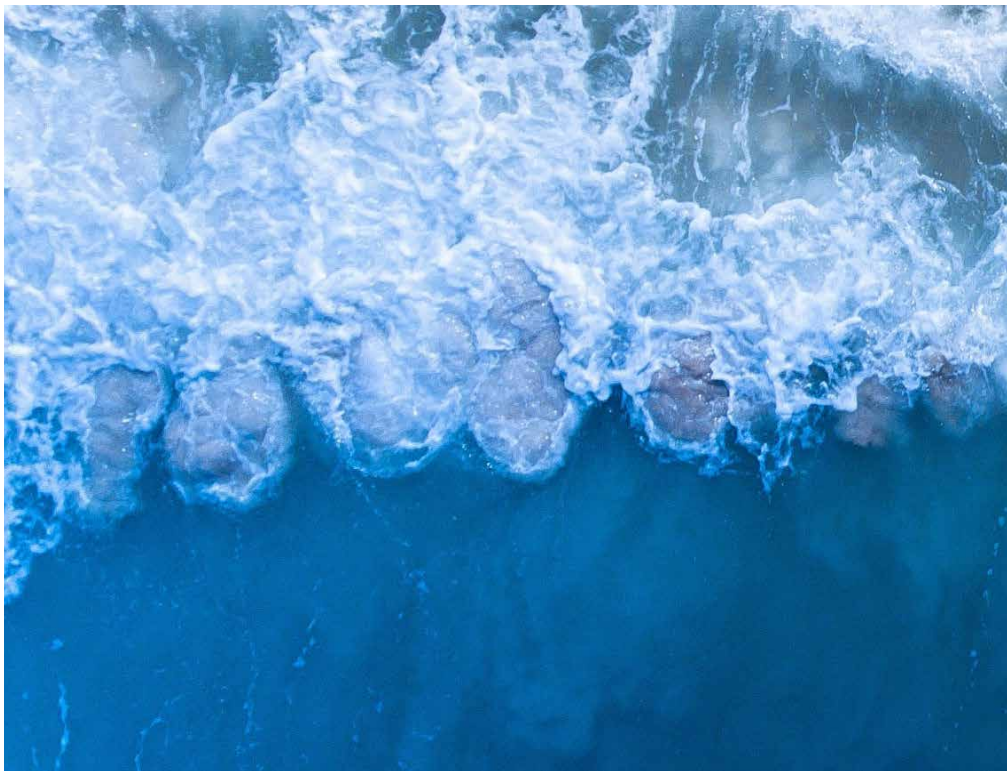
Table 3 12 List of Gaps of MED IPs in maritime surveillance sector

Integrated and interoperable maritime situational awareness platforms and services

From a strategic point of view, more efforts are needed to facilitate the implementation of these potential integrated monitoring systems. The national policies must be applied also for all those EU countries which now do not have specific national strategies. The most important example is Albania that has a substantial knowledge in maritime data transmission and should participate on the development of this innovation potential with as an active actor even if now no strategies are developed for this country.
An important gap of this potential is the occupational field. In fact, it is necessary the conversion of the current technical skills in all the EU countries to form operators able to manage this complex platform systems and deal with the big data processing. New specialized technical training courses are required in EU. Regarding financing, funding agencies of each EU nation need to be aligned according to the common strategies. However, there is a gap between the existence of technologies related to this field and the realization of real sharing data systems. R&D is fundamental to fill this gap. The research studies must be increase in EU nations, except to France, Italy, Greece and Albania, with the creation of new research projects or the involvement of the other countries in EU projects. This general gap in R&D in general for the maritime surveillance sector is also underlying by the non-participation in EU project by the majority part of EU nations. For specific technologies regarding the observing system in the marine environment, investments on the creation of technical and professional figures capable to understand and to process the data from monitoring systems should be necessary. A fast solution could be the reconversion of already existent figures working in space (Italy and France) or geosciences (Cyprus) observing systems field to the marine monitoring by specific training courses. The research and technological trend present a gap between the main EU actors in this field (France, Italy and Greece) and all the other countries. The increase of the participation of these nations in EU research projects is necessary in order to share the knowledge in R&D and technologies to homogenize the experience among all EU countries. A special example is Cyprus, as explained in Section 2.1, the research expertise in monitoring could be applied to the field of the monitoring and observation of maritime environment.

Interactive and Dynamic Atlas of Maritime Risk Maps

Specialized skills are required to develop this technology. Training courses by



research organizations are necessary in each EU countries. There is already available several funding from EU programs. But, funding strategies at national level need to be aligned according to common strategies at EU level. From the technological point of view, there are some available products ready to be used, especially in Italy and France. To fill this gap, an improvement of research activities in each EU nations is fundamental, increasing the participation in specific EU research projects.

Operative system for Search and Rescue Planning

Specialized skills are required to work in this sector. Training courses by research organizations are necessary. Funding strategies at national level needs to be aligned according to common strategies at EU level.
Now only single components are available, more effort is needed to have products ready for the market. Research is fundamental to fill the existing gaps. No marketing action are present. There is not cooperation connected to development of operational systems for marine Search and Rescue.

Development of Intelligent Vessels Monitoring Systems

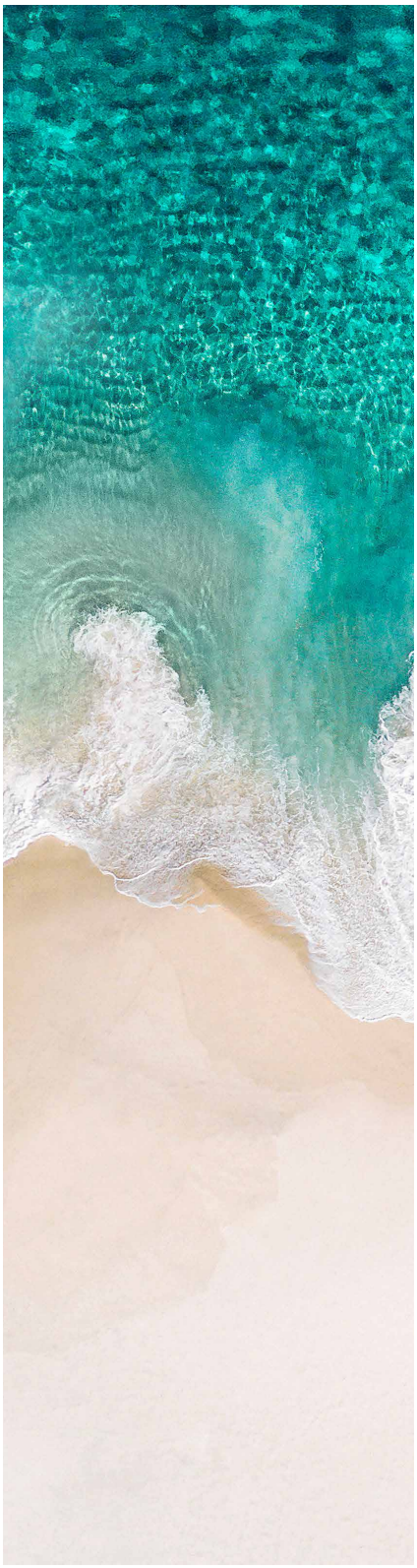
The principal actor in this technology (Greece and France) have few international researchers, laboratories and start-ups in the field of artificial intelligence, especially Greece. Research organizations should acquire the appropriate skills to effectively use it in the future. Scientists in Greece have managed to build an intelligent data collector which gives information about the systems and course of the vessel every 15 seconds. Even Italy has knowledge in the field of intelligent vessels, but the technologies are not applied to this maritime monitoring application.
An application of these systems is the control of illegal fisheries and only five Member States (Austria, Cyprus, France, Lithuania and Spain) detail the number or proportion of fishing vessels or consignments arriving in containers that are subject to physical inspections.
The problem of illegal fishing is above all the political will of each country to enforce international rules on illegal fishing. Preserving this fishing capital is an international challenge for tomorrow.
Today more than 800 million people depend on fishing as a means of livelihood. Being able to monitor such a population is impossible. We must therefore target and practice the rule of 20 / 80 to be able to monitor 20% of offenders who are responsible for 80% of 20 to 25 million tons of fish caught illegally each year. Beyond the human resources available, it is first and foremost the means of detecting these illegal fisheries that must be strengthened.
Illegal fishing represents a shortfall for the global economy estimated at between 8 and 19 billion Euros each year. At the same time, and for 2018 the budget of the European Union stands at 145 billion Euros of which 56 billion are devoted to support for agriculture, fisheries and the environment. The objective of the European Union's fisheries structural policy is to adapt the capacity of the fishing fleet to resources in order to remedy their overexploitation and for the sector to have a sustainable future. It is financed by the European Maritime and Fisheries Fund (EMFF), which supports in particular: (i) the adoption of sustainable practices by fishermen and aquaculture farm owners; (ii) diversification of economic activities of coastal populations.
Projects aimed at creating jobs and improving the quality of life along the European coastline. This fund has a budget of 5.75 billion euros for the period 2014-2020, including 588 million euros for France. The European Union has also contributed 1.5 million euros to support African states to fight against illegal fishing in the Indian Ocean.
Different surveillance means are privileged (detection by satellite, surveillance drones, atmospheric balloons or maritime surveillance aircraft). The equipment on board surveillance vessels, whether optical or based on radar systems, completes the overall surveillance system. Of course, here again the means of control of the maritime traffic (AIS, IFF, VTS, GPS, VTMIS, LRITS, etc.) are all mandatory tools to fight against the illegal fishing.
All these means with multiple uses, do not stop to improve and evolve so much in the level of confidence of the information delivered as in the precision of detection and classification of the ship identified or observed. Another gap concerns some conflicts between fishermen, (French, Spanish, British) at certain times of the year, we observe a respect of the regulations enacted by the IMO or by the European Commission.

Specialized Social Networking Services for Maritime Crisis Management

Lack of Strategic planning on Maritime Crisis Management that leads to significant impacts on life and economy.
Existence of qualified personnel in communication and technical specialization.
Ability to raise funding for this objective from a significant number of European a National programs. Research and technology trends are clarified and robust, their integration and mainstreaming into planning. The influencing role of social media can facilitate improved R&D interfaces in Maritime Security. Strong market perspectives including the public sector, shipping companies, energy distribution operators.
Transnational cooperation is needed for a comprehensive Maritime Crisis in the Mediterranean Maritime sector.

3.2.4 Outlook and expected trends

Monitoring European maritime areas and their approaches is certainly one of the major challenges facing Europe. It is necessary to consider that the seas are now our primary source of energy resources, raw materials and food. Europe's maritime domain is considerable, and it is our responsibility to develop it while preserving its immense wealth through reasonable exploitation. Whether it involves the implementation of reliable, coordinated surveillance systems or intelligent use of the means of action already wielded by different states at sea, setting up a maritime surveillance program should be considered a priority for Europe, now a world leader when it comes to skills in the wider maritime field. By contributing effectively and proactively to controlling its maritime areas, Europe is in prime position to manage and exploit the ocean in a reasonable way, something on which the future of our Blue Planet will hinge.
A major thread running through the actions proposed is the need for closer cooperation between civilian authorities (coastguards) and military authorities (navies), for example to make better use of military assets and information to improve the effectiveness of civilian operations. For example, a military drone, radar station or patrol craft often have more advanced technologies which can be useful also for civilian purposes[24].
In combination with "Big Data Analytics and Communication for the Surveillance of the Maritime space" and "Specialized Social Networking Services for Maritime Crisis Management", could significantly contribute to the development of the sector in the future.
As already explained in Section 1, in maritime surveillance sector different subsectors are defined which covered all the activities related to this field. The principal are: Transport Safety (T&S), Maritime Traffic Support (MTS), Maritime Security, Border Control and Migration (MS&BC&M), Illegal Fishery Control (IFC), Preparedness and Response to Marine Pollution (P&RMP), Observing Systems for the Marine Environment (OSME) that cooperate together with transversal aspect of the marine surveillance such as Big Data, deployment of drones, improvement of multi-sensors for surveillance and intervention applications. After analysing the MED panorama in the sector thanks to a benchmarking analysis, France, Italy



and Greece have been recognized as the three most active MED countries in every subsector of the sector. Among the other countries Albania, Spain, Cyprus have a very good knowledge in specific aspect of the sector. More specifically, Albania country has a strong experience on the ITC aspect of the sector with: data transmission, big data analysis and traffic monitoring. Spain shows a very good participation in the MED panorama on search and rescue activities, monitoring of pollutions and illegal fisheries. Moreover, Cyprus is fundamental for monitoring studies on the biodiversity and illegal fishery too. Only Portugal and Croatia do not have a strong impact in the maritime surveillance sector even if they have a strong tradition in naval field and they are starting to participate in EU project involved in this sector.
After the first step of the analysis, different innovation potentials of maritime surveillance have been identified. The principal innovations, common for most of the MED countries, are related to the development of Integrated and interoperable maritime situational awareness platforms and services, the development of an interactive and Dynamic Atlas of Maritime Risk Maps, an operative system for Search and Rescue Planning and the development of Intelligent Vessels Monitoring Systems. The development of these aspects will increase the importance of the maritime surveillance sector in the MED area in terms of economic, social and technological impact. At this moment, there are also many gaps that must be filled in order to bring the sector at its maximum development in all the MED countries. These gaps mainly concern the absence of specific professional skills and correlated technical courses to form operators able to properly work in the development of the "innovation potentials". Another important gap is due to the absence of correlation between national and EU strategies and policies, many countries do not have specific national strategies to support the marine surveillance growth. MED countries should also increase public/private funding in the sector, because at this moment, only EU funds are available to support these actions. For some innovations (e.g.; search and rescue, strengthening of EU Capability in observing the marine environment) there are not important marketing actions, this problem creates a gap in the realizations of the technologies related to these IPs. Finally, the specific knowledge and the research study should be increase to the countries which are not so into the sector experience by sharing knowledge and by the conjunct participation in research projects. From this point of view, also new networking research infrastructure must be built to give the possibility to the industries to test their technologies related to the IPs of the sector.

[24]Report on the Blue Growth Strategy Towards more sustainable growth and jobs in the blue economy, Commission Staff Working Document, 2017

3.3 FISHING AND AQUACULTURE

3.3.1 Introducing the sector and its subsectors

Production of sea-food for human consumption is currently worldwide almost equally divided between aquaculture and fishery. The EU market is still dominated by fishing activities covering 80% of production (European Commission, 2018), although fisheries production has decreased by more than 35% since 1995 (Eurostat database, own calculations). A more balanced activity between fishery (58%) and aquaculture (42%) is nevertheless already experienced in the Mediterranean (Figure 3.9).
Future growth in production is expected to originate from aquaculture, which is the fastest growing animal food-producing sector in the world. Aquaculture is an increasingly important contributor to economic growth, in spite of the fact that since 2000 it no longer enjoys the high annual growth rates of the 1980s and 1990s (10.8 and 9.5% respectively) that declined to a moderate 5.8% during the period 2001–2016 (FAO, 2018), when, however, the EU overall output has been more or less constant in volume. The global production from aquaculture is projected to reach 109 Mtons in 2030 with growth of 37% over 2016, while the estimated projection for EU aquaculture production in 2030 is roughly 1.7 Mtons, with an increase of around 370 ktons (28.8%) (FAO, 2018), or 1.5 Mtons in 2020, an increase of more than 300 ktons (25%) compared to the 2012 baseline (as calculated according to the figures presented in Member States' Multiannual National Strategic Plans developed in 2014-2015 for the promotion of sustainable aquaculture within the overall context of the EU Common Fisheries Policy). EU aquaculture seems not to be able to take advantage of the global development in the sector, whereas self-sufficiency rate remains below 50%, meaning that more of the consumed fisheries and aquaculture products are supplied through products imported from non-EU countries than through EU catches or aquaculture production (EUMOFA, 2018).
The global capture fisheries production is expected to reach about 91 Mtons in 2030, slightly higher (by 1%) than in 2016 (FAO, 2018). However in the last two decades, a clear negative trend in total fish landings was observed throughout the Mediterranean. Capture fisheries face the challenges of balancing the sustainability of stocks and that of the income of fishermen. Decades of overfishing and

mismanagement have severely degraded the marine resources, with over 85% of assessed stocks of the Mediterranean (essentially, the highest percentage worldwide) being overfished (FAO, 2016). There is a general agreement that overcapacity, particularly in the large-scale fleet, has been a major driver behind the current situation of overexploitation in many stocks. This is also threatening the survival of small-scale fishers and their families whose livelihoods and income depend on dwindling catches. Therefore protective restrictions for fisheries management purposes have been adopted for preserving fish abundance and biomass. Nevertheless, as reported by Pauly[25], if large-scale fisheries are characterized by a general lack of sustainability, small scale fisheries are closer to blue growth principles, even though their own characteristics imply major concerns in the optic of sustainable development.
The Fishing and aquaculture sector has been divided in the following four sub-sectors of interest, whichwill be described in detail in the following paragraph. The benchmark analysis covered a set of different attributes for the whole assessment in order to capture the related elements associated with the development and implementation of the sector.
The subsectors analysed are the following:

Pelagic and Demersal Large Scale Fisheries (LSF) and Distant Water Fleet (DWF)
include fisheries and the quite diversified range of gears used, with some significant differences among countries and regions. Among the Mediterranean countries the industrial segment operates mainly for Bluefin tuna fishing and is practiced by large tuna seiners in certain countries such as Spain and Italy. The LSF in the Mediterranean area (highly dependent on a small number of species) is mainly made up of vessels using active gears, especially demersal trawlers and purse seiners targeting sardines and anchovies.

Small Scale Fisheries (SSF)
targeting the local market for fresh fish, mainly sold directly to consumers, is widespread in the Mediterranean and generally operate in lagoons and the coastal area of the continental shelf, using small boats and not towed gears. If industrial fisheries are characterized by a general lack of sustainability, small scale fisheries are closer to blue growth principles (Pauly 2018).

Marine Finfish aquaculture (MFA):
Mediterranean fish farming focuses on the popular carnivorous finfish species with either a low production volume from capture fisheries or from over-fishing stocks; European sea bass (Dicentrarchus labrax) and Gilthead sea bream (Sparus aurata) are the main species grown.

Shellfish aquaculture (SA)
sector produced almost 550 ktons in 2012 at a value nearing EUR 900 million, accounting for roughly half of EU aquaculture output, one fifth of which produced in the Mediterranean with Mussels and Oyster production dominating the sector.

[25]Pauly D, 2018. A vision for marine fisheries in a global blue economy. Mar Policy. doi: 10.1016/j.marpol.2017.11.010

3.3.2 Fishing and Aquaculture in the MED area

In order to find out exploitation opportunities within the sector and identify innovation potentials to be implemented, the actual sector status in the MED area was studied based on a benchmark analysis across the eight countries of the MISTRAL project and covering a set of different attributes for the whole assessment. Here is presented a comparative overview to highlight the relevance of each attribute that describe the sector and the level of maturity of such attribute for the sector development. A detailed description of the methodology followed for the analysis is reported in Chap. 2 (section 2.4 MISTRAL methodological framework)
Qualitative analysis performed at Country level for each attribute is represented in Fig. 3.7 and Fig. 3.8. The Relevance and Readiness of each attribute has been assigned by self-assessment in a range that goes from "low" to "high".
The majority of MISTRAL Countries recognized the higher relevance for the sector growth of reference policy and strategies followed by research and technology trends, research infrastructures, research group and networks and funding agencies. The above finding reflects the perception to find innovation within the sector by focusing on technological drivers at different level within the target area whereas the socio-economic dimension is still perceived as a consolidated trend to unlock. The self-assessment analysis of readiness revealed a great variability among countries and reflects the current picture of the sector per each country.

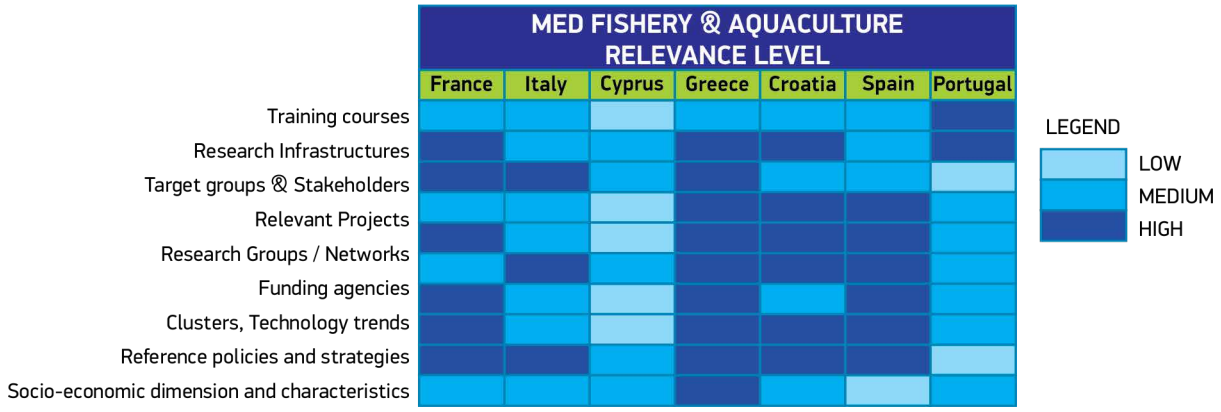


Fig. 3.7Relevance of Fishery and Aquaculture sector

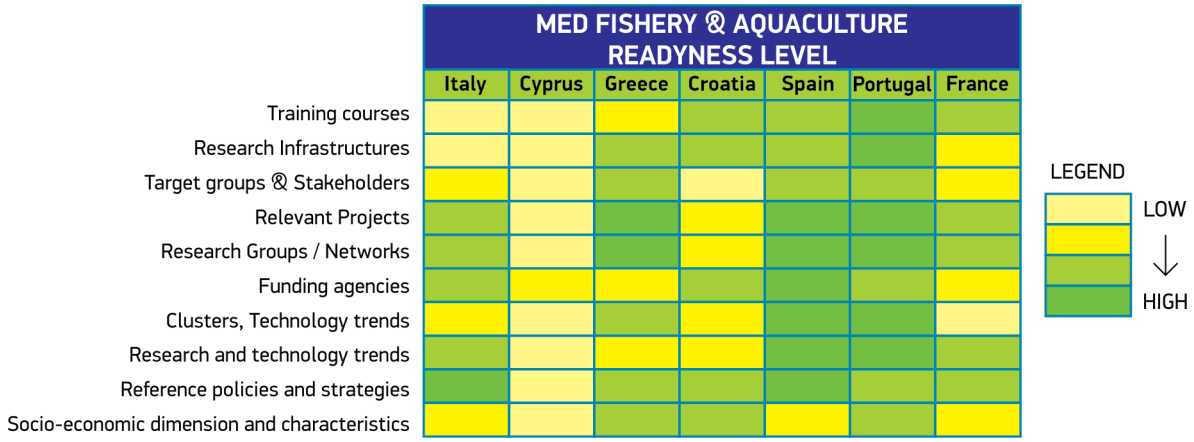


Fig. 3.8 Readiness of Fishery and Aquaculture sector

- Key economic figures
The Pelagic and Demersal Large Scale Fisheries (LSF) and Distant Water Fleet (DWF) subsectors generated in 2016 89% of the total landed weight, equivalent to 78% of the landed value (mainly from Italy, Greece, Spain and Croatia), whereas LSF accounted for 41% of the European number of vessels, but only 8.5% of the landed weight and 19.2% of the landed value. The LSF in the Mediterranean employs a total of 26.980 people, corresponding to 24,640 Full Time Equivalents and fall under the provisions of the multiannual management plan as adopted under the General Fisheries Commission for the Mediterranean.
The small-scale (SSF) coastal fleet (vessels under 12m using passive gears) in the Mediterranean is of vital importance from a social point of view since it represents the 86% of the total fleet by number of vessels and 61% of all employment in 2016. Greece and Italy represent major employers: Greece with 17.748 FTEs and Italy with 9.554 FTEs (Fig. 2). In addition, in Greece and Cyprus women play a key role in many small-scale coastal fleets very often through the provision of unpaid labour (STECF, 2018).
Marine aquaculture (MA) including shellfish and finfish with a diverse value chain, suitable areas, economical value, actors and technological challenges provide an important source of protein in many Mediterranean countries.

In 2012, EU Member States produced 330 ktons of marine finfish aquaculture (MFA) species with a value of €1.5 billion representing 25% of EU aquaculture production. Total EU production is close to 150 ktons at a value of €800 million. The main EU producers are Greece with roughly 60% of EU production, Spain (20%) and Italy (7%). These two species are also grown in several other EU Member States, namely Croatia, Cyprus and Malta, but at modest levels (less than 4 ktons annual production) or they contribute minimum quantities as in Albania.

Bluefin tuna (ThunnusThynnus) capture-based aquaculture is widespread in the Mediterranean. In 2016, the production reached 17.6 ktons, with Spain and Croatia producing 7.5 ktons (in Malta 10.1 ktons).

The EU shellfish aquaculture (SA) sector produced almost 550 ktons in 2012 at a value nearing €900 million, accounting for roughly half of EU aquaculture output, one fifth of which produced in the Mediterranean. Mussels dominate EU shellfish aquaculture with production nearing 450 ktons per year for a value of €417 million. The main EU producer in the Mediterranean is Italy with almost 60% of the farmed mussel production; Greece is the second largest producer (20%). Other Member States with significant

mussel production include France and Spain. Oyster is the second main shellfish species grown in the EU with approximately 95 ktons produced, valued at €450 million and France is the single largest oyster producer (90% of EU production), however production in the Mediterranean is limited to 6 ktons. In the Mediterranean there is also a significant production of clams in Italy (approximately 30 ktons).

Emilia-Romagna in Italy is the first region for shellfish production whereas regional mussel and clam production are nationally the firsts in quantity productions (22 and 15k tons/year) and they contribute, respectively, with the 33.6 and 53% of the country production. Similarly, the region of Central Macedonia in Greece produces approx. the 85% of the country annual production in mussels (18k tons/year).

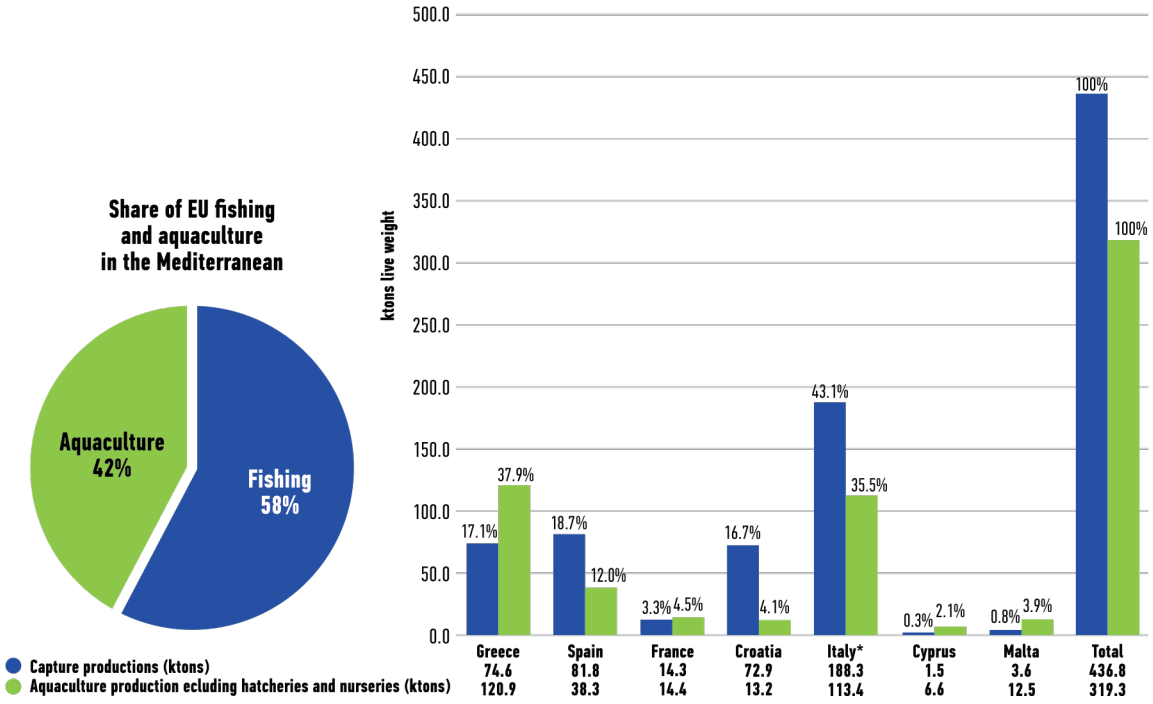


Fig. 3.9: Leading EU Member States in fishing and aquaculture production in the Mediterranean (2016) from Eurostat Database 2016

According to data extracted from Eurostat 2016 (Fig 3.9-3.11), EU capture fisheries production in the Mediterranean is mainly concentrated in Italy with 43.1%, Spain (18.7%), Greece (17.1%) and Croatia (16.7%), while marine aquaculture production is dominated almost equally by Greece (37.9%) and Italy (35.5%), in a profoundly different pattern, since marine finfish represents more than 80% of production in Greece, but only 10% in Italy. Italy and Greece are making up 65% in weight of EU totals in the Mediterranean.

[23]Eurostat Database, Fisheries-Mediterranean and Black Sea [fish_ca_atl37], and Production from aquaculture excluding hatcheries and nurseries [fish_aq2a]

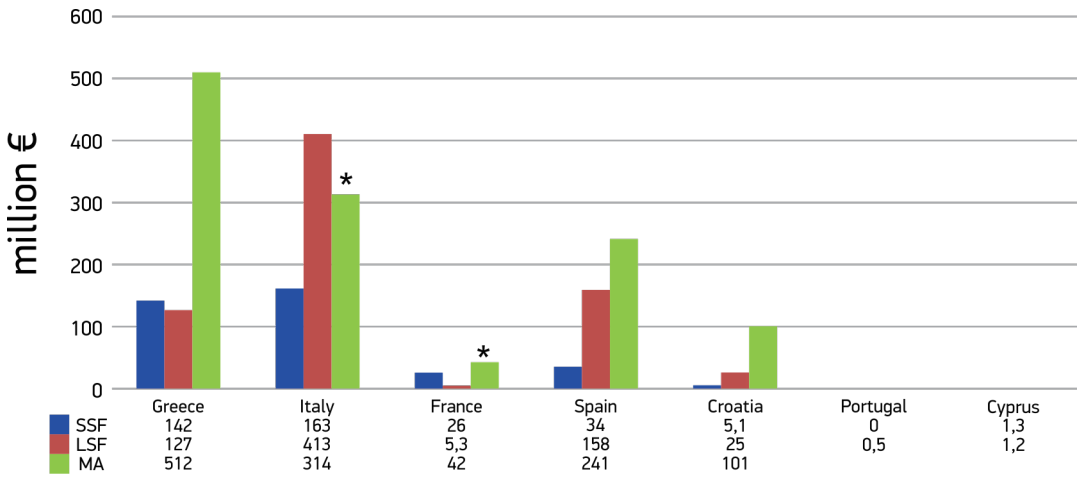


Fig. 3.11Key figures of the MISTRAL member countries: Gross Value Added of fisheries landings and Gross Production Value of aquaculture (MA) in the Mediterranean (2016). Sources: Eurostat Database, Fisheries, Production from aquaculture excluding hatcheries and nurseries (from 2008 onwards) [fish_aq2a]; European Commission, JRC, Scientific, Technical and Economic Committee for Fisheries (STECF). 2018. The 2018 Annual Economic Report on the EU Fishing Fleet (STECF-18-07). Publications Office of the European Union. Luxembourg. Doi:10.2760/56158.

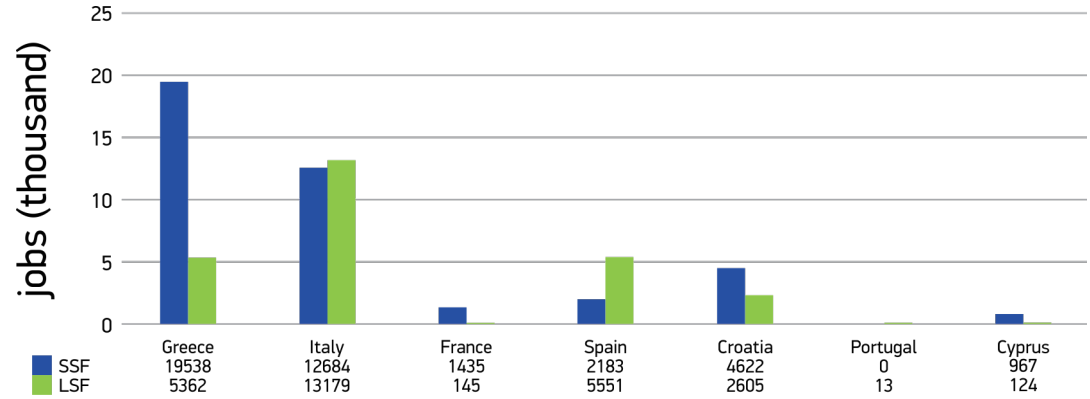


Fig. 3.10Contribution to the employment of small scale fisheries (SSF) and large scale fisheries (LSF) of MISTRAL member countries in the Mediterranean (2016).Source: European Commission, JRC, Scientific, Technical and Economic Committee for Fisheries (STECF). 2018. The 2018 Annual Economic Report on the EU Fishing Fleet (STECF-18-07). Publications Office of the European Union. Luxembourg. Doi:10.2760/56158.

As reported by MISTRAL partners the weak recovery in the Italian fisheries sector, which had begun in 2014, continued in 2016. The total volume of products landed in 2016 has remained unchanged. The value of landings increased by 1.6% thanks to the good performance of LSF (+2%). In Greece a downward trend was observed in 2014 and activity growth fell by 25% below 2009, while in 2016 it was still down to 7%.

In Italy until 2015 aquaculture registered an average reduction of about 7% in terms of production. However, only in 2015 the economic contribution of Italy is higher than 10%, placing it among the major EU producers and accounting for almost three quarters of the aquaculture production volume and value together with Spain, the UK, France and Greece. In Greece, following a downward trend after 2010, activity growth returned in 2016 to the levels of 2009.

- Reference policies and strategies

Fishing policies, strategies and management
All fishing opportunities are regulated to ensure that fisheries are ecologically, economically and socially sustainable.
In the EU, harvesting limitations are introduced autonomously and result from agreements reached in the framework of Regional Fisheries Management Organizations (RFMOs).
The Common Fisheries Policy (CFP), a set of rules for managing European fishing fleets and for conserving fish stocks, urges that if fishing is not to be controlled and limited at a maximum sustainable yield, at the latest by 2020, European fish stocks may collapse or fishing may cease to be economically viable. Another increasingly important aim of the CFP is to reduce unwanted catches and wasteful practices to the minimum or avoid them altogether, through the gradual introduction of a landing obligation. In preparation of the implementation of the landing obligation, the Commission has adopted two discard plans for the Mediterranean (through so-called delegated acts):

- Commission Delegated Regulation (EU) 2016/2376 of 13 October 2016 establishing a discard plan for mollusc bivalve Venus spp. in the Italian territorial waters.
- Commission Delegated Regulation (EU) 2017/86 of 20 October 2016, amended by Commission Delegated Regulation (EU) 2018/153 of 23 October 2017, establishing a discard plan for certain demersal fisheries in the Mediterranean Sea.

Furthermore, the CFP increasingly has recourse to Multiannual Plans that often combine different management tools. The European Commission is empowered in multiannual management plans to include the target of fishing at maximum sustainable yield and a deadline for achieving this target. In February 2017 the Commission proposed a multiannual plan for small pelagic stocks in the Adriatic Sea. The implementation of multiannual fisheries management plans at this sea basin level has been set as a specific objective of the EU Strategy for the Adriatic and Ionian Region (EUSAIR) as well. In March 2018 the Commission proposed a multiannual plan for the fisheries exploiting demersal stocks in the western Mediterranean Sea. These plans are still in the pipeline.
Meanwhile, a multiannual plan for small pelagic fisheries in the Adriatic Sea was adopted by the GFCM in 2013 (Recommendation GFCM 37/2013) and amended with additional restricting measures for 2017 and 2018.
Certain national (Croatian and Italian) management plans have been issued following GFCM recommendations and under Council Regulation (EC) No 1967/2006 of 21 December 2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea (the Mediterranean Regulation), covering purse seiners and pelagic trawls which are the gears involved in the small pelagic fisheries. There are management plans set down under national regulations as well. All the MISTRAL member countries have put in force such plans. On top of that, a number of specific actions have been taken for the Mediterranean towards aligning the Mediterranean strategy with the CFP, both within EU waters and with its international partners. This has already had an effect with the review and update of five national management plans in line with advice of the Scientific, Technical and Economic Committee for Fisheries (STECF, 2018). The process is expected to accelerate beyond 2018.
The European Commission is also empowered in multiannual plans to establish biologically sensitive protected areas, including areas where there is clear evidence of heavy concentrations of fish below MCRS and of spawning grounds. In such areas, fishing activities may be restricted or prohibited in order to contribute to the conservation of living aquatic resources and marine ecosystems. In the Mediterranean, GFCM and the United Nations Environment Program (UNEP)/ Mediterranean Action Plan Secretariat to the Barcelona Convention (UNEP-MAP) signed a Memorandum of Understanding in 2012 that has already achieved results, including the harmonization of existing criteria for identifying Specially Protected Areas of Mediterranean Importance and Fisheries Restricted Areas (FRAs) (FAO, 2018). FRAs can contribute to biodiversity conservation, even though their primary target might not be conservational per se (i.e. conserving ecosystems as a whole), but rather focus on maintaining or improving the status of particular stocks and enhancing the respective fisheries.

Aquaculture policies, strategies and management

Albeit fisheries are intended in a strictly regulated and controlled or even inspected manner, for attaining sustainable development of aquaculture in the EU, however, the EU legislation has established the high quality, respecting strict environmental sustainability, animal health and consumer protection standards that EU aquaculture activities have to comply with:

- Environmental respect: Marine Strategy Framework Directive 2008/56/EC (MSFD), Directive 2014/89/EU for Maritime Spatial Planning (MSP), and more generally, Habitats (Natura 2000) Directive 1992/43/EEC .
- Use of alien and locally absent species in aquaculture: Regulation (EU) N°304/2011.
- Health and welfare of livestock: Animal Health Directive 2006/88/EC and Live Animal Transport Directive 1995/29/EC .
- Food processing and adherence to market-oriented quality and/or certification labels: Product quality control systems (HACCP) 487/2000 and quality management systems as described in the EC Directive 2004/41/EC concerning food hygiene and health conditions for the production and placing on the market of certain products of animal origin intended for human consumption.

Within the framework of the Common Fisheries Policy, the Aquaculture Advisory Council (AAC) was established in late 2016. This stakeholder-led organisation has as main objective to provide the European institutions and the Member States with recommendations and advice on issues related to the sustainable development of the sector.

Notwithstanding the foregoing, national authorization and leasing processes (granting the exclusive right to use an area of water for marine aquaculture, usually for a defined period) are setting main constraints hampering the development of the sector in the Mediterranean. In order to facilitate the responsible competitiveness of EU aquaculture, in 2013, the newCFP introduced the Open Method of Coordination (OMC) that aims at spreading best practice and at giving practical answers to common challenges identified by Member States and stakeholders, identifying common objectives and, where possible, indicators to measure progress towards these goals.

GFCM has recently adopted two relevant resolutions, namely Resolution GFCM/41/2017/1 on a strategy for the sustainable development of Mediterranean and Black Sea aquaculture and Resolution GFCM/41/2017/2 on guidelines for the streamlining of aquaculture authorization and leasing processes.Under the OMC in particular, the EU Member States developed, in 2014-2015, Multiannual National Strategic Plans for the promotion of sustainable aquaculture. In these plans, Member States address the four priorities identified in the Strategic Guidelines for the sustainable development of EU aquaculture (COM/2013/0229 final) and propose for the period 2014-2020 concrete actions to address them.

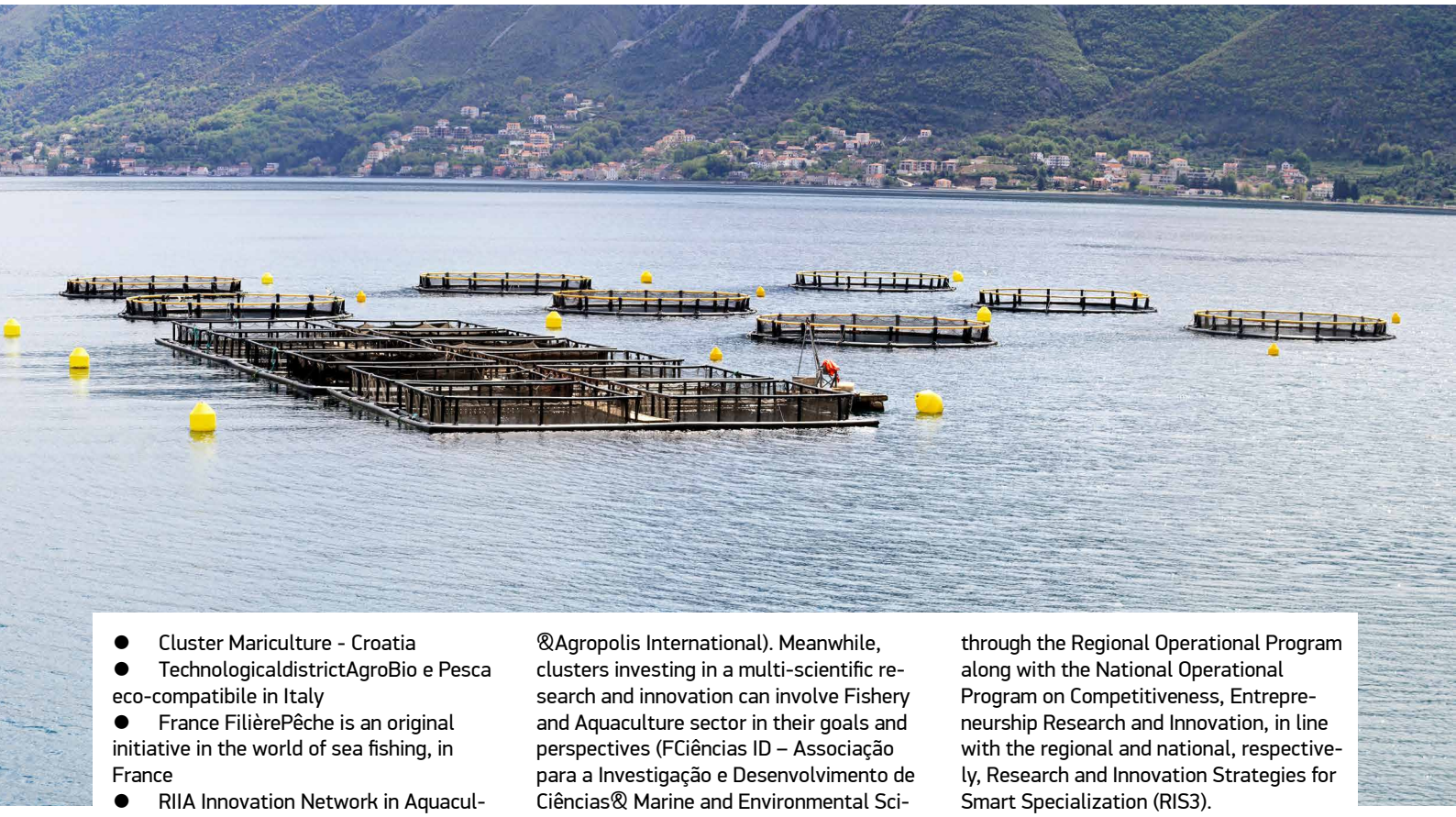
The evaluation of the OMC for EU aquaculture will be completed by mid-2019. However, despite the good intentions at EU level and the national plans, actions seem not be a match for the sector's expectations and the initial enthusiasm is being transformed to deception and defeatism (European Parliament, 2018).

For nearly all the Countries of the Med area there is an alignment of all the above described objectives with: the Blue Growth Strategy the long-term strategy to support sustainable growth in the marine and maritime sectors with priorities such as sustainable aquaculture. The Biodiversity Strategy and Action Plans aiming to halt the loss of biodiversity and ecosystem services, with the priority of the integration of biodiversity conservation into fisheries policies; the Climate change adaptation strategy which defines a series of priorities and make some proposal to mitigate the impact on fish stocks and the aquaculture industry.

- Clusters, Technology Platforms

In the MISTRAL MED area a few clusters and technology centres have been developed dealing exclusively with Fishery and Aquaculture and highlighting the importance and the prospective of the sector in each country separately and in the MED region.

- The EATiPMirror Platforms (MiPs) which are industry-driven multi-stakeholder aquaculture clusters (with experts from the industry and the academia), supporting the implementation of strategic research and innovation activities at a regional/national level (HETEPA –Greece, PTEPA-Spain, ITAQUA-Italy).



- Cluster Mariculture - Croatia
- TechnologicaldistrictAgroBio e Pesca eco-compatibile in Italy
- France FilièrePêche is an original initiative in the world of sea fishing, in France
- RIIA Innovation Network in Aquaculture Industries of the Valencian Community, Aquaculture Technology Center of Andalusia-CTAQUA in Spain.

Part of the existing Clusters and Technology Platforms are involved in all sectors of Blue Growth in order to promote research, technology, innovation, sustainability and environmental protection as well as education and training within and for the maritime industry. These clusters are indicative of the maturity and readiness of the above countries/regions to boost Blue Economy including Fishery and Aquaculture as one of the sectors of Blue Growth.

- Pôle Mer Méditerranée & French Maritime Cluster in France;
- National Technology Cluster - Blue Italian Growth in Italy;
- Oceano XXI – Cluster doConhecimento e Economia do Mar in Portugal;
- Maritime Cluster of the Balearic Islands & IDIMAR - Balearic Marine Innovation Cluster in Balearic Islands-Spain).

Clusters involved in agriculture, food, biodiversity and the rural environment including the Fishery and Aquaculture sector activities in their interests and efforts are reported from Croatia and France (Croatian Network for Rural Development and French Agri Sud-Ouest Innovation &Agropolis International). Meanwhile, clusters investing in a multi-scientific research and innovation can involve Fishery and Aquaculture sector in their goals and perspectives (FCiências ID – Associação para a Investigação e Desenvolvimento de Ciências& Marine and Environmental Sciences Center-MARE in Portugal; Mediterranean Advisory Council -MEDAC in Italy. In countries where the sector is less mature (Cyprus, Albania), it seems that no cluster was created but professional organisations or networks play that role of structuring the sector.

- Funding Agencies

The European Union, through its various funds and funding schemes is the key funding provider supporting sustainable fisheries and aquaculture, which avail of the following:

- The European Maritime and Fishery Fund (EMFF) through the National Operational Programmes “Fisheries and Maritime 2014-2020” - Almost half of the EMFF 2014-2020 budget of €5.7 billion covers the “sustainable fisheries” (27%) and “sustainable aquaculture” (21%) priorities, being used in the responsibility of Member States under shared management.These programs can also contribute to the competitiveness of the fisheries and aquaculture sectors by promoting marketing actions, producers organizations and actions undertaken through Community-Led Local Development (CLLD).
- The European Regional Development Fund (ERDF), with the participation of the European Social Fund (ESF) as well, through the Regional Operational Program along with the National Operational Program on Competitiveness, Entrepreneurship Research and Innovation, in line with the regional and national, respectively, Research and Innovation Strategies for Smart Specialization (RIS3).
- The European Investment Bank (EIB) backed by the European Fund for Strategic Investment (EFSI) and relying on national promotional banks across the partner countries.
- The EU Research and Innovation 7 years (2014-2020) program, Horizon 2020, LIFE + (for environmental issues) and the cross-border and interregional cooperation program of INTERREG.
- Such funding can de-risk private investment and make investments more attractive for private funds (bank loans, equity funds and venture capital).

The rationalization and streamlining of all funding, either EU or national and regional, public and private, carried out at the regional level, is a major challenge ahead. The ‘Plan Littoral 21 Méditerranée’ of the French region Occitanie is a characteristic response to this challenge, aiming to develop integrated and innovative coastal and maritime economic activities and preserve the natural wealth, where the objective of strengthening the competitiveness of fishery and aquaculture is included as well.

A list of the principal national or regional fund managing authorities of each partner country can be found in Table 3-13.

COUNTRY	FUNDING MANANGING AUTHORITY
Grece	The national as well as certain regional (Ionian Islands, South Aegean, Crete, Attica, Epirus, East Macedonia-Thrace, Western Greece) Research and Innovation Strategies for Smart Specialisation (RIS3) have highlighted "Fishing and aquaculture" as a priority economic domain (A.03). This priority is linked to the use of the ERDF, through the Ministry of Economy and Development (EU Funds National Coordinator) and the respective Regional Authorities, only in a pre-industrial research phase, otherwise is linked to the use of the EMFF through the Ministry of Rural Development and Food.
France	ANR "AgenceNationale de la Recherche", the French public bank for Investment Bpi, Ministry of Agriculture and Food-Directory for maritime fisheries and aquaculture– DPMA (National EMMF), FUI (Le Fonds Unique Interministériel), PIA (Programmed'Investissementd'Avenir), France FilièrePêche, Occitanie –Paca and Corsica Region.
Spain	Ministry of Agriculture, Fisheries and Food; Center for Industrial Technological Development – CDTI (INNPRONTA, Technological Fund or INNVIERTE program) Ministry of Science, Innovation and Universities; Government of Spain and ERDF; Government of the Balearic Islands; Private investment funds; SEPIDES; National Board of Marine Crops advisory (JACUMAR).
Croatia	Ministry of Agriculture, Fisheries and Rural Development; Ministry of Science and Eduation
Portugal	Fundação de Ciência e Tecnologia (FCT), Mar2020 , Fundo Azul
Cyprus	Department of Fisheries and Marine Research; Research Promotion Foundation
Albania	Directory of Agriculture Production & Trade Policies in the Ministry of Agriculture, Rural development & Water Administration.

Table 3 13 List of the principal national or regional fund managing authorities of each partner countryin F&A sector

- Research Groups, networks and other resources

There are several types of research bodies: state-controlled institutions, specialized laboratories in university departments, non-profit research organizations, privately owned research institutes and multiple state-controlled institutions and laboratories are in line with governmental policies supporting R&D of fishery and aquaculture.

Italy: the National Research Council (CNR) is the largest public research institution and the only one under the Research Ministry performing multidisciplinary activities such as fishery and aquaculture R&D activities (Institute of Biological Resources and Marine Biotechnology - IRBIM; Institute of Anthropic Impacts and Sustainability in marine environment – IAS of CNR).The National Institute of Oceanography and Applied Geophysics – OGS, located in Friuli Venezia Giulia Region, is a public research Institute funded by the Italian Ministry of Education, University and Research (MIUR), which acts internationally in the fields of Earth and Marine Sciences, Oceanography, Geophysics and Seismology.The Interuniversity Center for Marine Biology and Applied Ecology (CONISMA) is controlled by the Italian Ministry of Education, Universities and Research. Finally, the Consortium for the Inter-University Center of Marine Biology and Applied Ecology (CIBM) carries out basic and applied research in the field of fishing and oceanography.

Greece: the Hellenic Centre for Marine Research (HCMR) is a governmental Research Centre operating under the auspices of the General Secretariat for Research and Technology (Greek Ministry of Education) including three large Institutes: the Institute of Marine Biology Biotechnology and Aquaculture (IMBBC), the Institute of Oceanography (I.O) and the Institute of Marine Biological Resources and Inland Waters (IMBRIW). The Fisheries Research Institute-Kavala (FRI/INALE) is a semi state marine research organization responsible for the collection of scientific data on the fisheries sector and aquaculture industry.

France: French Research Institute for Exploitation of the Sea IFREMER, the Private Interaction host-pathogen Environment IHPE, Station de Sète-Pôle Mer &LagunesFish Research Centre, the Federated research unit for Marine Biodiversity Exploitation and Conservation MARBEC and the Mediterranean Institute of Oceanology MIO.

Spain: There are several federal research bodies. The Public Research Organization (IEO), linked to the Ministry of Science and Innovation; the Institute of Aquaculture Torre de la Sal (IATS) devoted entirely to aquaculture research, under the responsibility of the State Agency Superior Council of Scientific Research (CSIC); the Andalusian IFAPA-AGUA DEL PINO. The Fish and Aquaculture Research and Training Center which promotes research, technological innovation and training in the field of agriculture, fisheries, aquaculture and food industries and the Balearic Oceanographic Center. IMIDA Murcia Institute of Agricultural Research-Development and Food, is a public body of the Region of Murcia, research, with the status of autonomous body, whose priority objective is the attention of research needs demanded by the agricultural sector.

Croatia: the Institute RuđerBošković in Zagreb presents the largest scientific activity and the highest international recognition in research disciplines and the Institute for Oceanography and Fisheries, which is the oldest marine research institute in Croatia.

Portugal: the Institute of Sea and Fisheries (INIAP/IPIMAR) is a unit of the Instituto Nacional de InvestigaçãoAgrária e das Pescas (INIAP), a governmental research institution constituted by two units agro/rural (INIA) and fisheries (IPIMAR).

Cyprus: the main actor in research and innovation related to fisheries and aquaculture is the Department of Fisheries and Marine Research and the Cyprus Marine Aquaculture Research Centre (CyMARC) with the vision of the economic and social prosperity of the fisheries sector.

Albania: the Fishery Research Institute in Durres is responsible for fisheries research under the responsibility of the Directorate of Fisheries Policies of the Ministry of Environment, Forestry and Water Administration.

Finally, some private efforts and non-for profit research organisations provide their own dedicated R&D on the sustainability of the sectors of aquaculture and fishing. Such examples are indicative in

the most industrialised countries such as in Italy(UNIMAR SocietàCooperativa, NISEA, COISPA Tecnologia e Ricerca and the Italian Research Centre for technology innovation in fishery and aquaculture M.A.R.E./ConsorzioMediterraneo as a service centre linked to governmental institutions), France(Paul Ricard Oceanographic Institute) and Spain(LEITAT Technology Center). A separate case is in Portugalthe Centre of Marine Sciences (CCMAR), an independent multidisciplinary, non-profit research organisation attached to the University of Algarve.
A whole list of University Departments specialized in fishing and aquaculture in the MISTRAL countries area could be found in next Table3-14.

UNIVERSITY	DEPARTMENT	COUNTRY
University of Dubrovnik	Department for Mariculture shell fish cultivation	Croatia
University of Zadar	Department for ecology, agronomy and aquaculture fish cultivation	Croatia
University of Zagreb	Faculty of Agronomy in Zagreb	Croatia
University of Venice (Cà Foscari)	Faculty of aquaculture	Italy
University of Bologna	Alma Mater Studorium; Lab of Marine Biology and Fisheries; Depart. of Veterinary Medical Sciences(DIMEVET); Inter-Departmental Centre for Research in Environmental Sciences (CIRSA), Ravenna Campus	Italy
University of Bari	Aldo Moro	Italy
University of Parma	Chemistry Laboratory /Consumer behaviour on fish food	Italy
University of Modena and Reggio Emilia	MeioLAB	Italy
University of Ferrara	Ichthyology laboratory; Cell Biology Laboratory	
University of Perpignan	Research & training center on Mediterranean environments - CEFREM	France
University Pierre & Marie Curie / CNRS	Villefranche-sur-merOceanologic Observatory	France
University Pierre & Marie Curie / CNRS	Banyuls Oceanologic Observatory	France
University of Corsica / CNRS	Sustainable TEchnologies for Littoral, Aquaculture and Marine Research – STELLA MARE	France
Polytechnic University of Valencia-	Aquaculture and biodiversity group Institute for animal science and technology and the Aquaculture and Environment Group (ACUMA)	Spain
University of Málaga	Natural Resources Research Group	Spain
University of the Balearic Islands	Marine Biology Department	Spain
Autonomous University of Barcelona	Department of Animal and Food Science	Spain
University of Murcia	Department of Zoology and Physical Anthropology	Spain
University of Porto	CIIMAR - Interdisciplinary Centre of Marine and Environmental Research, a leading research and advanced training institution	Portugal
University of Aveiro	CESAM – Centro de Estudos do ambiente e do Mar	Portugal
University of Porto	Department of Aquatic Production (DPA)	Portugal
University of Algarve	CIMA – Centro de InvestigaçãoMarinha e Ambiental	Portugal
University of Cyprus	Oceanography Center	Cyprus
Agricultural University of Tirana	Laboratory of Fisheries and Aquaculture	Albania
Univ. of Thessaly, School of Agricultural Sciences	Department of Ichthyology and Aquatic Environment	Greece
University of Crete (UoC), School of Sciences & Engineering	Department of Biology / Fish Physiology Laboratory	Greece
Agricultural University of Athens	Faculty of Animal Science and Aquaculture, Department of Applied Hydrobiology	Greece
Aristotle University of Thessaloniki (AUTH), School of Veterinary Medicine	Laboratory of Ichthyology	Greece
University of the Aegean, School of the Environment	Depart. of Marine Sciences / Laboratory of Aquaculture	Greece
University of Patras	Department of Biology/ Marine Ecology and Fisheries	Greece
Western Greece University of Applied Sciences	School of Agricultural Technology and Food and Nutrition Technology, Department of Fisheries and Aquaculture Technology	Greece
Alexander Technological Educational Institute of Thessaloniki	Department of Civil Engineering (School of Technological Applications)	Greece
	Departments of Food Technology and of Nutrition (School of Agricultural Technology, Food Technology and Nutrition)	

Table 3 14 University Departments specialized in fishing and aquaculture in the MISTRAL countries area

- Relevant projects

Considering the Strategy adopted by EU, concrete collaborative projects aim to address technical, environmental, market, socioeconomic and governance issues of the sector and they are mainly financed by EU funding programs (FP7, H2020, Interreg-Med, EMFF). The EU support to aquaculture research has targeted issues related to: technological optimization and competitiveness, quality health and environmental standards, access to space and water, climate change adaptation and capacity building (including communication) the National Policy and administration.
On the other hand, Fisheries research is mainly focused on fisheries management, ecosystem approach and mitigation of fishing impacts.
Most relevant projects promote and consolidate the environmental sustainability of the EU aquaculture production, especially among the dominant countries such as Greece, Italy, France,and Spain.
National and transnational co-operation actions, financed by private and public sources of finance, target the sustainable economic development of local fisheries through market-driven multi-stakeholder fishing approaches. These programs are mostly from Italy, France, Portugal(with strategies and good practices aiming to develop innovative solutions for monitoring and control of aquatic resources that can be adopted from the Atlantic). As well as Croatiathat has a strong presence in the preservation of degraded marine habitats mainly for sustainable fishing and slightly less projects for aquaculture by improving existingand developing new techniques and restoration actions.
On the other hand, inCyprusthere is a need to develop national research and development projects to support economic growth in the sectors of fishery and aquaculture.
Similarly,Albanianeedto develop relevant research and development projects to support economic growth and environmental safety of the sector in national and transnational level. In the last twenty years, the fishery and aquaculture sector have undergone a radical change thus few national efforts are presented. The main scientific projects of the Institute are fish stock assessment, study of Albania's lagoons and their potential and the restocking of inland water bodies with fingerlings.
The EU is supporting the Albanian fishery sector with a project "Establishing and Strengthening a Monitoring, Control and Surveillance (MCS) System for Fisheries in Albania", which aims at increasing the capacity of the fishery inspectors and the installation of Vessel Monitoring System (VMS) devices on all vessels longer than 12 m.
A complete list of Aquaculture and Fishing EU R&D projects, National and Transnational project in the MISTRAL Countries can be found in the next Tables 3-15 and 3-16.

PROJECT NAME	PROJECT TITLE	MISTRAL COUNTRIES INVOLVED								PROJECT DURATION
MedAID	MediterraneanAquacultureIntegrated Development	IT	FR	GR	SP	HR		PT		2017-2021
TAPAS	Tools for Assessing and Planning of Aquaculture Sustainability		FR	GR	SP					2016-2020
TargetFish	Targeted Disease prophylaxis In EU Fish Farming	IT	FR	GR	SP					2012-2017
Aquaspace	Ecosystem Approach to Making Space for Aquaculture	IT	FR	GR	SP					2015-2018
TROPOS	Floating multi-use off-shore platform adapted to deep waters		FR	GR	SP			PT		2012-2015
H2OCEAN	Development of a wind-wave power open-sea platform equipped for hydrogen generation with support for multiple users of energy	IT			SP					2012-2015

PROJECT NAME	PROJECT TITLE	MISTRAL COUNTRIES INVOLVED								PROJECT DURATION
MERMAID	Innovative Multi-purpose offshore platforms: planning, design & operation	IT		GR	SP		CY			2012-2015
PerformFISH	Integrating Innovative Approaches for Competitive and Sustainable Performance across the Mediterranean Aquaculture Value Chain	IT	FR	GR	SP	HR		PT		2018-2022
DIVERSIFY	Exploring the biological and socioeconomic potential of new/emerging candidate fish species for the expansion of EU aquaculture industry	IT	FR	GR	SP					2013-2018
ClimeFish	ClimeFish - Adapting to a changing word	IT		GR	SP					2016-2020
ParaFishControl	Advanced Tools and Research Strategies for Parasite control in European Farmed Fish	IT	FR	GR	SP	HR				2015-2020
PARASITE	Parasite risk assesment with integrated tools in EU fish production value chains	IT	FR		SP	HR				FR7 2013-2016
ARRAINA	Advanced Research Initiatives for Nutrition & Aquaculture	IT	FR	GR	SP			PT		2012-2016
SUCCESS	Strategic Use of Competitiveness towards Consolidating the Economic Sustainability of the European Seafood sector	IT	FR	GR	SP					2015-2018
FISHBOOST	Boosting EU aquaculture by advancing selective breeding to the next levels	IT	FR	GR	SP					2014-2019
VIVALDI	Preventing and Mitigating Farmed Bivalve Diseases	IT	FR		SP					H2020 2014-2016
MYSIS	A novel weaning diet to optimize performance of farmed shrimp larvae							PT		H2020-SME 2017
EOSAI	Earth Observation Services for Aquaculture Industries		FR	GR						H2020 (Neptune) 2017-2018
SEA-On-A-Chip	Real time monitoring of SEA contaminants by an autonomous Lab-on-a-chip biosensor	IT	FR	GR	SP			PT		EU FP7 2013-2017
SEAFOODTOMORROW	Nutritious, safe and sustainable seafood for consumers of tomorrow	IT	FR	GR	SP			PT		H2020 2017-2020
PrimeFish	Developing Innovative market orientated prediction toolbox to strengthen the economic sustainability and competitiveness of European seafood on local and global markets	IT	FR		SP					H2020 2015-2019
Future EU-Aqua	Future growth in sustainable, resilient and climate friendly organic and conventional European aquaculture	IT		GR						H2020 2018-2022
	Farmed in the EU school project- Learning about EU aquaculture	IT	FR	GR	SP					FP7 2014
MINOUW	The Science, Technology and Society Initiative to Minimise Unwanted Catches in European Fisheries	IT	FR	GR	SP			PT		H2020 RIA 2015-2019
DRIFTMED	Identification and characterization of the small-scale driftnets fisheries in Mediterranean	IT	FR	GR						EU 2013-2014
STREAM	Strengthening Regional cooperation in the Area of fisheries biological data collection in the Mediterranean and Black Sea	IT	FR	GR		HR				EU DG MARE 2018-2019
SafeNet	Sustainable fisheries in EU Mediterranean waters through a network of MPAs	IT	FR		SP					EU DG MARE 2016-2018
BENTHIS	Benthic Ecosystem Fisheries Impact Study	IT	FR	GR						EU FP7 2013-2017

Table 3 15 Aquaculture and Fishing EU R&D projects in the MISTRAL countries area

PROJECT NAME	PROJECT TITLE	MISTRAL COUNTRIES INVOLVED								PROJECT DURATION
	Internationalisation of study programmes of Marine fisheries and Military Maritime at the University of Split					HR	CY		AL	ESF 2018-2021
BLUE SMART	Blue Education for Sustainable Management of Aquatic Resources					HR				EASME 2017-2018
Novofeed	Novel feed ingredients from sustainable sources	IT								ERA NET 2020
FAIMMAC	Fishery and aquaculture integrated management model along the Adriatic coasts	IT				HR				EASME 2016-2018
AQUAACCEPT	Developing novel socio-environmental indicators and management tools for a sustainable aquaculture	IT								2015-2018
EcoFilmShellfishing	Ecological and Sustainable Management of the Shellfish Harvesting on Foot	IT			SP			PT		ERASMUS-EU
INvertebrateIT	Disruptive and forward-looking opportunities for competitive and sustainable aquaculture		FR		SP			PT		EASME/EMFF 2017-2019
ENTROPI	Enabling Technologies and Roadmaps for Offshore Platform Innovation		FR		SP			PT		EASME/EMFF 2017-2020
ValorMar	Integral Valorization of Marine Resources: Potential, Technological Innovation and New Applications							PT		SI&IDT funds 2017-2020
ECOAST	New methodologies for an ecosystem approach to spatial and temporal management of fisheries and aquaculture in coastal areas	IT		GR				PT		EU-COFASP 2016-2018
ECOCRIN	ECrinOstréicole Eco-ConçuRecyclable et INnovant		FR							Private 2015
VIBEA SeaPix	Volumic Imaging for Biomass estimation in aquaculture		FR							Private 2017
NINAqua	Des aliments aquacoles « nouvelle génération »		FR							FUI 2015-2019
BioBreED-H2O	Exploreaquaculturedevelopment policies	IT								MIPAAF
	Tools for the authentication and certifications of fish products from organic aquaculture	IT								MIPAAF
IDMA	Innovative Development of Multitrophic Aquaculture			GR						GSRT 2018-2020
BIOACTIVE	Production of high quality and value-added biomolecules using fish by-products and discards			GR						GSRT 2018-2020
DORY	Capitalization actions for aDriatic marine envirOnmentpRotection and ecosYstem based management	IT				HR				INTERREG 2018-2019
	Transforming Mediterranean Small-Scale Fisheries	IT		GR		HR				WWF 2017-2022
FISHINMED	Mediterranean Network of sustainable small-scale fishing communities	IT		GR						EMPI CBC 2013-2016
ARIEL	Promoting small-scale fisheries and aquaculture transnational networking in Adriatic-Ionian macroregion	IT		GR		HR				ADRION 2018-2019
ADRIAMED	Scientific cooperation to support fisheries in the Adriatic	IT				HR			AL	2007-
	Mechanism modeling and biosensor development for live fish transportation with water-free condition					HR				CHINA-HR 2017-2019
	Environmental aquaculture and seafood monitoring in South-Adriatic coast (Croatia) using Raman spectroscopy techniques and SERS-based sensors					HR				NEWFELPRO 2014-2016
INNOVAQUA	Technological Innovation for the improvement of productivity and competitiveness of Sicilian aquaculture	IT								PON R&C 2012-2015
PESCATEC	Develop a sustainable and competitive Sicilian fishery.	IT								PON R&C 2012-2016

PROJECT NAME	PROJECT TITLE	MISTRAL COUNTRIES INVOLVED								PROJECT DURATION
TESEO	High efficiency technologies on-board energy and environmental sustainability	IT								PON R&C 2012-2017
	Valorizzazione della produzione sostenibile delle ostriche nel sistema produttivo della molluschicoltura in Sardegna - OstrInnova	IT								POR FESR 2014 - 2020
	Integrate Aquaculture: an eco-innovative solution to foster sustainability in the Atlantic Area							PT		Interreg Atlantic 2017-2020
CephsandChefs	Octopus, squid, cuttlefish, sustainable fisheries and chefs							PT		Interreg Atlantic 2017-2020
Primrose	Predicting risk and impact of harmful events on the aquaculture sector		FR		SP			PT		Interreg Atlantic 2017-2020
Seatraces	Smart traceability and labelling toolbox for a sustainable seafood production							PT		Interreg Atlantic 2018-2020
CORAL	Sustainable Ocean Exploitation: Tools and Sensors							PT		National PH2020 2016-2018
INNOVMAR	Innovation and Sustainability in the Management and Exploitation of Marine Resources -							PT		National PH2020 2016-2018
FishMPABlue2	Fishermen and marine protected areas, a partnership for sustainability in the Mediterranean	IT								Interreg MED 2016-2019
ArtFISHMed	Support measures for the small-scale fishing pilot project – Actions aimed to enhance the participatory role of Mediterranean small-scale fishing in the decision making and advisory processes at national and EU level	IT				HR				MEDAC-UNIMAR 2016-2017

Table 3 16 Aquaculture and Fishing National and Transnational projects in the MISTRAL countries area

- Target groups and stakeholders

The main target groups and stakeholders belong to professional organisations assembling workers and producers from fishery and marine farming (fish & shellfish farmers) sub-sectors at the country or regional level. They are mainly evaluated with high relevance and readiness and have an important role to play in the innovation process and potential. They provide scientific and technologic support to their members for the improvement of the used practices, the protection of the environment and the promotion of their products. Meanwhile, professional associations are aiming at the continuing education and training of their members and the implementation of national and EU regulations concerning the sector. They are participating in research projects that contribute to innovation and development of the European fish farming sector and the sustainable fishing. General maritime professional associations also include Fishery and Aquaculture in their interests and activities as a major sector of the maritime economy while public authorities in all countries are responsible for the development and the implementation of policies dealing with maritime fisheries, sea products and aquaculture.

A detailed list of stakeholders can be found in next Table 3-17.

COUNTRY	TARGET GROUP/STAKEHOLDER
France	National Committee of maritime fisheries/marine farmers - CNPMEM
	Regional committee of maritime fisheries/marine farmers-CRPMEM
	National committee for shellfish -CNC
	Mediterranean committee of shellfish farming -CRCM
	Inter-Branch Organisation for aquaculture products –CIPA
	Thau Basin Producer Organisation
	Mediterranean Association of Producer– AMOP
	Fishmarkets
	Parlement de la Mer- Occitanie region
	Maritime assembly for regional growth and environment – AMCRE, PACA region
	Comité France Maritime
	France Filière Pêche
	Toulouse Agri Campus
	French Maritime Cluster
Greece	Federation of Greek Maricultures
	Union of Greek Aquaculture Medium Companies
	Hellenic Aquaculture Producers Organization
	Ostria SA | Mussels Producers Group
	Management Authority of Axios-Loudias-Aliakmonas National Park
	Panhellenic Society of Technologists Ichthyologists
	WWF Greece
Italy	API (Associazione Piscicoltori Italiani)
	AMA (Associazione Mediterranea Acquacoltori)
	SIRAM (Molluscan Applied Research Italian Society)
	Consorzio per la Gestione e la Tutela della Pesca dei Molluschi Bivalvi (Co. Ge. Vo.)
	Reef Ball Foundation
	FEDERPESCA
	Legambiente
	Associazione generale cooperative italiane - AGCI Agrital
	Alleanza delle cooperative Italiane - Pesca
	Associazione Nazionale Piccoli Imprenditori della pesca - ANAPI
	Federcoopesca
	Unione Nazionale Cooperative Italiane –
	UNCI pescaConfsal pesca
	Progetto Pesca Flai CGIL
	Consorzi di gestione tra imprese della piccola pesca artigianale - Co. Ge. P. A.Co.Ge.P.A. Augusta
	Ass. Produttori Pesca fra Pescatori ed Armatori della Piccola Pesca PORTO SAN GIORGIO; Civitanova; Adriatica; di Ancona; di Goro; Etruria ; San Marco; Cattolica; Cesenatico; di TriesteCooperativa fra Pescatori LA SIRENA
	O.P. di Trapani (PdGL Isola di Pantelleria)
	Organizzazione dei Produttori Ittici del Sud Adriatico
	Organizzazione di Produttori Armatori ed Operatori della Pesca di Cesenatico
	Organizzazione di Produttori Consorzio Linea Azzurra
	Organizzazione di Produttori Coopesca
	Organizzazione di Produttori della Pesca di Fano, Marotta e Senigallia; di Trapani Consorzio; San Basso
	Organizzazione di Produttori Il Gambero e la Triglia del Canale
	Organizzazione di produttori pugliesi di pesce azzurro
	Organizzazione di Produttori Sulla Rotta di Ulisse
	Organizzazione Interprofessionale della Filiera Pesca e Acquacoltura in Italia (O.I. Filiera Ittica)

COUNTRY	TARGET GROUP/STAKEHOLDER
Spain	Official Chamber of Commerce, Industry, Services and Navigation of Mallorca
	FEDERATIONS OF FISHERMAN'S FELLOWSHIPS of the Balearic Islands, Alicante, Barcelona, Girona, Tarragona, Comunidad-Valenciana, Murcia, Andalusia
	IVEAEMPA - Spanish Federation of Entrepreneurs of the Sea - CATALONIA
	Spanish Federation of Aquaculture Health Defense Groups (FEADSA)
	APROMAR - Business Association of Aquaculture of Spain
Croatia	Guild for fisheries and aquaculture
	FLAG BRAČ
Portugal	For-mar – Centro de formaçãoprofessionaldasPescas e do Mar
	Docapesca – Portos e Lotas, S.A.
	Fileira do Pescado
	InstitutoNacionaldosRecursosBiológicos (INRB)
Cyprus	Pancyprian Professional Fishing Association
	Cyprus Freshwater Angling Association
	Cyprus Recreational Fishing Association

Table 3 17 List of target groups, stakeholders in the MISTRAL Med area

- Research Infrastructures

The main body of the research infrastructures in the Fishery and Aquaculture sector are the public research centres and/or institutes and university departments, which are supported by the participant countries central government or local regional authorities. The scientific directions are multi- disciplinary varying from oceanography and marine biology to purely fishery and aquaculture education, research and training. Some of the research entities are also involved in the promotion and transfer of the produced knowledge to the relevant business professionals. Meanwhile, the monitoring of the development of the sector on country or regional level is also among the scientific deliverables of the infrastructures.

Research infrastructures contribute to the development of Aquaculture with relevant equipment, facilities, measurements and data. Marine Stations (Palavas Experimental Aquaculture Research Station (PEARS), STELLA MARE Platform) in France; Aqualabs - Souda in Greece; Laboratory of Marine Research and Aquaculture (LIMIA); Observatory of Aquaculture-Foundation (FOESA) in Spain; Ramalhete- Algavre Marine Station in Portugaland research vessels (L'Europe, Thétis II in France; Aegaeo, Philia, Alcyone in Greece; Mar Portugal, Noruega, Diplodus, Tellina, Puntazzo in Portugal).

The Aquaculture and animal experimentation facilities such as Bioterium of Aquatic Organisms (BOGA) operating by the CIIMAR in Portugal, Experimentation Lab of the Instituto de Acuicultura de Torre de la Sal (IATS) –CSIC; Instituto de Investigaciones Marinas (IIM) in Spain.

The Experimental Platform in Aquaculture (EPA) of the Univ. of Lorraine, Fish nutrition Farms and Platform (STPEE - INRA), Fish Infectiology Platform (FERP–INRA) in France, are focused on the development and support of the aquaculture industry and the promotion of the benefits of aquaculture to consumers and the society.

Networks of excellence among EU members are activated in order to support the sustainable growth of the aquaculture sector across Europe (AquaExcel2020 with partners from Italy,France,Greece, Spain and Portugal). Networks providing to researchers and companies easy access to ecosystems, biological marine resources, cutting-edge equipment and complementary skills such as the EMBRIC (Italy,France,Greece, Spain and Portugal) are also available to support research and innovation.

Networks among research entities are contributing to the knowledge exchange among partners in order to promote aquaculture (SIPAM in Croatia, Reference Research Network in Aquaculture of the Generalitat of Catalonia -XRAq in Spain) and the management of research infrastructures (Marine Research Infrastructures database in Portugal). Research centres across the EU coast of the Mediterranean Sea are following the state of the art in research and innovation of the sector and constitute a promising and powerful instrument of the Blue Growth in the MED area. Moreover, the effort will be completed by the perspective to include non-EU counties towards integration and standardisation of fisheries and aquaculture tools and performance in the whole Mediterranean basin.

There are no research infrastructures / Networks in Cyprus and Albania only BYTHOS in Cyprus dedicated to the management of oceanographic data.

- Training Courses

Many University level courses (undergraduate and Master of Science) concerning Aquaculture and Fisheries Research and Management have been established in all MISTRAL participating countries. They offer education and training to young scientists dedicated to the Fishery and Aquaculture sector. Some of the courses have a broader content including Marine Science, Marine Biology and Ecology, Marine Engineering.

Francereferred also to the operation of maritime technical schools for the training of students (and/or professionals) in professions concerning the sea in order to foster interaction between educational establishments and the labour market. Professional training has been introduced in the Fishery and Aquaculture sector in Spain.

In Cyprusno courses have been identified, the Human Resource Development Authority of Cyprus, the main certifying organization of professional qualifications, has recently issued a booklet, which outlines the needs for qualifications for a series of professions related also to aquaculture.

For the complete and detailed list of Training courses in fishing and aquaculture in the MISTRAL participating countries refers to next Table 3-18.

COUNTRY	TYPE OF TRAINING AVAILABLE
ALBANIA	Agricultural University of Tirana/ Laboratory of Fisheries and Aquaculture
CYPRUS	Univ. of Central Lancashire operates in Cyprus modules and courses in aquaculture; Future planned seminar in Fish production and aquaculture in Univ. of Cyprus
CROATIA	Univ. undergraduate, graduate and doctoral studies all over the country (Univ. of Dubrovnik, Univ. and Institute for Oceanography and Fisheries Split, Univ. of Zadar, University College Rijeka, University Juraj Dobrila Pula, Univ. of Zagreb Faculty of Agriculture) with many completed, ongoing and future planned in mariculture, fisheries and sea ecology.
FRANCE	Univ. ongoing courses for aquaculture, fish resources and the marine environment (Montpelier and Toulon). Maritime technical school with apprentices and adult trainees at Montpellier (Skilled technician in aquaculture degree, Project and operational manager in aquaculture and fish resources degree, Aquaculture company manager degree-CNAM) Corsica (Seaman Certification-CAP, Fishery Technical school Certificate-BEP, Maritime business Operation and management professional degree-BAC PRO) and Sète-Occitanie Region (Fishmonger/Seaman/ Shellfish Aquaculture Certification-CAP, Fishery professional degree-BAC PRO, Marine culture professional degree-BAC PRO, Aquaculture Advanced Agricultural Technician Certificate-BTSA).
GREECE	Univ. level ongoing courses in Aquaculture and Fisheries Research and Management from all the Univ. Departments presented in Table 3.
	MSc courses from the Univ. of Crete (Aquaculture, Environment and Society (ACES) in a joint program with SAMS-Scotland and Nantes-France), Univ. of Thessaly-Department of Aquaculture and Fish Diseases (Aquaculture and Aquatic Animal Health), University of Thessaly-Department of Ichthyology and Aquatic Environment in cooperation with TEI of Epirus (Mediterranean Aquaculture).
ITALY	Univ. level ongoing undergraduate course in Aquaculture and Fish Production, hatchery technology, Hygiene- Quality and Safety of production, Food Marketing (Bologna). Summer schools organised by Univ. of Bologna and Parma, related to Aquaculture and seafood economy.
PORTUGAL	Univ. and Technological ongoing courses in Marine Biology, Biotechnology and Marine Resources, Marine Science and Engineering, some of them oriented in Aquaculture and Fishery (Instituto Politécnico de Setubal, Instituto Politécnico de Leiria, ISPA - Instituto Universitário de PsicologiaAplicada, Univ. of Aveiro / Algarve, Univ. of Lisbon, Univ. of Porto, Univ. of Azores).
SPAIN	Univ. and Technological ongoing courses (Univ. of Balearic Islands, Univ. of Valentia, Polytechnic Univ. of Catalonia) in Marine Science and Engineering, some of them oriented in Aquaculture and Fishery.
	Professional training concerning the sea with Practice in the Laboratory of Invest. Marinas and Aquaculture (LIMIA), thePolytechnic Maritime Fishing Institute of the Mediterranean Alicante, Approved public and private centers of the Region of Murcia (Local fishing skipper, Sailor fisherman), Valencian Community (Senior Technician of Fishing and Maritime Transport, Professional Recreation Skipper), Catalonia (Fishing captain, Aquaculture Crops), Region of Balearic Islands and Andalusia (Fishing captain and Local Fishing skipper).

Table 3 18 Training courses in fishing and aquaculture in the MISTRAL participating countries

3.3.3 Identifying innovation potentials and key enabling factors

3.3.3.1 Opportunities and benefits

Based on the analysis of sector attributes, each Country identified a number of Innovation Potentials as a result of the application of common criteria. The integrated analysis of IPs revealed common trends as well as different patterns among Countries and the intent of this paragraph is to present an overall picture of Innovation Potentials per Sector in the target area. The critical analysis performed on data collected at Country level revealed the following 10 Specific InnovationPotentials that could be divided in two macro-groups of IPs of reference: Small Scale Fisheries (SSF, IP 1-5) and Marine Aquaculture (MA, IP 6-10). The following list reports the identified specific IPs relative to the two macro-groups.

Small Scale Fisheries (SSF)

1. Control and Monitoring of SSF Activities
2. Post-Harvest Subsector/ Branding and Eco-certification of products
3. Co-management with other uses and activities
4. Valorisation of underutilised species/ waste or by-products
5. Diversification of Fishing activities from the traditional activity

Marine Aquaculture (MA)

6. Reduction of feed costs combined with feed improvements
7. Diversification with larger-size, higher-value-added finfish species
8. Post-harvest sector/ Sustainability certifications and labelling
9. Development of floating multi-use platforms adapted to deeper waters
10. Integrated multi-trophic aquaculture - IMTA

Only Italy mentioned an innovation potential within Large Scale Fisheries (LSF) subsector with a specific reference to the importance of Sustainable Management in terms of the application of an ecosystem-based approach that contribute to adjusting fishing exploitation to levels that ensure the maximum sustainable yield and the less impact on the environment. The discussion will follow only to SSF and MA Innovation Potentials.

Spatial distribution of IPs identified at Country level by MISTRAL partners is showed in Fig. 3.12.Geo localization refers to SSF and MA macro-groups of IPs.

Fig. 3.12 Geo localization of innovation potentials in Fishing and Aquaculture Sector among MISTRAL Countries. Numbers corresponds to specific IPs, icons define the two sub group

The five specific IPs identified under the SSF group and their corresponding benefits are here described:

Control and Monitoring of SSF activities
Although SSF is the major part of the fishing activity, is actually uncharted and the main source of illegal fishing. Control and monitoring of SSF activities is of vital importance for the assessment of the corresponding fishing effort that by now is totally unreported. The traceability of SSF vessels can be achieved using technologies/methodologies developed, or under-development, for large-scale fisheries based on radio frequencies, satellites and/or internet applications, as well as methodologies for data gathering and manipulation. The possibility however of producing cheaper, even if less powerful, instruments needs to be evaluated as their cost is generally high. Mapping of fishing activities will empower MSP implementation and the tracing of the illegal catches will improve sustainable use of fishing resources.

Geographical designations/ Branding and Eco-certification of products
This aspect (including buyers, processors, and market linkages) is part of the fishery system, as well as its governance system plays a central role in the related value chain as fishers are directly connected with other local actors such as public and

private institutions and consumers. Due to a growing interest in sustainable and eco-friendly products, SSF products, if well processed and promoted, could perfectly integrate in a new market dynamic (e.g. as Km0 products). This permits the creation of competitive economic clusters, which can foster the development of coastal communities. In this context, best practices for value creation could be implemented in the fields of labelling, direct sale, processing, diversification, inter-sectoral integration, and vertical coordination. Local value chains and labels do not imply a technological advantage; available marketing technologies for direct retail might be a future asset for the sector. Moreover, the revival of SSF, especially through innovative ways of preparing and selling fishery products, could attract newcomers and the younger generation to SSF. A promising development in the Mediterranean involves the Marine Stewardship Council (MSC) fisheries certification standard, which for the first time is implemented in this sea.

Co-management with other uses and activities
This can be an effective approach for developing innovative solutions for the management of SSF. Markets are ready to

receive SSF products that are firmly rooted in local communities. An individual fisher will not be able to access the market directly, apart from some possibilities to sell directly to restaurants or customers over the dockside, since SSF industries are typically local based. Furthermore the co-existence of SSF with different uses and activities and the creation of new organizations through co-management (e.g. aquaculture, renewable energy for fishing boats and/or onshore processing facilities) would generate new business and might result in the better exploitation of new technologies.

Valorisation of underutilised species/ waste or by-products

Within the context of a more sustainable use of fishing resources, the valorisation of underutilised species(e.g. cephalopods) can increase the profitability of the value chain, help fishermen to be more competitive and it could impact the profit margins of restaurants and fishers (connection with hospitality industry).Furthermore, all countries and many regions are characterized by a relevant production of waste and by-products in the fisheries and aquaculture sector. This biomass, which at the moment is a cost item must instead become a resource to be recovered within the supply chain, in applications related to food and feed, or as a resource for other sectors/compounds with medium-high added value (for example biofuels, fertilizers, soil improvers) mainly in regions with a high biomass availability.The use of innovative technologies and production processes (pre-treatment, stabilization, storage, transport) are necessary so that the unused high quality biomass can be channelled into a different supply chain or reused in the supply chain itself, as a secondary product or a co-product. The above cannot be separated from the bio refinery approach as each biomass must be valorised “in total”, with processes that allow the sequential recovery of different compounds following the concept of “Zero Waste”.

Diversification of fishing activities from the traditional activity

Diversifying traditional fishing activities into other fields will offer the potential to contribute to job creation, social inclusion as well as the revitalization of fisheries-dependent communities. Starting multifunctional activities also means an effort reduction and a turn to sustainability, reducing environmental impact and improving the environmental status of the whole ecosystem. CFP (EU, 2014) considers diversifying fishing activities as a priority for a successful sector re-conversion. One strategy is to diversify into tourism-related activities by complementary activities for examples Pesca tourism, ichtyo-tourism and/or recreational fishing (wildlife observation, direct sales to tourists-promotion in local restaurants, and festivals/ workshops/museums/thematic villages that raise awareness of the area’s fishing activity and products). Although diversifying fishing activities do not represent a technological improvement, the inclusion of marketing tools to the SSF value chain, could promote the activity to a broader range of customers. The use of these synergies would enable diversification in the local economy, provide additional jobs and income to families, and help stabilize the declining profitability and employment in the fisheries sector. Fisheries Local Action Groups (FLAGs) already operate in tourism hotspots; however, tourism development should not by-pass the fisheries community with FLAG working closely with established tourism interests to promote local fisheries, identify target markets, domestic and international. In a context of overfishing, Marine Protected Areas (MPAs) as tools for protecting biodiversity are subject to preservation measures to protect habitats that are necessary for fish reproduction and growth. SSF and protected areas are in principle compatible as in MPAs there are synergistic benefits among fisheries, tourism and the local community as a result of increased involvement of fishermen in local tourism.

The second group of the identified specific IPs are related to Marine Aquaculture and are described as follows:

Reduction of feed costs combined with feed improvements

There is a need for high quality sustainable feed, reduction of fish meal/ fish oil use as a major protein source (it has several disadvantages, including high cost and instability of supply) and a lowering of nitrogen and phosphorous in effluent. Feeds are currently produced using the components of the fish carcass that are not used for human consumption (by-products). Alternate feed derivations have been a major subject of aquaculture research and development, and efforts are intensifying to substitute for fishmeal, with good success. Biotechnology offers opportunities for development of alternatives to fishmeal, especially plant-based protein sources and waste products from other operations by enhancing production and processing techniques. Enhanced feed delivery includes investigation into methods for more efficient feeding and feed additives that would stabilise the faecal matter would benefit surrounding water quality.

Diversification with larger-size, higher-value-added finfish species
New product development with a consumer focus, as demand has dropped for sea bass and sea bream, which are the most popular species currently farmed in the Mediterranean. Species chosen tentatively that given their large size and/or fast growth, they provide for high dress-out and fillet yield, short time to market and suitability for product diversification and development of value-added products as well as the potential to be reared in sea cages -especially offshore, where the future expansion of marine aquaculture may lie. Among the new emerging species for Mediterranean aquaculture, the meagre is the most promising for its remarkable growth speed, large sizes, low fat content and meat consistency. In 2013, the techniques of reproduction and breeding of the meagre (Argyrosomus-regius) were introduced in Sicily. Already in 2016, the meagre reared in Sicily had become the product of the GDO chain. A strong emphasis is also given at greater amberjack (Serioladumerili) with no production and very limited research in order to develop adequate husbandry practices and technologies for the industry to solve the bottlenecks for spawning and breeding and enable production. The culture of species with low Fish Feed Dependency Rate (FFDR) is important, such as the grey mullet (Mugil caepahalus), as it can be farmed with diets formulated with high levels of fishmeal replacement (up to 75%) by alternative plant protein sources. Closing the aquaculture cycle of Blue tuna will permit Bluefin tuna domestication and scaling up of production. Among innovative species, invertebrates such us sea cucumbers represent good candidates. Application of Blue Biotechnology provides powerful tools to introduce new technical knowledge/practices and opens up new horizon for farming high performing novel species.

Sustainability certifications and labelling
For a more friendly production (animal welfare, health and naturalness). Live organisms of aquaculture suffer large stress during transportation to long distance destinations with a significant mortality. In order to reduce their loss, it is advisable to develop more sophisticated transport and better monitoring system. The development of certification schemes in collaboration with established international certification bodies is a key issue in order to certify freshness, traceability and animal welfare so that more people will choose the products, more retail chains will stock them and more farmed animals will have a better life. An example is namely the scheme of the Aquaculture Stewardship Council (ASC) for species that are not being certified at present, being exemplified in Greece by WWF and dominant companies, a retail chain and a fish farming company.

Development of floating multi-use platforms adapted to deeper waters
There is growing interest in moving coastal farming to offshore sites, because it would reduce constraints related to competition for space with other activities and reduce environmental and aesthetical impacts significant advantages. They can be feasible systems shared with other facilities like offshore wind turbines, platforms for maritime transport and innovations in the leisure sector and oceanic observation activities. Therefore, stronger versions of conventional inshore technologies or alternative concepts altogether will be necessary. Highly specialized, remote control and monitoring capabilities via leading-edge telemetry systems are a major component of the operating methodology along with the feasibility to feed and observe the fish regardless of whether staff is present on site.

Integrated multi-trophic aquaculture – IMTA
Establishing integrated cultivation systems can increase productivity, profitability and sustainability as a tool for an ecosystem approach to the marine farming sector. The waste products from one food production process is assimilated by other food organisms and converted to valuable products. IMTA is the co-cultivation of fed species (such as finfish) together with extractive species, such as suspension feeding (e.g., mussels and oysters) and deposit feeding (e.g., sea-cucumbers and sea-urchins) invertebrates and macro algae that may feed on the organic and inorganic effluents generated by the fed species. Each of the individual components must be marketable or adding value through accounting for the ecosystem services that extractive species provide. Its development in the Mediterranean is still in the very early stages and the economic trade-off of IMTA practice is not sufficiently positive to motivate the large-scale uptake. The main obstacle preventing IMTA to be commercially adopted is the lack of scientific information on choosing compatible species, knowing the carrying capacity of a production area and interactions between species feeding at different trophic levels, as well as its socio–economic impacts. Technological improvements related to farming and harvest methods need to be developed and conventional inshore technologies will be necessary.

	IP	DESCRIPTION OF INNOVATION	BENEFIT
SSF	Control and Monitoring of SSF Activity	Research and Development on technical issues and data management; radio frequencies, satellites and/or internet applications	Traceability of vessels; Mapping of fishing activities; Implementation of spatial planning; the tracing of the illegal catches will improve sustainable use of fishing resources
	Geographical designations/ Branding and Eco-certification of products	Local value chains, labels, governance; integrate a new market dynamic; Research and development in sustainable and eco-friendly products	New market dynamic and labelling,
			Creation of competitive economic clusters, which can foster the development of coastal ; innovative ways of preparing and selling fishery products, could attract newcomers and the younger generation
	Co-management with other uses and activities	co-existence of SSF with different uses and activities creation of new organizations	Markets and Marketing, Markets are ready to receive SSF products that are firmly rooted in local communities in co-existence with different uses and activities and the creation of new organizations through co-management
	Valorisation of underutilised species/ waste or by-products	Increase profitability of the value chain, reintroduce waste into new products for various market applications	Markets and Marketing, impact the profit margins of restaurants and fishers
			increase the profitability of the value chain, help fishermen to be more competitive; This biomass, which at the moment is a cost item must instead become a resource to be recovered within the supply chain, in applications related to food and feed, or as a resource for other sectors/compounds with medium-high added value
	Diversification of Fishing activities from the traditional activity	multifunctional activities (as tourism); Branding and Eco-certification of product;	Markets and Marketing, diversification in the local economy, provide additional jobs and income to families, and help stabilize the declining profitability and employment in the fisheries sector
			Effort reduction and a turn to sustainability, reducing environmental impact and improving the environmental status of the whole ecosystem

Table 3 19 Summary of the described SSF IPs

	IP	DESCRIPTION OF INNOVATION	BENEFIT
MA	Reduction of feed costs combined with feed improvements	Enhanced feed delivery; methods for more efficient feeding and feed additives; use of biotechnology	Alternate feed derivations, development of alternatives; benefit surrounding water quality;
	Diversification with larger-size, higher-value-added finfish species	New product development; examples are meagre, greater amberjack, grey mullet, Bluefin tuna; sea cucumbers (invertebrates); Bluebiotechnology development to farming high performing novel species	Research and Development opens up new horizon for farming high performing novel species;
			Markets, open new market possibilites
	Sustainability certifications and labelling	development of certification schemes	Policy/Market, certifications is a key issue in order to certify freshness, traceability and animal welfare so that more people will choose the products, more retail chains will stock them and more farmed animals will have a better life
	Development of floating multi-use platforms adapted to deeper waters	feasible systems shared with other facilities; they can be feasible systems shared with other facilities like offshore wind turbines, platforms for maritime transport and innovations in the leisure sector and oceanic observation activities	Research and Development to reduce environmental and social impact;to reduce constraints related to competition for space with other activities and reduce environmental and aesthetical impacts
	Integrated multi-trophic aquaculture - IMTA	co-cultivation of fed species together with extractive species and deposit-feeding invertebrates and macroalgae that may feed on the organic and inorganic effluents generated by the fed species; integrated cultivation systems for an ecosystem based approach	Research and Developmentto reduce environmtal impact and to produce more valuable products; increase productivity, profitability and sustainability as a tool for an ecosystem approach to the marine farming sector; Each of the individual components must be marketable or adding value through accounting for the ecosystem services

Table 3 20 Summary of the described MA IPs

As shown in Tables 3-19 and 3-20, despite the large differences in fishing and aquaculture practices in the different MISTRAL member countries, all have the same approaches to enhancing competitiveness. They focus on the importance of research and development, cooperation of stakeholders, promotion of environmentally sustainable practices and diversification and marketing. Structures facilitating lifelong learning of those working in the sector are considered as a specific competitiveness tool. This is achieved through intense cooperation with the research institutes and thanks to the presence of dedicated resources available both at local and European level. All MISTRAL member countries resulted in focusing on re-organizing production sites to optimize the use of available space and foresee a possible expansion in offshore areas.

3.3.3.2 Gaps and enabling factors to address

A broad range of opportunities and benefits for the sector has been described according to Innovation Potentials. The innovation process is still perceived as a technological issue, however incremental innovation is required and support systems, markets, policies, or regulatory frameworks that influence the uptake of new technology.
Here is reported the analysis per macro-group (SSF and MA) of those elements that have been identified to be responsible for unlocking the potential performance of the above identified IPs, i.e. Gaps and Key Enabling Factors.

Small Scale Fisheries
Small scale fisheries in the MISTRAL MED area face similar characteristics including declining fish stocks, competition from other sectors (e.g. industry, tourism) and sometimes conflicts between fleets (large scale and recreational), low capital and labour intensive, few alternative livelihoods, weak representation and voice in resource management, post-harvest problems such as lack of infrastructure, weak market and bargaining power among fishers.
Although small-scale fisheries management plans are deliberately promoted by the GFCM in order to establish specific rules designed to ensure, in particular, preferential access for small-scales fishers along the coastal band (GFCM, 2018b), the multiannual plans proposed by the European Commission, under the CFP, for this sea basin do not reserve any special conditions or exclusions. On the contrary, SSF continue to show signs of reduced performance with negative trends due to higher space conflicts with conservation measures (Habitats and Birds Directives requirements) as well as with other coastal marine uses (mainly intensive coastal tourism, aquaculture and marine aggregated extraction) (Stobberupet al., 2017; EASME, 2018).

Gaps and Enabling Factor to be addressed have been identified among:
-Public policies need to refocus on addressing the needs of SSF. Government ministries and policy makers need to work on the implementation of guidelines and good practices to ensure the sustainability of SSF as well as the benefit of small-scale fishers. There is a particular need for improved inter-ministerial collaboration and policy coherence given that small-scale fisheries touch trade, environment, tourism, socio-economic development. Fishers should play a more significant role in the decision-making process. Collaboration between scientists, government agencies, small-scale fishery organizations, fishing communities and other stakeholders could advance policy formation with fisher's experience, knowledge and opinions giving feedback to those in charge of making policy and setting regulations; the lack of their input into policies often creates an environment in which fishers would be unlikely to adhere to rules and regulations. Spatial distribution of resources is important to consider otherwise measures such as the reduction of effort capacity or of the number of vessels may not be effective. Spatial effort allocationbased on the individuation of relevant areas for fishing and for fish species according to life stages could have a high potential for an ecosystem based approach of the fisheries management including SSF. For example, no-take zones based on ecology and seasonality of resources could be planned.

-Skills/Human Resources. There is a need for more interaction between researchers and those working on the sea. Technical skills are required for a participatory management system for improving the knowledge transfer and dissemination along the different actors of the production chain. Specialized skills required to work in this subsector deals with the effective communication and dissemination among scientist, stakeholders and policy makers for the active use and take up of process outputs. For diversification into tourism-related activities, fishing families and local residents must acquire the necessary skills and knowledge to handle incoming tourists and their widely differing requirements. Capacity-building strategies must take into account the different offerings of the locality, create a road map for those involved in the transformation, and structure an action plan, which sets the foundation for the new economic activity, for synergies management and conflict resolution. Traditional anglers need to adapt to the service orientation of the tourism sector and restructure vessels and infrastructures. The upgrading of fishing vessels following strict safety guidelines and with new facilities is an important aspect when considering the support of diversification into tourism activities, especially in the case of fishing tourism and recreational fishing. The contribution of women in self-employed activities is recognized in the Directive 2010/41/EU on the application of the principle of equal treatment between men and women engaged in an activity. Women can contribute greatly to helping families diversify into tourism activities with activities; the current trend is to support women not only to help their husbands in the fishing tourism activities but also in initiating and managing the complementary tourism-related businesses themselves.

-Marketing is important in the fishery products value chain as there are generally many intermediaries. The value chain is far more complex than what is required. The organization of SSF into marketing associations, rather than simple fishermen associations, will help to shorten the value chain. The fish processing is characterized by a reduced propensity to export, deriving from the pulverization of companies, above all family-run or artisanal, companies too small for the global market and therefore struggling to export their products. A potential for development should be based on the po-

tential commercial aggregation among the micro-enterprises. Further and parallel actions have been marked with respect to the protection of brands/certifications, label, and, in general, on non-tariff barriers that limit the entry of production into new markets. Actions are needed to promote the activity for a broader range of customer. In tourism related activities, it is essential to develop close collaboration with regional and national tourist boards in order to access their specialized marketing skills.

-Transboundary cooperation is imperative as SSF unreported and illegal catches affect fish stocks that are exploited also by other countries. There is a need to increase common regulations among Mediterranean countries, develop common methods and reference points through which satisfactory management can be achieved. Co-management means collaboration among countries in the case of shared fish stocks, such as the case of the Adriatic Sea, where the effort of fishermen from Italy,Slovenia, Croatia, Albany, and Montenegro insists on the same fish population. In similar cases, common rules are individuated, and every actor involved have to guarantee transparency and respect of those rules to ensure to success of measures proposed. A good tool is the EMODnet project, which actually deals with the collection of several data source and creation of maps, including relative to human activities as fishing. EMODnet, at the state of the art, considers only large-scale fleet for fishing effort reconstruction, due to absolute lack of small-scale fleet data.

Marine Aquaculture

Aquaculture in the Mediterranean is intended to increasingly fill the shortfall in aquatic food products for an increasing population, resulting also from the deterioration of the capture fisheries. It is immediately critical, however, to overcome a long lasting stagnation. Based on the above-described situation of the sector, an array of well-known and established research interact with stakeholders in production system, value chain, and policy system, and deliver significant insights supporting the development of an innovative and competitive, notwithstanding resilient and sustainable, marine fish farming sector. Nevertheless, major gaps identified in the Mistral study area currently constitute a barrier to further and smoother development of the sector.

-Policies: Aquaculture has been considered as an integrant part of the fishing system and the sector is a key component of both the Common Fisheries Policy and the Blue Growth agenda. In the Mistral MED area, only in France the National Strategic Plan for the development of marine aquaculture is carried out at the regional level. In the three French regions boarding the Mediterranean (Occitanie, Provence Alpes Côte-d'Azur and Corsica) regional spatial plans (SRDAM) have been decided under the French law with the aim to reference in each region the existing/favourable sites development for marine aquaculture development. In Greece the National Framework for Spatial Planning and Sustainable Aquaculture (active since 2011), as well in France the Regional Spatial Plans -SRDAM, are still highly challenged in terms of applicability as there are no tangible results achieved so far. Therefore, public policies on aquaculture should be better fostered and promoted from public authorities, and this can be achieved through the harmonization of national and regional interventions. Strategic National Plans 2014-2020 proved to be ambiguous strategies with weak exemplification so far in all countries. No advancement has been reported at all goals and mainly in reducing the administrative burdens and enhancing aquaculture spatial planning. There are two basic regulatory problems concerning the aquaculture industry in the Mistral study area complicated and sometimes-contradictory legislation, decentralized and scattered legislative responsibility and lack of spatial planning as there are conflicts for access to space with beach tourism, shipping, oil and gas extraction, marine mining sectors. Administrative constraints in particular concerning licensing procedures are amongst the challenges to growth. An optimal governance strategy is needed to achieve the twin goals of industry development and public confidence. This could be achieved by the collaborative decision-making mechanisms between government and communities or user groups. Pushing decision-making, especially over site locations and the conditions of licences, downwards to the community level with larger roles for municipal institutions and local stakeholders in aquaculture, is a significant tool. Better inclusiveness (extent to which specific target groups and different stakeholders interact) further elucidate the multi-dimensional and multi-level interplays and enhance the effectiveness of the endeavour.

-Research and Technology trends are clarified and robust, their integration and mainstreaming into planning, however, should be elevated. Technological optimisation of production is a broad issue that includes engineering aspects, biosecurity principles, improved husbandry, control of escapes, traceability. The improvement of stocks for desirable performance traits (i.e. disease tolerance, growth rate, feed conversion efficiency) is important. Genetic improvement of major Mediterranean aquatic species. Genetic linkage maps have now been made with many of the aquaculture species, such as seabream and European seabass in order to study performance traits controlled by multiple loci as well as genetic selection for disease-resistant fish stocks seems to be a realistic possibility for the future. Improvements in the health management of cultured organisms. Development of aquaculture diagnostic technologies, early detection of specific pathogens over the time, expanding registration and availability of effective vaccines, dietary supplements and nutritional strategies which may modulate overall fitness, gut health and immune responses, non-chemical control methods as part of an integrated pest management strategy. Sustainable zoning of production sites determining the assimilative capabilities and the environmentally acceptable critical loading rates of biogenic wastes, per volume and per area of sea floor, that can permit a robust capacity planning and allocation mechanism.

With respect to MA, traditional techniques are always under development and improvement and are in constant evolution (works on strains and genetics, on robustness, feed improvement, on species diversification, on new aquaculture schemes such as Integrated Multi-Trophic Aquaculture). As explicitly presented by all countries there are still many topics on which research must be done and for which innovation must be developed, investing however in technologies and practices with minimal environmental per-

turbations. Intensify research on climate change likely to be a primary driver for change in the MED aquaculture industry over the next 50 years. If temperature has probably, no effect at finfish production at the sea there is a gap in knowledge about the effect of ocean acidification on mussels and oysters and extreme weather on all farming activities. Specific environmental conditions causing algal blooms and the spread of bio toxins with links to human and aquatic organism health also have a strong interest. Needed are robust national plans for research and technology development for established and new cultured/farmed species, sustainable feed production, new farming technologies, new biotech products, processing, and environmental management and policy. Other broader issues like environmental impact and consumer demand related to the introduction of new species, adaptation to climate change are also intended. Interestingly in Cyprus and Albania, more effort must be addressed in research and innovation for the sustainable development of the sector.

-Skills/ Human Resources. The development of new technologies, new products and new business models has to be duly supported by ad-hoc training processes that can generate new professional skills and job opportunities.Despite the fact that different training courses exist with competences and expertise already available, they are few training courses concerning professional lifelong learning. There is a lack of professional courses and qualifications, although specialised skills are needed for specific technologies and infrastructures. As reported in France there are few skilled people in aquaculture, due to the small number of jobs and markets. In Cyprus even though no courses have been identified, the Human Resource Development Authority of Cyprus, the main certifying organization of professional qualifications, has recently issued a booklet which outlines the needs for qualifications for a series of professions related to blue growth and hence, aquaculture. This means that relevant professional courses will be implemented shortly. It is worthy to mention that in France, Italy and Greece the shellfish industry companies are mainly family companies with the need of developing new transfer schemes, including new entrants in the profession. There is a need in terms of training and extension and strengthen visibility and responsibility.

-Marketing. There is a general distrust on aquaculture products, which need to be deleted. Knowledge on production process and traceability has to increase. It is worthy to mention that Aquaculture development in the Mediterranean Region in the past years, showed price reductions for both, European seabass and gilthead seabream. Different interpretations exist for this phenomenon, including the considerations of oversupply and inadequate marketing efforts as the presence of too many suppliers, who are geographically dispersed, for relatively few buyers, who were concentrated in one major market, namely Italy. In France, fry production is well developed and sold in most Mediterranean countries; fish production and sells have to increase as today, the fish production for a more direct consumption numbers, are lower than the fry one. In each country, national market requires targeted informative and marketing activities in order to increase the consumption of farmed products and improve the consumer perception on the farmed products. Furthermore, it is necessary to promote in cooperation with producers the importance of the creation of producers organisations, determine the minimum quality standards, develop marketing channels within the sector, as well as a marketing strategy, while at the same time taking into account the regional and cultural particularities. Public perception of aquaculture depends on how informed the public is, and what is missing for improving the public perception of aquaculture is to ensure active presence of the industry itself in synergy with the state, regional and local administration which supports and monitors aquaculture development. In this sense, the task of the administrative bodies needs to provide a quality legislative framework. Cooperation between the sector and the various state and regional institutions shall be further developed. Supporting efforts for the development and market replication of innovative solutions is defined highly significant in particular in the fields of aquaculture and marine biotechnology related technologies and services. Furthermore, appropriate economic and regulatory incentives could alleviate, through a synergistic approach, the high cost of production for feeds

alternatives that makes them infeasible commercially for several farmed species. Therefore, marketing, communication to consumers and publicity are indicated as the most influential and impactful factors for future developments in aquaculture in the MISTRAL MED area. The social relevance of finfish/shellfish aquaculture has to be developed by raising awareness on aquaculture and processes.

-Transboundary cooperation. The use of systemic transboundary approaches elucidates the multi-dimensional and multi-level interplays and enhances the effectiveness of the endeavour. Addressing aquaculture-related transboundary issues is key for the promotion of the sector so that it is globally more competitive, sustainable, productive, profitable and equitable. Compliance of non-EU countries with the EU and alignment to common standards are essential for long-term sustainability.

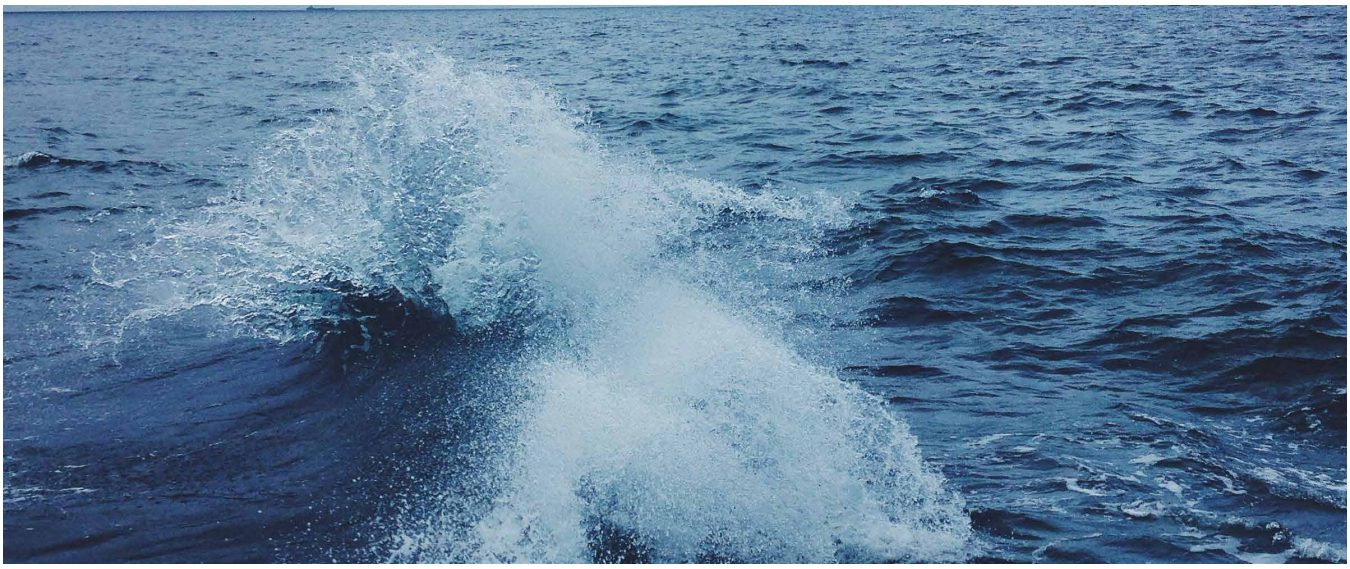
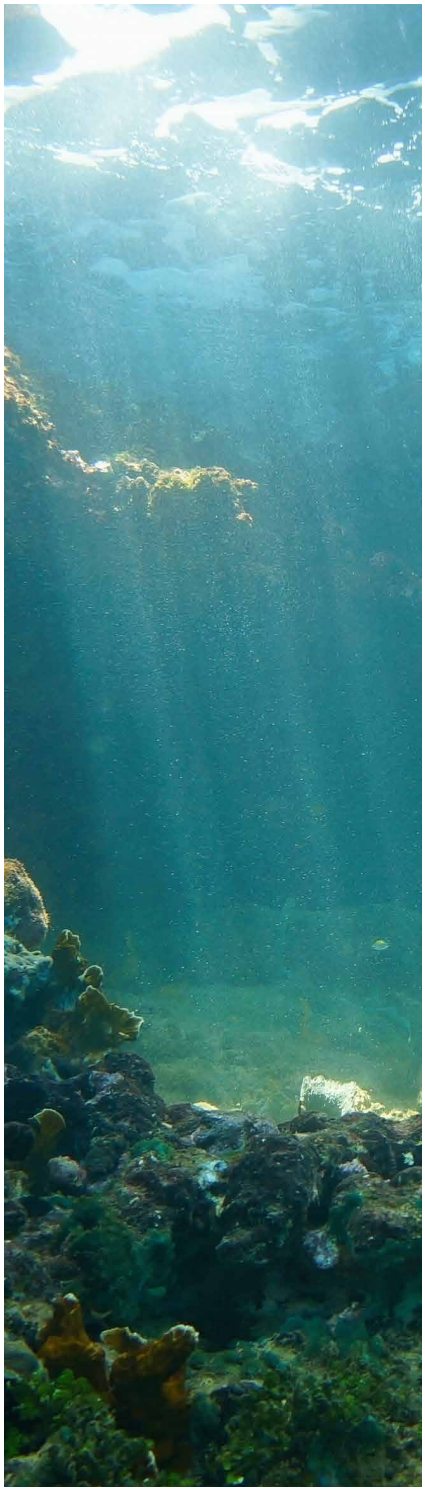


Table 3 21Summary of description of IPs and the corresponding relevant GAP/KEF based on the integrated analysis among MISTRAL Countries: SSF (up) & MA (below)

	Policy	Skills/human resources	Markets and Marketing	Transboundary cooperation	Research and technology
SSF	Need for improved inter-ministerial collaboration and policy coherence given that small-scale fisheries touch trade, environment, tourism, socio-economic development; collaboration between scientists, government agencies, small-scale fishery organizations, fishing communities and other stakeholders could advance policy formation with fishers' experience.	Form Younger generations; Specialized skills required; acquire new competences from other sectors; Upgrading of fishing vessels Support woman for initiating and managing the complementary tourism-related businesses.	Value chains and reduced exports; potential commercial aggregation among the micro-enterprises; protection of brands/ certifications, label; develop connection among the value chains to develop close collaboration with regional and national tourist boards.	Need to increase common regulations among Mediterranean countries, develop common methods and reference points	Improvement are needed mainly to lower the cost of technology application and to permit the creation of competitive economic clusters; development of integrated technologies.
MA	Decentralized and scattered legislative responsibility and lack of spatial planning as there are conflicts for access to space with beach tourism, shipping, oil and gas extraction, marine mining sectors. Public policies on aquaculture should be better fostered and promoted from public authorities, and this can be achieved through the harmonization of national and regional interventions. Administrative constraints in particular concerning licensing procedures are amongst the challenges to growth.	Need in terms of training and extension and strengthen visibility and responsibility.	Improve of marketing channels within the sector, as well as a marketing strategy; maintain the regional and cultural particularities.	European resources are available to derisk private investment and to demonstrate large-scale demonstration of commercial feasibility.	Investments in technologies and practices with minimal environmental perturbations. Intensify research on climate change; other broader issues like environmental impact and consumer demand related to the introduction of new species, adaptation to climate change are also intended.

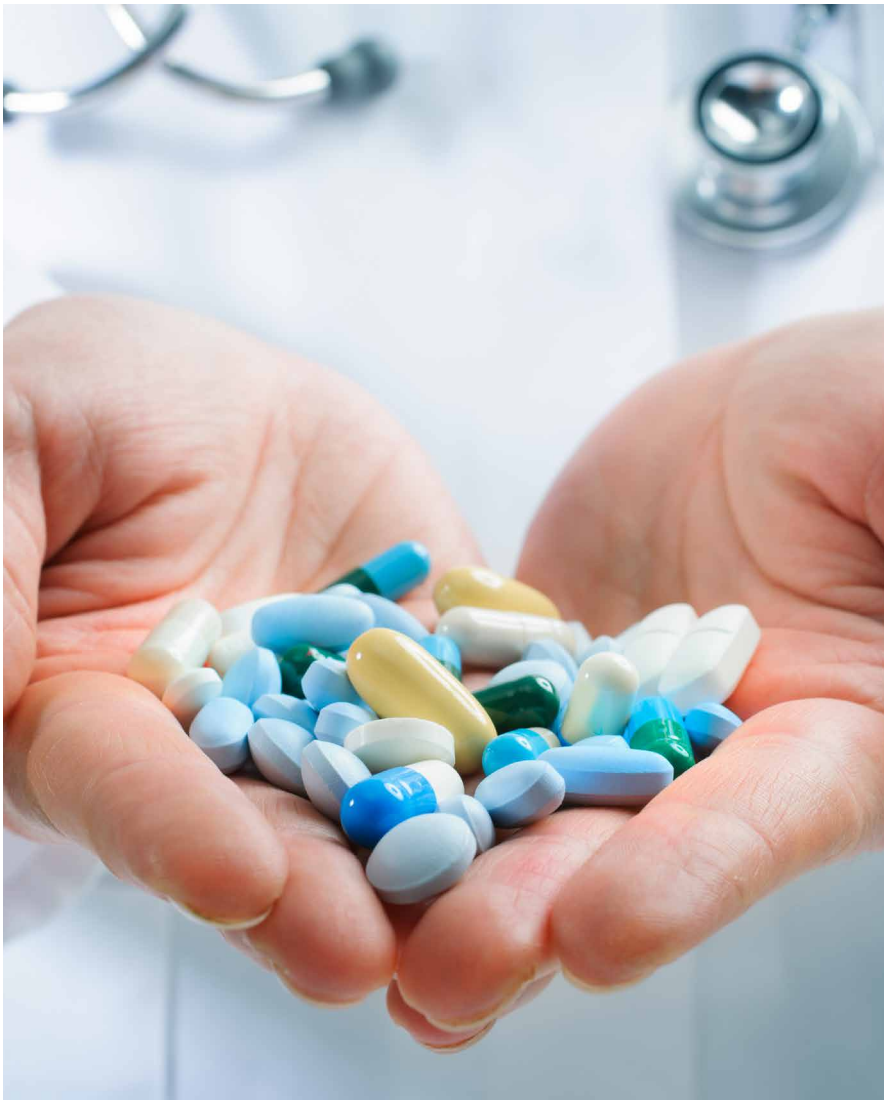
3.3.4 Outlook and expected trends

The EU is the largest trader of fishery and aquaculture products in the world in terms of value. In 2016, the trade flow grew to €54.3 billion and 14.1 Mtons. The trade balance deficit (exports minus imports) of 2016, when the value of imported fish reached €24.4 billion, was the largest ever, confirming the EU as a net importer of fisheries and aquaculture products (EUMOFA, 2018). Whereas, however, the state of fishing is stable to decreasing – overall, its performance has been deteriorated due to overfishing, particularly in the Mediterranean – EU aquaculture seems not to be able to take advantage of this market opportunity. An opportunity also reflected by the high level of environmental sustainability and the quality of EU products and the know-how and continuous search for innovation of EU aquaculture enterprises.
In a background of economic recession and growing competition from third countries, the volume of aquaculture production in the EU has suffered a downward trend. Although from 2016 has regained production levels and it returned to the levels of 2009 (Eurostat database), expectations today do not match the sector's ambitious growth objectives shared in the recent past by all main EU producing countries within the overall context of the CFP (within the Multiannual National Strategic Plans developed in 2014-2015 for the promotion of sustainable aquaculture). This has also led to structural shifts within the sector, principally consolidation and mergers of small companies, leading to a prevalence of large companies in the marine finfish aquaculture but few new investors (European Parliament, 2018).
Mobilizing investment – still missing today – is one of the main challenges ahead. Competitiveness of products compared to similar production in third countries is indeed an important challenge. All MISTRAL partners aim to address this issue through the development of more cost-effective production techniques incorporating research and development outputs, improved marketing of products and better linkages between economic operators in the industry. Compliance of non-EU countries with the EU and alignment to common standards are essential.
Mediterranean countries have competitive advantages of suitable coastline morphology, favourable environmental and climatic conditions (temperatures and physiochemical parameters) as well as a longstanding experience and scientific know-how at all stages of the production cycles. The Mediterranean diet, in which seafood is one of important components is widely considered nutritious and healthy, supports the increasing demand of aquaculture products and highlights aquaculture as one of the key primary productive sectors. The deterioration in capture fisheries and the increasing demand for fish in the Mediterranean basin have created unprecedented opportunities for aquaculture.
The objective for EU marine finfish aquaculture is to increase production to 480 ktons by 2020, a 60% increase compared to the 2012 production levels. In the Mediterranean, this growth objective is shared by all the MISTRAL member countries. From the other, the objective for EU marine shellfish aquaculture is to increase production from 550 ktons to 680 ktons by 2020, a 25% increase compared to the 2012 baseline. Such a moderate, compared to finfish, growth objective, is similarly expressed in the Mediterranean and shared by all the MISTRAL member countries. This deviation may be attributed to the low market value of mussels.
According to EATIP (2017), the vision for 2030, as a comparison to 2010, is the higher expansion rates for meagre and sole, 10.000 more jobs and a 20% increase of the productivity/employee as well as a 20% increase of the juvenile survival and decrease to 1.2 of the Food Conversion Ratio-FCR (35% improvement).
It is immediately critical, therefore, to overcome a stagnated development and growth pattern and a failure to deliver value for money and effective EU financial support for the sustainable development of aquaculture, a failure to give new impetus to EU aquaculture. The regional implications from such a failed pattern are considerable in terms of locking a new growth potential, hence it is relevant to consider an increased pressure for change in the Mediterranean where marine fish farming has been defined as a "rising star".
In spite of the high technological, commercial readiness and economical relevance levels for change claimed by all main producers of the MISTRAL member countries, unlocking the potential of sustainable aquaculture needs disruptive innovation to occur. The Mediterranean is eco-historically best placed to embrace disruptive innovation, and fisheries and aquaculture industry to plan and even manage together, engaging a broader group of stakeholders – including characteristically small-scale fishers, to ensure sustainable supplies of seafood – the world's most valuable proteins for human health – in the setting of the Mediterranean diet in a world context.
Along the seafood value chain, the way Mediterranean fisheries and aquaculture economies are organized may change, with consumers asking for sustainably caught or farmed seafood from traceable and transparent sources, and fishing and aquaculture offering "on-demand" products from selective and safe fisheries and farms. It is considered essential to demonstrate the environmental sustainability to both SSF and MA to the broader public. The need to better communicate, through certification or promotion campaigns, on the environmental impact of aquaculture (use of water, energy and medicines and other additives), of ecosystem based approach for fisheries management while protecting biodiversity, animal welfare and public safety is acknowledged.



3.4 BLUE BIOTECHNOLOGIES

3.4.1 Introducing the sector and its subsectors



Blue (marine) biotechnology could be defined as the application of science and technology for the production of knowledge, goods and services from (marine) biological resources. Blue Biotechnology involves basic and applied research in the full value chain, from the marine habitat to the biotechnology product and it uses living organisms as either a source or a target of biotechnology applications according to OECD definition[24]. It includes sampling, isolation and identification of marine organisms, their preservation in culture collections, the extraction, purification, structure elucidation and characterization of natural products, optimization of production conditions, possible industrial application and scale up to a pilot scale for biotechnological production of bioactive natural products.
Products from marine biotechnology research and innovation are already exploited in several sectors ranging from food to pharmacology. To date, the commercially available blue biotechnology products include mainly drugs and enzymes and have been obtained mainly from marine animals such as sponges, molluscs, snail etc. However, recently the potentialities of marine microorganisms to provide inputs to the blue bio economy is being progressively appreciated worldwide and efforts to explore and exploit marine (micro) organisms for the development of new products are being intensified. According to the commission staff working document "Report on the Blue Growth Strategy Towards more sustainable growth and jobs in the blue economy" and a specific report launched by the Commission to look into marine products derived from marine organisms, it was found that most products on the market were used in cosmetics, food supplements and aquaculture. Currently the EU Biotech industry has an estimated annual revenue of € 15 billion while the Blue Biotechnology sector`s higher-end revenue generation is estimated to be around € 754 million. An estimated annual compound growth rate of Blue Biotechnology of 6-8% in 5 years could lead to an annual revenue generation of up to € 1 billion. This growth rate could effectively result in an increase in demand of high-end jobs as well as an increase of end products. The employment increase in the Blue Biotechnology sector, given the ambitious overall growth rate, could amount to up to 10.000 additional work places in 5 years[25].
Blue biotechnology is not indeed a cross-cutting sector, but it has the potential to contribute to different biotechnology and industry sectors like human health, cosmetics, fisheries/aquaculture, energy, technology and environmental health. Different kind of biomasses (e.g. whole fish, discards from wild harvest or processing, aquaculture products, macro-algae -both wildland cultivated- micro-algae, marine invertebrates and marine microorganisms) can be used.

Blue biotechnology has been subdivided into subsectors considering the application products that are:

- Healthcare and Pharmaceuticals
- Agriculture, Livestock, Food processing
- Industrial Processes and Manufacturing
- Biofuels
- Bio-monitoring and bio-remediation

[24]Marine biotechnology definitions, infrastructures and directions for innovation. OECD science, technology and innovation policy papers, September 2017 No. 43

[25]ECORYS, 2014

Healthcare and pharmaceuticalapplications: biotechnology has led to the discovery and development of advanced medicines, therapies, diagnostics, and vaccines. For example, biotechnological breakthroughs have created new medicines for patients suffering from growth diseases, metabolic diseases, multiple sclerosis, rheumatoid arthritis and cancer.
Agriculture, livestock, food processing: biotechnology has improved animal feed (food supplements to strengthen the immune systems of livestock and reduce the consumption of antibiotics), produced vaccines for livestock, and improved diagnostics for detecting diseases such as BSE, foot and mouth disease, and salmonella. It has also enabled the use of enzymes for more efficient food processing and improved the breeding of plants to obtain desired characteristics.
Industrial processes and manufacturing: biotechnology has led to the use of enzymes in the production of detergents, pulp and paper, textiles, and biomass. By using fermentation and enzyme biocatalysis instead of traditional chemical synthesis, higher process efficiency can be obtained, decreasing energy and water consumption. This leads to a reduction in toxic waste.
Biofuel: as through the use of micro-algae technology a theoretical volume of 20 000-80 000 dm3 of oil per hectare per year could be produced.
Bio-monitoring and bio-remediation: CO2bio-remediation using micro-algae cultures for the treatment of atmospheric emissions from industry

An overall description of the selected subsector with markets, products and applications of the blue biotechnologies is reported in Table 3-22.

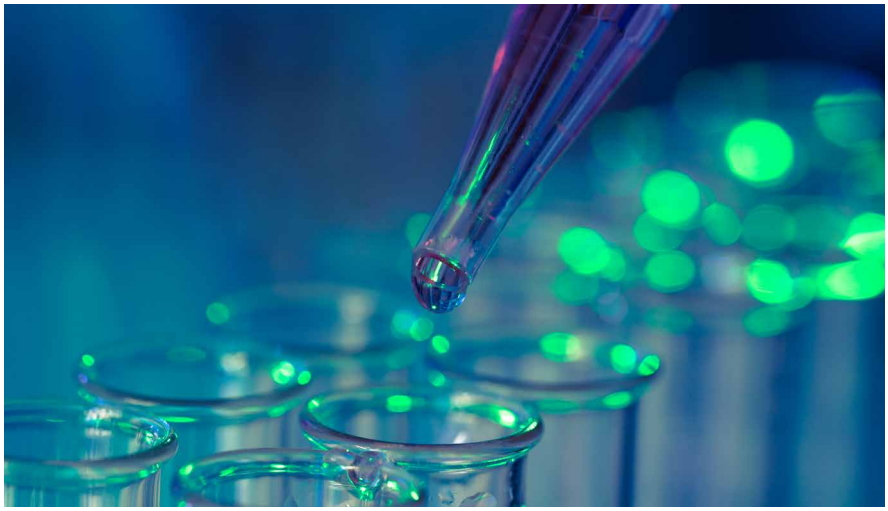


Table 3 22 Potential blue biotechnology applications, products and services (ECORYS,2014). 1: bioactive compounds, 2: biomass

MARKETS AND APPLICATIONS		PRODUCT	CONSUMER	MARINE ORGANISM USED AS (BC[1] OR BM[2])	ORGANISMS
Healthcare and Pharmaceuticals	Pharmaceutical	Medicines: Drugs, novel antibiotics, wound healing, anti-inflammatory, immunomodulatory agents; Biomaterials: Bio-adhesives, dental-medical biomaterials, disinfectants (more environmentally friendly)	Humans	BC	All
	Cosmetic	Functional Ingredients: UV filter; after sun; viscosity control agents; surfactants; liposomes; preservatives; carrier systems for active ingredients; regulation of sebum; Raw materials: Micro-and Macro-algae extracts; colorants; pigments; fragrances; hair styling raw materials		BC	All
	Nutraceutic	Food supplements: Functional Foods: Prebiotics; ω3 supplements; Nutraceuticals: Antioxidants; anti-inflammatory; anti HIV; fat loss; reducing cholesterol; antibiotic and mutagenic properties anti-tumor; iodine deficiency; anti influenza; treatment of gastric ulcers; Food products: Stabilizer- suspending-bending-foaming agents;		BC or BM	All
		Food packaging and conservation: Films and coatings with antimicrobial effects			
Agriculture and Livestock	Animal feed	Nourishment, food supplements…	Animals	BM or BC	Mainly algae
	Veterinary products	Antibiotics, antiseptics, vaccines…		BC	All
	Agriculture	Fertilizers…	Soil and plants	BM	All
Industrial processes and Manufacturing		Enzymes, catalizers,…	Industry	BC or BM	All
Biofuel		Bioethanol and Biodiesel	Industry	BM	Mainly algae
Bio-monitoring and Bio-remediation		Biomass	Industry	BM (as treatment system)	Mainly algae

3.4.2 Blue Biotechnologies in the MED area

The benchmark analysis covered a set of different attributes for the whole assessment in order to capture the related elements associated with the development and implementation of the sector. Here is proposed a comparative overview to highlight the relevance of each attribute that describe the sector and the level of maturity of such attribute for the sector development.

Qualitative analysis performed at Country level for each attribute is summarized in Figures3.13-3.14. Albania data on Blue Biotech are missing.

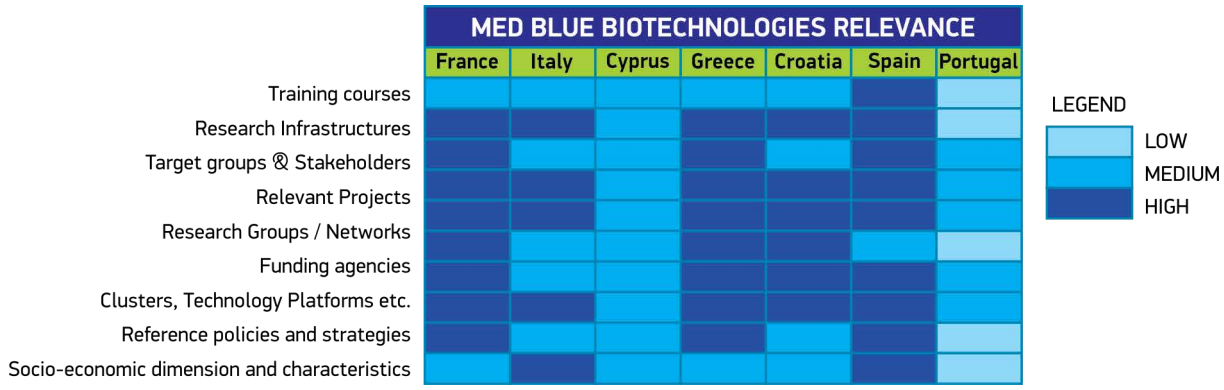


Fig. 3.13Relevance of Blue Biotechnologies in MED Countries

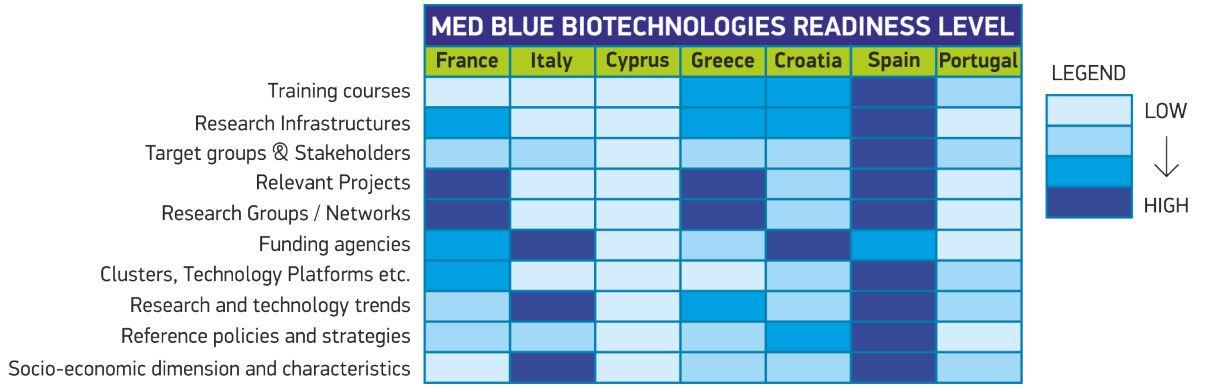


Fig. 3.14 Readiness of Blue Biotechnologies in MED Countries

- Key economic figures

At the actual state of development of Blue Biotechnology in MED there are difficulties in assessing its size and structure, as well as its socio-economic performance. The sector is still in emergence and the main part of the efforts are concentrated in R&D activities working on the different applications of blue biotechnology, apart for algae for which the Technology Readiness Level (TRL) is higher (France, Italy, Greece and Spain). Despite this, commercial products already exist, especially in high added value area such as pharmaceutical industry, and not only based on algae organisms. On the other hand, Blue Biotechnology has the potential to contribute to diverse biotechnology and industrial sectors with different socio-economic weight. These considerations make Blue Biotechnology's economic growth difficult to describe in terms of precise indicators.
Among the Countries object of this study only Spain, France and Italy mentioned companies with a current market of application.
The use of blue biotechnology in Healthcare and Pharmaceuticals is the first application for Spain, France and Italy. Among others, examples are PharmaMar (Spain), one of the world leader companies in medicine production starting from marine (micro)organisms, Hemarina (start-up, France) a recent successful example is the production of marine worms to produce haemoglobin (blood substitute oxygen transporter). BIOSEARCH srl (Italy) that has its focus on pharmaceutical discovery and production, and the Oyster Cosmetic (Italy) that uses chitin in a production line employing 56 people with a turnover of about 20 million €/year.
Very few companies commercialize microalgae for aquaculture and agriculture, while there are two Italian University spin off (Alga&zyme Factory and ALGARES) dealing with bioremediation. The biotechnology companies operating in marine environmental monitoring, protection and recovery, mainly develop bio sensing technologies for monitoring of environmental quality and health risks, biotechnological solutions for the containment of fouling and bioremediation strategies for the recovery of polluted sites. There are no specific indications on the industrial processes and manufacturing subsector.

- Reference policies and strategies

Nearly all the Countries of the MED area

take part to European policies and strategies in the bio economy field such as:
- BlueBio economy Forum - has the goal of bringing together a partnership of industry, public authorities, academia and finance in order to strengthen Europe's competitive position in the Blue Economy;
- European Marine Board (EMB) - provides a strategic forum to develop marine research foresight, initiate state-of-the-art analyses and translate these into clear policy recommendations to European institutions as well as national government;
- Marine Strategy Framework Directive (MSFD), EU Bio economy Strategy and EU Biodiversity Strategy aim to protect the resources upon which marine-related economic and social activities depend to achieve, respectively, Good Environmental Status, implementation of an ecosystem-based management and a halt to the loss of biodiversity and ecosystem services;
- Blue Med initiative -strategy to support a sustainable growth in the marine and maritime sectors in EU Member States;
- European Energy Research Alliance
- contributes to the coordination of a massive public research effort to develop more efficient and cheaper low carbon energy technologies, where sub-programme (SP) 2: Bio-Chemical Platform and SP5: Stationary Bioenergy consider, respectively, all kind of biomass and microalgae as sustainable alternative fuels.

Croatia, Greece and Italy, as EU countries, Albania, Bosnia, Herzegovina, Montenegro, and Serbia, as non–EU, take part to EU Strategy for the Adriatic and Ionian Region (EUSAIR). Itsaim is to create synergies and foster coordination among all territories in the Adriatic-Ionian Region in four thematic areas/ pillars one of which is the Blue Growth with the aim to promote stainable economic development and jobs and business opportunities in the Blue economy, including blue biotechnologies.
Italy, Greece and Croatia have National Research and Innovation Strategies for Smart Specialization where Blue Biotechnology either can be included as part of the Bio economy, or are clearly identified as a strategic priority
At regional level, some Regions of Italy, Spain and France take part to the Vanguard Initiative, which is intended to use the smart specialisation strategy to boost new growth through bottom-up entrepreneurial innovation and industrial renewal in European priority areas.
Italy, Greece and Croatia have National Research and Innovation Strategies for Smart Specialization where Blue Biotechnology either can be included as part of the Bioeconomy, or are clearly identified as a strategic priority. In France: Regions Sud Provence-Alpes-Côte d'Azur and Occitanie; Greece: Regions of Attika, Crete, Ionian islands and in Italy Emilia-Romagna Regionwith the following policies: Smart Specialization Strategy S3 of Italian Regions, Vanguard Initiative, Regional Strategic Document and Circular Economy Regional Law.
Also Catalonia in Spain has the Maritime Strategy of Catalonia whose objective is to promote the development of the so-called 'blue economy'.
Some Countries have National policies, below listed, which can include Blue Biotechnologies.

Croatia
Strategy for Promoting Innovation of the Republic of Croatia
Strategy of Clusters Development of the Republic of Croatia
Research and Innovation Infrastructure Development Plan in the Republic of Croatia

Italy
National Programme for Research 2015-2020
National Committee for Biosafety, Biotechnology and Life Sciences (CNBBSV)

France
National strategy for the sea and coastal areas and the Mediterranean seafront strategical document

- Clusters, Technology Platforms

There are specific European clusters to which each country can adhere, for example EABA (European Algae Biomass Association) or BBI (Bio based Industry) consortium.At National level, the number of clusters does notseem to correspond to the degree of sector development in the country.
A detail list of Cluster and Technology Platforms is given in Table 3-23.

COUNTRY	CLUSTERS, TECHNOLOGY PLATFORMS
Italy	National Technology Cluster - Blue Italian Growth (BIG)
	Regione Emilia-Romagna CLUST-ER Associations
	Cluster Spring (Chimica verde)
Greece	Hellenic Initiative MicrovioKosmos
	Hellenic BIO Cluster –HBIO
France	Pôle Mer Méditerranée
	Association France Microalgues (French National Microalgae Association)
	Mallabar (Métabolomique Appliquée à L'étude de LA Biodiversité mARine: metabolomics applied to the study of the marine biodiversity) Technology platform of IMBE - Marseille
	Platform BIOTECHSERVICES Technology platform of the university of Toulon – Toulon CEATech Cadarache Technology platform of CEA –Saint Paul Lez Durance
	The BioTech Nursery of Grand Luminy Biotech
Portugal	FÓRUM OCEANO – Associação da Economia do Mar
	(Association of Maritime Economy)
	AP BIO Biotechnology Industry Organization
Croatia	Varaždin Biotechnology Cluster
	EUVITA Cluster of North-Western Croatia
	BIOTECH Regional Centre for Biotechnology Research in Brodsko-Posavska County
	European Cluster Collaboration Platform
Spain	Biotechnological and Biomedical Cluster of the Balearic Islands
	Innovation circle in biotechnology Madrid. Community of Madrid
	Andalucía BioRegión – Andalusian Biotechnological Cluster
	XRAQ Reference Network of R & D & I in Aquaculture – Ctalonia
	IRTA Receiving Institute and Agro-food Technology Tarragona - Catalonia

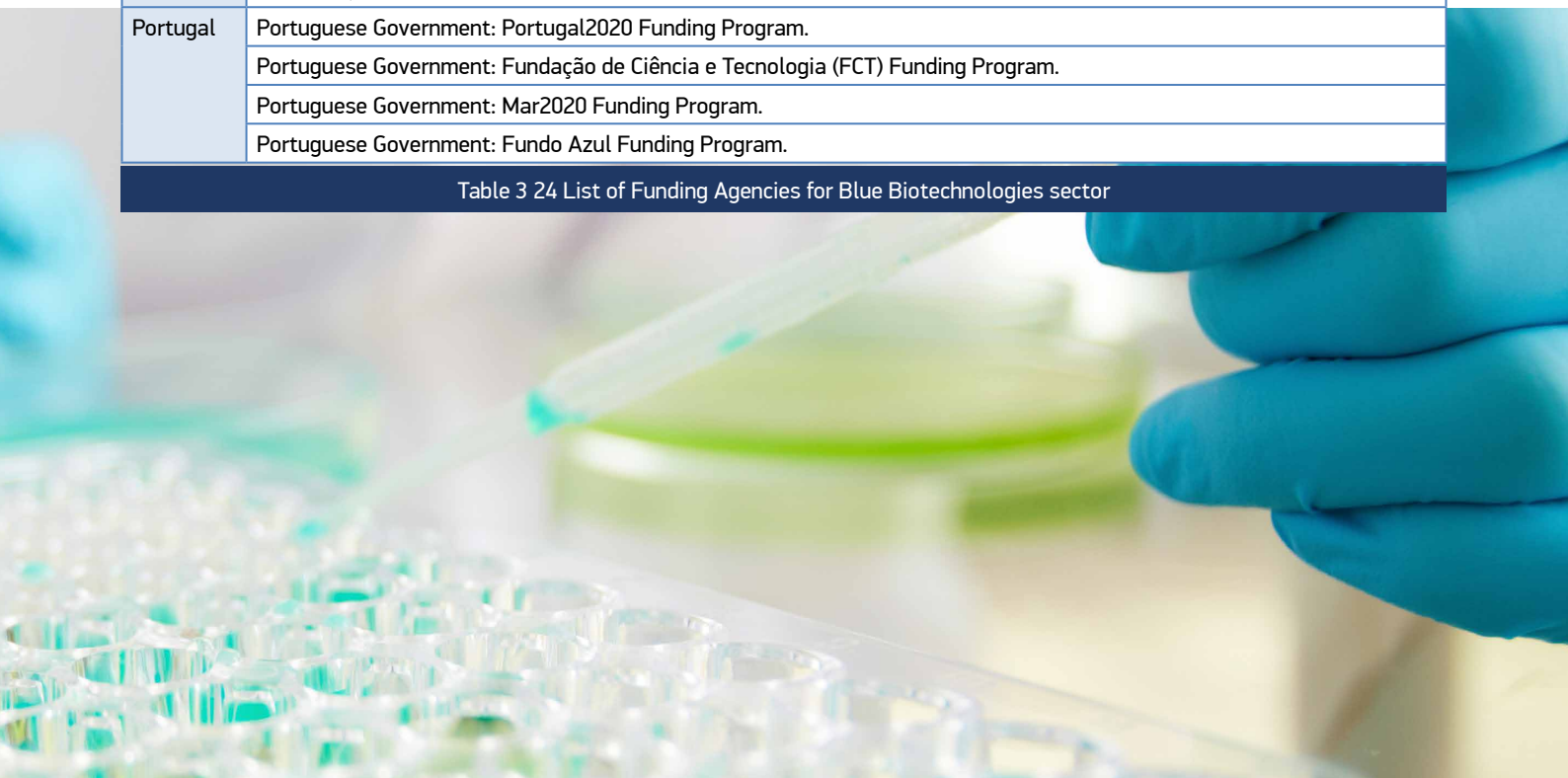
Table 3 23 Cluster and Technology Platform in Blue Biotechnologies sector

- Funding Agencies

Each country can have access to European funding from: European Regional Development Fund, Horizon 2020 Funding Program, BBI Bio Based Industries consortium, ERA-NET Marine Biotech, European Maritime and Fisheries Fund (EMFF), JPI-ocean, Interreg Programmes, EFSI – European Fund for Strategic Investment, ESIF – European Structural and Investment Funds, European Economic grants (EEA).
A detailed list of National Funding agencies can be found in next Table 3-24.

FUNDING AGENCIES	
Spain	Ministry of Science and Innovation (MICINN) – Government of Spain.
	Biotechnology companies (BC), strictly speaking, that are those that carry out R&D&I activities or productive investments, and that lead most of their business to biotechnology.
	Industrial, service and trade companies (IST) with interests, developments and products in biotechnology.
	SUPPORT TO R&D PROJECTS IN THE BIOTECHNOLOGY AND BIOMEDICINE FIELD 2016 – SODERCAN – Society for the regional development of Cantabria.
	CAIXA CAPITAL BIOMED – CAIXA INNVIERTE BIOMED II
	General Secretariat for Industry and SMEs
	Center for Industrial Technological Development - CDTI
	Sabadell Bank
	Spanish Foundation for Science and Technology (FECYT)
France	National Research Agency (AgenceNationale de la Recherche – ANR)
	ADEME (Energy Management and Environment Agency)
	French government
	OccitanieRegion
	SUD Provence-Alpes-Côte d'AzurRegion
	Bpifrance
Italy	Ministry of Education, University, and Research (PON, PRIN)
	AllInstitutional Bodies of regionsfacing the sea (Friuli Venezia-Giulia, Regione del Veneto, Regione Emilia-Romagna, Regione Marche, Regione Abruzzo, Regione Molise, Regione Puglia, Regione Calabria, Regione Campania, Regione Lazio, Regione Toscana, Regione Liguria, Regione autonoma Siciliana, Regione autonoma della Sardegna)
	Emilia-RomagnaRegion (ESIF Funds)
	Fondazione Cariplo
	Fondazione Banca del Monte
Greece	Research and Innovation Strategies for Smart Specialisation (RIS3)
	Private investment funds (equity funds and venture capital)
	The "Green Fund" set up in 2010; money is distributed to various targeted actions enabling environmental benefits.
Croatia	Croatian Foundation for Science
	Ministry of Economy
	Ministry of Science and Education
	ESI funds, WB
Portugal	Portuguese Government: Portugal2020 Funding Program.
	Portuguese Government: Fundação de Ciência e Tecnologia (FCT) Funding Program.
	Portuguese Government: Mar2020 Funding Program.
	Portuguese Government: Fundo Azul Funding Program.

Table 3 24 List of Funding Agencies for Blue Biotechnologies sector



- Research Groups, networks and other resources

Countries on the Mediterranean coast have many research groups of different disciplines dealing with the various themes of the blue biotechnology.In Table 3-25 a list of research group and networks is given.

COUNTRY	RESEARCH GROUPS, NETWORKS AND OTHER RESOURCES
Italy	Italian National Institute for Environmental Protection and Research (ISPRA).
	National Research Council (CNR): Insitute of Biological Resources and Marine Biotechnology (IRBIM); - Institute of Marine Science (ISMAR); Institute of Anthropic Impacts and Sustainability in marine environment (IAS).
	Interdepartmental Centre for Industrial Research in Renewable Resources, Environment, Sea and Energy (CIRI-FRAME).
	Universities of:
	Torino, Napoli Federico II, Milano, PolitechnicUniversity of Marche, Ferrara, Parma, Modena-Reggio Emilia, Padova, Firenze, Roma Tor Vergata, Alma Mater Studiorum-Bologna, Trieste, Udine.
Greece	Hellenic Centre for Marine Research (HCMR)/Institute of Marine Biology, Biotechnology and Aquaculture (IMBBC);
	National Hellenic Research Foundation/Institute of Biology, Medicinal Chemistry & Biotechnology;
	MINOTECH Biotechnology;
	Institute of Applied Biosciences;
	National Technical University of Athens, School of Chemical Engineering/Lab. of Biotechnology;
	Technical Univ. of Crete, School of Environmental Engineering/Lab. of Biochemical Engineering & Environmental Biotechnology
France	IFREMER - French Research Institute for Exploitation of the Sea - (sites of Sète and Palavas in Med area and site of Nantes on the Atlantic coast).
	Villefranche Oceanology Observatory
	Member of EMBRC Banyuls Oceanology Observatory (Observatoire Océanologique de Banyuls-sur-mer - OOB).
	MIO (Mediterranean Institute of Oceanography).
	Laboratory of Bioenergetics and Biotechnology of Bacteria and Microalgae (LB3M).
	MAPIEM - University of Toulon.
	Universities of Aix-Marseille, Montpellier, Nice, Perpignan and Toulon
Portugal	CIIMAR - Interdisciplinary Centre of Marine and Environmental Research.
	The Centre of Marine Sciences – CCMAR
Croatia	Institute RuđerBošković in Zagreb.
	University of Zagreb, Faculty of Food Technology and Biotechnology.
	University of Rijeka, Department of Biotechnology
Spain	The Center for Marine Biotechnology of the University of Las Palmas of Gran Canaria.
	The Institute of Marine Research (IIM), belonging to the Higher Council for Scientific Research (CSIC).
	Spanish Institute of Oceanography (IEO)
	Science and Technology Parks.
	Mediterranean Institute of Advanced Studies - IEDEA (CSIC-UIB, University of the Balearic Islands).

Table 3 25 List of research groups and networks for BB sector

- Relevant projects

The European Union has been and is supporting the development of marine biotechnology throughout Europe and beyond. Under FP7, marine-related projects are to be found mainly within the KBBE programme. Ten relevant projects were funded with marine biotechnology scope (ALGAE COM, MicroB3, KILL SPILL, BIOCLEAN, LEAF, EUROSHELL, CHIBIO, ULIXES, BLUEGENICS, CORESHELL). In H2020, marine related projects are to be found across different themes. In total 30 H2020 projects were funded specifically with marine biotechnology scope under different funding schemes (BBI; ERANET; Blue Growth, CSA, Interreg, etc) with a total volume of around80 million €. Moreover, different projects have been financed at regional/national level in the different countries includingItaly (COMISAR, COltivazione di ceppiMIcroalgaliSARdi; GOBIOM – Optimization of regional/national biomethane production); France (on-going: BIOPAINTROP; FACTEUR 4, PHYCOVER; VASCO II or concluded: ECIMAR, SHAMASH); Croatia (BIOPROSPECTING); Greece (MEDSUSHI, BIOALGAFOOD) Spain (BIOIB) and Portugal (BLUE BIO VALUE). In Table 3-26the list of relevant H2020 projects for the BlueBiotechnology sector.

LIST H2020 FUNDED PROJECTS
ALGAE-CEUTICALS (https://cordis.europa.eu/project/rcn/213018/factsheet/en)
PHARMASEA (https://cordis.europa.eu/project/rcn/104338/reporting/en)
NOMORFILM (https://cordis.europa.eu/project/rcn/193300/factsheet/en)
SEABIOTECH (http://spider.science.strath.ac.uk/seabiotech/)
SUSTAIN-ALGAE
ALGAE4A-B (https://cordis.europa.eu/project/rcn/200152/factsheet/en)
AlgaeCom http://www.algaecom.aua.gr
SOLENALGAE (https://cordis.europa.eu/project/rcn/199416/factsheet/en)
EUROSHELL(http://www.euroshell-net.eu/)
CHIBIO(https://www.chibiofp7.fraunhofer.de/index.html)
PLASTIC BUSTERS MPAS(https://plasticbustersmpas.interreg-med.eu/)
INMARE(www.inmare-h2020.eu/)
TASCMAR (http://www.tascmar.eu/)
PLASTOX(https://www.sintef.no/projectweb/plastox/)
OCEAN MEDICINES(http://www.oceanmedicines.eu/)
CSA OCEANS 2(http://www.jpi-oceans.eu/csa-oceans-2)
ASSEMBLE PLUS(http://www.assembleplus.eu/)
MARIBE (https://maribe.eu/)
INNOBLUEGROWTH (https://www.facebook.com/InnoBlueGrowth/)
MARPIPE (http://www.marpipe.eu/)
MARISURF (http://www.marisurf.eu/)
NOVOFEED (http://www.marinebiotech.eu/novofeed)
VALUEMAG (https://www.valuemag.eu/)
RESERVE (https://cordis.europa.eu/project/rcn/14805/factsheet/en)
BENEFIT (http://www.benefit4transport.eu/)
MACBIOBLUE (http://macbioblue.com/)
AQUABIO PRO-FIT (https://www.aquabioprofit.eu/)
MicroB3
KILL*SPILL www.killspill.eu
BIOCLEAN www.biocleanh2020.eu
LEAF-AntiFOUL www.leaf-antifouling.eu
BIOEXPLORE
ANTIFOUL (http://www.agence-nationale-recherche.fr/Project-ANR-16-COFA-0003)
RESERVE BENEFIT
MED-ALGAE (http://www.med-algae.eu/)
BIOHORIZON (http://www.ncp-biohorizon.net/funding-opportunities/h2020)

Table 3 26list of relevant H2020 projects for the Blue Biotechnology sector

- Target groups and stakeholders

In the different countries, the target groups and stakeholders are represented mainly by SMEs as well as academic/ research institutions as well as some Ministries. Italy and France include mainly Industries and start-ups. In addition, Italy referred to services supplier according to the environmental application of the sector. Greece, Spain, Italy and Portugal reported industrial associations/networks of bio-companies. The lack of mentioning associations or companies that could beneficiate from Industrial/Agriculture application (except for Italy) reflects the state of the art in terms of implementation of Blue Biotech.
The full list is available in Table 3-27.

COUNTRY	NATIONAL ACTORS
Italy	FEDERPESCA
	ASSOBIOTEC
	Associazione Italiana per lo Studio e le Applicazioni delle Microalghe (AISAM)
	Italian Society of Agro-Food and Environmental Microbiology (SIMTREA)
	Phycological group of the Italian Botany Siciety
	Marevivo
	Oyster Cosmetics S.P.A (Mantova, Italy)
	F.lli Terzi (Bergamo, Italy)
	Micoperi Blue Growth srl (Ravenna)
	ECOBIOS Italia (Roma)
	ArterraBioscience
	EcoTech Systems Srl
	Fotosintetica e Microbiologica srl—F&M
	Bictsrl
	BIOPOX srl
	PharmaMar
	BiosearchAmbientesrl
	ENI
	ENEL
	Capua Bioservices S.P.A.
	Biodermol Ambiente srl
	BSA Ambiente srl
	Ambiente & Risorse Srl
	InnovenSrl
	Eurovix S.p.A.
	Ministry for the Environment, Territory and Sea
Greece	Hellenic Phycological Society (HEL.P.S)
	Hellenic Association of Pharmaceutical Companies –SFEE
	The Greek Bioeconomy Forum
	European Federation of Biotechnology (EFB)-MEDBIO
	Mediterranean Biosciences
	European Network for Algal Bio Products-EUALGAE
	Competent companies with R&D DepartmentsAPIVITA – Natural Cosmetics, KORRES, PLANGTON S.A, MicroPHYCOS
Spain	Private Research Companies in Health area at regional level – Spanish Mediterranean Sea Región
	SPANISH ASSOCIATION OF BIOCOMPANIES-ASEBIO
	UNIVERSITY OF BALEARIC ISLANDS
	Laboratory of Marine Research and Aquaculture (LIMIA)
	Official Chamber of Commerce, Industry, Services and Sailing of Mallorca
	Catalan Association of Biotechnology Companies (CataloniaBIO)
	Barcelona Science Park

COUNTRY	NATIONAL ACTORS
France	CORALBIOM(https://www.coralbiome.com/)
	GREENSEA (http://greensea.fr/en/presentation/)
	MICROPHYT (http://www.microphyt.eu/en/get-to-know-us/)
	CORALIOTECH (https://monacotech.mc/en/startups/coraliotech/)
	CYPREOS (http://www.sponges.fr/index-en.php)
	SPIRULINE DU SOLEIL (http://www.spirulinedusoleil.fr/)
	ACRI (http://www.acri-he.fr/)
	INALVE INNOVATION (https://inalve.com/)
	MICROBIA (https://www.microbia-environnement.com/)
	PROTEUS (http://www.proteus.fr/en/)
	Ministry of Ecological and Inclusive Transition (MTES)
Portugal	3B's Research Group – Universidade do Minho
	Algaplus, Lda – Produção e comercialização de algas e seusderivados
	Bluebio Alliance
	Bluemater S.A. – Soluções Eco-Eficientes
	Universidade do Minho
	IPMA – InstitutoPortuguês do Mar e da Atmosfera Marinnova – Marine and Environmental Innovation, Technology and Services
	Ocean Vision
	Mar (Association of Maritime Economy); APBio – AssociaçãoPortuguesa de Bioindústrias; CIIMAR – Centro Interdisciplinar de InvestigaçãoMarinha e Ambiental
Croatia	Centres of Research Excellence (CoRE)
	Centres of Competitiveness (CEKOM)

Table 3 27Target groups and stakeholders

-Research Infrastructures

Next Table 3-28 shows the Research Infrastructures among the Countries represented in the Mistral consortium.

COUNTRY	INFRASTRUCTURE NAME AND TYPE	ORGANIZATION (NAME, CITY AND COUNTRY)
Italy	Marine Biology and Fisheries Laboratory of Fano (PU)	Alma Mater Studiorum Univ. di Bologna – Dept. of Biological, Geological and Environmental Sciences – BiGeA
	University Center for Fish Farming	Alma Mater Studiorum Univ. di Bologna – The Department of Veterinary Medical Sciences
	The Inter-Departmental Centre for Research in Environmental Sciences (CIRSA)	Alma Mater Studiorum Università di Bologna
	EMBRC – ERIC	
	ELIXIR (www.elixir-europe.org/)	
	Marine Institutes	CNR National Research Council (CNR) Department of Earth System Science and Environmental Technologies (CNR-DTA) in particular IRBIM, ISMAR, IRSA and IAS
	Experimental facilities for biology and ecosystem studies	DBAE Cagliari (Department of Animal Biology and Ecology), UNICA - University of Cagliari
	Facilities of the Unit "Bioenergy and high value products from microalgae"	National Research Council (CNR), Department of Earth System Science and Environmental Technologies (CNR-DTA)
		Research Institute on Terrestrial Ecosystems, unit of FIRENZE

COUNTRY	INFRASTRUCTURE NAME AND TYPE	ORGANIZATION (NAME, CITY AND COUNTRY)
France	PIICTO	Association with the Marseille Fos Port Authority and different institutions from across the territory.
	HelioBiotec - Biotechnology research infra - Production of energies by microalgae	Hosted by the Laboratory of Bioenergetics and Biotechnology of Bacteria and Microalgae (LB3M) on the site of the CEA of Cadarache – Saint-Paul-Lez-Durance – France (SUD PACA Region)
	Full Spectrum - Biotechnology research infra - Solar greenhouse for algae production	Hosted by the Villefranche Oceanography Laboratory (LOV) of Villefranche Oceanology Observatory (OOV), Villefranche sur Mer, France (SUD PACA Region)
Greece	The European Marine Biological Research Infrastructure Cluster to promote the Blue Economy-EMBRIC/HCMR)	Institute of Marine Biology, Biotechnology and Aquaculture –IMBBC
	European life-sciences Infrastructure for biological Information - ELIXIR/HCMR-	Institute of Marine Biology, Biotechnology and Aquaculture –IMBBC
	Towards an Alliance of European Research Fleets - EUROFLEETS	HCMR-Institute of Oceanography
	AQUAEXCEL 2020 (Aqualabs Souda and Genomics-Bioinformatics)	HCMR-Institute of Marine Biology, Biotechnology and Aquaculture –IMBBC
Spain	Oceanographic Center of Balearic	Ministry of Economy and Competitiveness
	Spanish Institute of Oceanography (IEO)	Research, Development and Innovation Secretary of State of Ministry of Economics and Competitiveness, Madrid
	ICTS (Scientific Infrastructure and Singular Technology) - SOCIB (Balearic Islands Coastal Observing and Forecasting System)	Ministry of Science and Government of the Balearic Islands, Balearic Islands
Croatia	Institute, public	Ruđer Bošković Institute, Zagreb. Institute for oceanography and Fisheries, Split
	Faculty, public	University of Zagreb, Faculty of Food Technology and Biotechnology, Zagreb. University of Osijek, Faculty of Food Technology and Technology, Osijek

Table 3 28 List of Research Infrastructures

- Training Courses.

Several training courses covering activities/subjects related to blue biotechnology are ongoing in different EU countries participating to MISTRAL project and the full list is indicated on Blue Biotechnologies Sector Report at MISTRAL website. Italy is the Country with the largest number of international PhD programs (3) based on Marine Applications and Biotechnology. A dedicated Master Course in Bio economy highlights the close connections between research and bio-industries in Italy. In Spain, as well as in Croatia, there is one PhD program related to Biotechnologies respectively with an application to medical field (Spain) and food technology and nutrition (Croatia). Greece reported a specialization course in Environmental Biotechnology while France, among others, a Master in Blue Biotechnology in Nice. Table 3-29 shows the list of training courses in Blue Biotechnology sector.

COUNTRY	TRAINING CENTER	COURSES
Italy	11 partners based in 8 countries leaded by CNR and SZN	MARPIPE – PhD training project
	University of Bologna	Master Degree in Marine Biology and International Master Program Offshore Engineering; Offshore International Summer School.
	University of Bologna/CNR	International PhD programme: FishMed-PHD on Innovative technologies and sustainable use of Mediterranean Sea fishery and biological resources.
	Programme offered by a consortium of 24 partners from 14 countries, coordinated by Ghent University (FPA 2011-0016). The Italian partners include Universities of Bologna and Pavia and ENEA	International PhD programme: MARES. A joint Doctoral Programme on Marine Ecosystem Health & Conservation funded through Erasmus Mundus.
	University of Milano-Bicocca	Master on marine sciences
	University of Messina	University course on Marine Biotechnology
	Università di Genova	University course- Marine biotechnologies
	4 Universities (University of Bologna, University of Milano-Bicocca, University of Naples Federico II, and University of Turin), and by non-academic partners (Intesa Sanpaolo, NovamontSpA, GFBiochemicalsSpA, and PTP Science Park di Lodi)	European Master (level II): Bioeconomy in the Circular economy.
Spain	University of Sevilla	Master in Advanced Biology: Research and Application.
	Catholic University of Valencia	Master in Applied Blue Biotechnology
	European University of Madrid	Degree in Biotechnology + Posgrade Diploma in Biotechnology Management
	University of Balearic Islands	Master in Applied Biotechnology
	University of Balearic Islands	PhD in Medical and Evolutive Biotechnology
	University of Basque Country	Master MER (Marine Environment and Resources)
	University of Basque Country	Master in Marine Biological Resources (IMBRSEa)
	University of Basque Country	Master in Environmental Contamination and Toxicology
	University of Alicante	Degree in Marine Sciences
	Catholic University of Valencia	Master's Degree in Applied Blue Biotechnology
	University of Valencia	Degree in Biotechnology
	IUCT - University Institute of Science and Technology – Barcelona	Master's Degree in Industrial Biotechnology Research
Portugal	University Lusofona	Biotechnology
	University Aveiro	Biotechnology
	Instituto Politecnico de Setubal	Biotechnology
	Universidade Nova Lisboa	Biotechnology

COUNTRY	TRAINING CENTER	COURSES
Croatia	University of Zagreb, Faculty of Food Technology and Biotechnology	Undergraduate studies on: biotechnology; food technology; nutrition.
		Graduate studies: bioprocess engineering; molecular biotechnology, food technology; nutrition;
		PhD study on biotechnology, food technology and nutrition
	University of Osijek, Faculty of Food Technology and Technology	Undergraduate studies on: food technology; nutrition.
		Graduate studies: process engineering; food science and nutrition
		Post-graduate study, PhD study on nutrition
	University of Rijeka, Department of Biotechnology	Undergraduate and graduate studies on biotechnology; Doctoral study on medical chemistry
	University of Zagreb, Faculty of Science	Undergraduate, graduate and doctoral study on molecular biology
	University of Split, Faculty of Chemistry and Technology	Undergraduate studies on nutrition; food technology.
		Graduate study on food technology
	University of Zagreb, Faculty of Agronomy	64 studies on agriculture (currently on going) including courses on microbiology, dairy technology; PhD study
	University Juraj Dobrila, Pula	Undergraduate study on marine science
	University of Zagreb, Faculty of Pharmacy	2 Graduate studies on pharmacy and medical biochemistry;
		6 post-graduate studies
		2 PhD studies: pharmacy and medical biochemistry
Greece	Univ. of Crete	Marine Biotechnology'The sea as a source of research and development of innovative products'
	Depart. of Biology	
	Univ. of Aegean Depart. of Marine Sciences	Marine Biotechnology
	National University of Athens, Depart. Biology-Section of Genetics and Biotechnology	Biotechnology
		Use of microorganisms in Biotechnology
		Enzyme technology
		Industrial and commercial exploitation
	Technical Univ. of Athens, School of Chemical Engineering-Depart. Synthesis and Development of Industrial Processes (IV)	Environmental and Biochemical Engineering
	Technical Univ. of Crete, School of Environmental Engineering	Biological Methods for Environmental Remediation
	Technical Univ. of Patras, School of Chemical Engineering	Specialization Course, Environmental Biotechnology
	Agricultural Univ. of Athens, School of Food-Biotech and Development	Biotechnology
	Univ. of Thessaly, Department of Ichthyology & Aquatic Environment (DIAE)	Microbiology
		Genetics
		Aquafeed technology
	Kapodistrian Univ. of Athens, School of Pharmacy	MSc Pharmacognocy and Chemistry of Natural Products
	International Hellenic University	MSc in Bioeconomy: Biotechnology and Law

COUNTRY	TRAINING CENTER	COURSES
France	University of Nice	Master in Blue Biotechnology
	Aix-Marseille University - Pythéas Institute - Observatory of sciences of the universe	Master Degree in Oceanography : Marine Biology and Ecology
	University of Toulon – Training and Research Unit of Science and Technology	Bachelor Degree in Life Science : Biochemistry, cellular and molecular biology
		Master Degree in Science, Technology and Marine Environment: Reactive analytical chemistry and environmental modelling
	University of Montpellier – Regional apprentice training center of higher education, South of France	Master Degree in Biodiversity, Ecology, and Evolution
	University of Montpellier – Lifelong learning service	Master Degree in Bio aquatic resources in Mediterranean and tropical environment, Aquaculture course
	University of Perpignan Via Domitia	Master Degree in Biodiversity, Ecology, and Evolution
		Master Degree in Marine geosciences and Aquatic environments: Bioactive molecules and Environment
	University of Toulouse III Paul Sabatier	Master Degree in Biodiversity, Ecology, and Evolution
	Banyuls Oceanology Observatory (OOB)	Master Degree in Science of the Universe, Environment and Ecology: Ecophysiology and Ecotoxicology
		Master Degree in Science of the Universe, Environment and Ecology: Systematic Evolution Paleobiodiversity
	AgriCampus of Hyères	BP REA of Maritime and Continental Aquaculture (BP REA: Brevet Professionnel de Responsible dÕExploitation Agricole niveau IV, (Professional Certificate of Farm Manager)
	Vocational Training and Agricultural Promotion Center (CFPPA)	Specialty Spirulina (Adults training; Long training)
		Initiation to Spirulina culture(Adults training; Short training)

Table 3 29 List of Training courses for BB sector

3.4.3 Identifying innovation potentials and key enabling factors

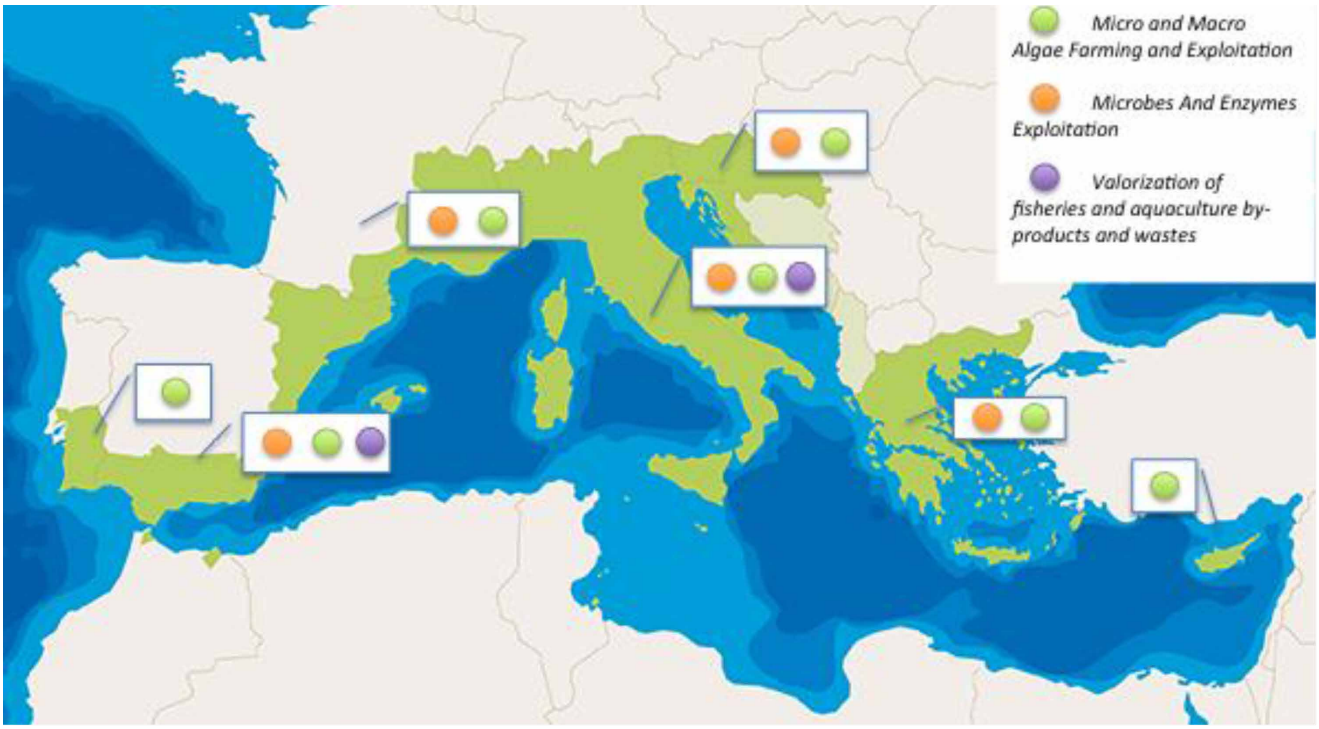
3.4.3.1 Opportunities and benefits

Blue biotechnology is a field with massive potential for innovation and economic growth. There is a huge range of marine organisms that can support the development of new products, which may in turn benefit society, and the marine biodiversity is largely understudied. Given that Blue Biotechnology is a relatively young discipline, many innovative activities are likely to become economically viable in the medium to longer term. The sector is still in development and the main part of the efforts is concentrated in R&D activities, apart from algae for which the Technology Readiness Level is higher. Despite this, commercial products already exist, especially in high added value area such as pharmaceutical industry, and not only based on algae organisms. In the context of rapid climate change and increasing pressure on natural resources, recent advances in methodology and technology, particularly in bioprocessing, and in the study of marine biodiversity in conjunction with the various -omics fields have fostered interest in marine biotechnology.
Based on the analysis of sector attributes, each Country identified a number of specific Innovation Potentials within the Blue Biotechnology sector. By the integrated analysis of IPs the following thee Innovation potentials have emerged across the MED area that are:

1. **Micro and Macro Algae Farming and Exploitation**
2. **Microbes and Enzymes Exploitation**
3. **Valorisation of fisheries and aquaculture by-products and wastes**

Spatial distribution of IPs among MISTRAL Countries is shown in Fig. 3.15.

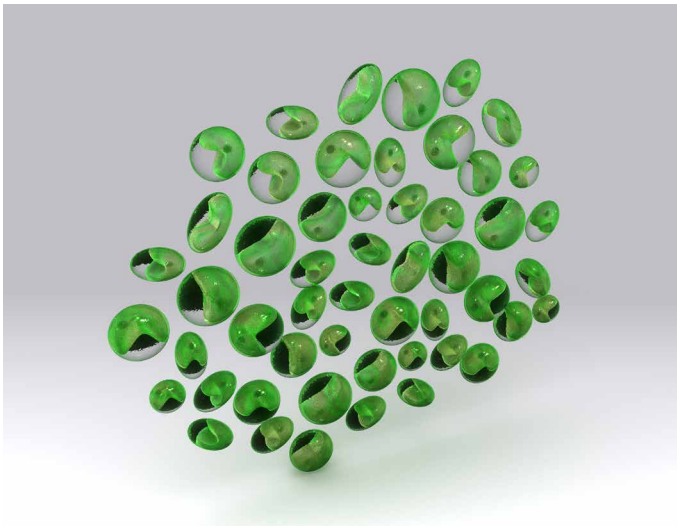
Fig. 3.15 Geo localization of innovation potentials in Blue Biotechnology Sector among MISTRAL Countries. Legends: Colors corresponds to specific IPs



All the Countries recognized Micro and Macro Algae Farming and Exploitation as an Innovation Potential. Except Cyprus, all the remaining Countries found a great potential in Microbes and Enzyme Exploitation for different application as described in detail in the tables below. Only Italy and Spain recognized the Valorisation of fisheries and aquaculture by-products as an Innovation for BlueBiotech Application. The IPs identified and the corresponding benefits per application field are described as follow.

Micro and Macro Algae Farming and Exploitation M&MAFE
Algae are representing a strategic biological resource for their multi-purpose valorisation in a number of sectors (food, feed, nutraceutical, cosmetic, pharmaceuticals and agriculture) joined with the possibility to exploit aquatic plant organisms for the containment of the atmospheric CO2 increase or for wastewater treatment. There are two main categories of food market products obtained from micro-algae: dried algae (in particular Spirulina and Chlorella), which are by far those mostly produced, and high-value nutrients that can be extracted from micro-algae, such as carotenoids, phycobilins, fatty acids, antioxidants. Other commercialized products from microalgae consist in preparations (solutions, dry or frozen biomass) to be used as feed for small-farmed marine organisms. Macro algae are increasingly exploited in food and in cosmetics but the greatest use is in agriculture where especially brown algae extracts are included in a variety of formulations that act as “biostimulants” for crops. While microalgae are increasingly cultivated, macro algae are usually imported.

The Table 3-18 highlights opportunities, benefits and the corresponding enabling factors for Micro and Macro Algae Farming and Exploitation with respect to different applications (or subsectors).



	OPPORTUNITIES	BENEFITS	KEY ENABLING FACTORS
General overview	High biodiversity, cultivability and high productivity per unit area, use of non-agriculture soil, low level of pollution in productive sites, base technologies quite advanced,	Atmosphere and water pollution decrease, possible source of health-promoting molecules or of new medicines, employment increase, link with other sectors, help to protect the resource upon which marine-related economic and social activities depend, meet actual societal challenges in food energy and health,	Policies are at a medium-high levels,
	good acceptability for many products, qualified human resources in the area, increasing demand of related products, increasing advanced methods for cultivation	connection between researchers and entrepreneurship investment	R&D is at high levels and many technologies are already developed,
			Human skills require training courses now limited but implementable, need of interdisciplinary cooperation and of specific inter-sectorial training, the sector has economic relevance and could have positive impact on a number of different sectors
			Funding at national level are scarce
- Healthcare and Pharmaceuticals	Increasing demand for nutraceuticals, green cosmetics, new and natural pharmaceuticals	Health benefit compared to synthetic molecules,	Marketing of nutraceutical/cosmetic products is ready and it has an increasing trend;
		discovery of new bioactive molecules	pharmaceuticals are far from being produced and only in vitro assays have been performed
- Agriculture and Livestock	Many products already developed for agriculture and for animal feed	Reduction in the use of pesticides, antibiotics, alternative to existent vaccines, new food with high nutritional value, plant and animal health improvement, allergens reduction	Market ready for a new generation of food product, good acceptability of natural products
Bio-monitoring and Bio-remediation	Bioremediation through algae has been demonstrated mainly at lab scale but few commercial applications already exist, applications are eco-friendly and have low cost	Bioremediation: CO2 or nutrient pollution decrease, production of algal biomass for other purposes, Biomonitoring: possibility of decreasing negative impact of algal bloom	Impact on many industrial activities
			Activities are supported by the EU legislative instrument, Marine Strategy Framework Directive (MSFD), which aims to achieve Good Environmental Status (GES) of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend
- Biofuels	Coupling with the use of algae for bio-remediation, possibility to use existing biomasses, large acceptability	High eco-sustainability, completely renewable	Impact on many other sectors

Table 3 30List of benefits of M&MAFE

Microbes and Enzymes Exploitation
The activities deal with the exploitation of marine organisms (other than fish and shellfish) including microorganisms (archaea, bacteria and fungi) for the production of metabolites/compounds of interest in chemical, pharmaceutical, food, nutraceutical and cosmeceutical sectors. Currently, almost all the marine-derived products that reached the market are drugs that have been obtained from marine animals such as sponges, snail and so on. However, there is now a considerable amount of experimental evidence demonstrating that many of the bioactive molecules isolated from sponges for example, are produced by microbial symbionts. Furthermore, marine bacteria and fungi are producers of several compounds with potential applications in various fields. These include enzymes (cosmetic, pharmaceutical and food industries and in bioremediation), antimicrobial/bioactive compounds (medical/health sector), biosurfactants (BS)/bioemulsifiers (BE) (bioremediation, cosmetics, drug and food industries) or exopolysaccharides (EPs) (thickeners, stabilisers and gelling agents in food products. Also, antitumoral, antioxidants and/or prebiotics in pharmacology) or as bioemulsifiers or metal binder in bioremediation, polyunsaturated fatty acids (antioxidants, nutraceuticals) and pigments (antioxidants, food colorants).
The table 3-19 highlights opportunities, benefits and the corresponding enabling factors for Microbes and Enzymes Exploitation with respect to different applications (or subsectors).

	OPPORTUNITIES	BENEFITS	KEY ENABLING FACTORS
General overview	Currently, microbes and their derived products have been well studied and exploited mainly from terrestrial environments. Only few microorganisms from marine origin have been obtained in culture and very few of them are being exploited. However, the marine environment is characterised by a very high biodiversity that needs to be studied, characterized and exploited.	Development of the green chemistry and bioeconomy	The exploitation of marine microbes and enzymes are among essential research priorities in the EUH2020/national policy and strategies in blue biotechnology sector.
		Discovery of novel compounds for the development of new bioproducts to be used in cosmetics, pharmacy or medicine.	The blue biotechnology sector is also supported under the umbrella of other national and/or regional strategies/programmes in different EU countries like Italy, France, Spain, Greece and Croatia
		Improvement of the industrial processes through the use of biocatalysts (enzymes)	Marketing of microbial enzymes/enzyme-based formulations is ready and it has an increasing trend
		Improvement of the environmental health as a result of the reduction of the use of chemical compounds from synthetic origin and through the application of non-toxic biodegradable compounds	
- Industrial Processes and Manifacturing	Blue biotechnologies are used to improve industrial processes (enzymes for the production of detergents, pulp and paper, textiles, and biomass; and fermentation and enzyme biocatalysis instead of traditional chemical synthesis) and, as biomass, for industrial purposes (in Green Chemistry (biorefinery concept), fermentation industries…).	Higher process efficiency and lower energy and water consumption compared to traditional processes, extremozymes stable and active under harsh working conditions (extremes of temperature, pH ad/or low water activity, high)	Microbial enzymes working under conventional conditions are already applied in various industrial processes, use of extremozymes would result in the improvement of process performances
- Healthcare and Pharmaceuticals	The high diversity of marine microorganisms (archaea, bacteria and fungi) and their ability to withstand extreme conditions for life reflects the high opportunities for obtaining new antimicrobial compounds (antibiotics, bioactive peptides and polysaccharides), biopolymers (mainly exopolysaccharides) and enzymes for the development of new drugs, cosmeuticals and nutraceuticals.	Blue biotechnologies could offer important progress for theimprovement in the health sector through the discovery of new antimicrobial compounds active against drug resistant bacteria and fungi and hence the contribution to the efforts to search solutions for the antibiotic resistance issue.	Pharmaceutical sector is well developed in some EU countries like France or Spain where companies of the sector offer a high level of knowledge and support the investment in the sector.
- Agriculture and Livestock	The high diversity of marine microorganisms and their ability to withstand extreme conditions for life reflects the high opportunities of obtaining new compounds for the development of new drugsor immunostimulators to be applied in the Agriculture and Livestock sector.	The use of blue biotech products as feed supplements to strengthen the immune systems of livestock and for aquaculture wouldreduce the consumption of antibiotics and represents analternative to traditional drugs and treatments (antiseptics, vaccines…)	
Bio-monitoring and Bio-remediation	Currently devices based on biosensors for the detection of marine pollutants are available as prototypes.	Biomonitoring technologies can provide the necessary information helping to protect coastal activities/industries and human health	Activities are supported by the EU legislative instrument, Marine Strategy Framework Directive (MSFD), which aims to achieve Good Environmental Status (GES) of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend.
	Enzyme and microorganisms-based products are available for the bioremediation of soils and water treatments while products for the marine environment are not commercialized yet.	The use of marine microorganisms and their derived products for example BS/BE is beneficial to the environment since these compounds are biodegradable, not toxic, highly stable and active under the marine environmental conditions	

Table 3 31 List of benefits of Microbes and Enzymes Exploitation

Valorisation of fisheries and aquaculture by-products and wastes
The activities deal with the use of fisheries and aquaculture by-products (generated from fish processing) and/or wastes (fish by-catch and/or algal proliferation) as feed streams for the development of chemical and/or biotechnological process for the production of compounds and materials to be applied in different industrial sectors. These include aquaculture, chemical, pharmaceutical, cosmeutical, nutraceutical as well as building sectors. Worldwide every year, some 6 million to 8 million tonnes of fishery by-products and wastes are produced. These materials harbour useful chemicals — enzymes, protein, calcium carbonate and chitin. The organic fraction can be exploited for the production of bioactive peptides through (bio)chemical hydrolysis of fish proteins; biomaterials and polyunsaturated fatty acids. Calcium carbonate can have applications in the pharmaceutical, agricultural, construction and paper industries. Chitin can be used in cosmetics, textiles, water treatment and biomedicine.
The Table 3-32 highlights opportunities, benefits and the corresponding enabling factors for valorisation of fisheries and aquaculture by-products and wastes with respect to different applications (or subsectors).

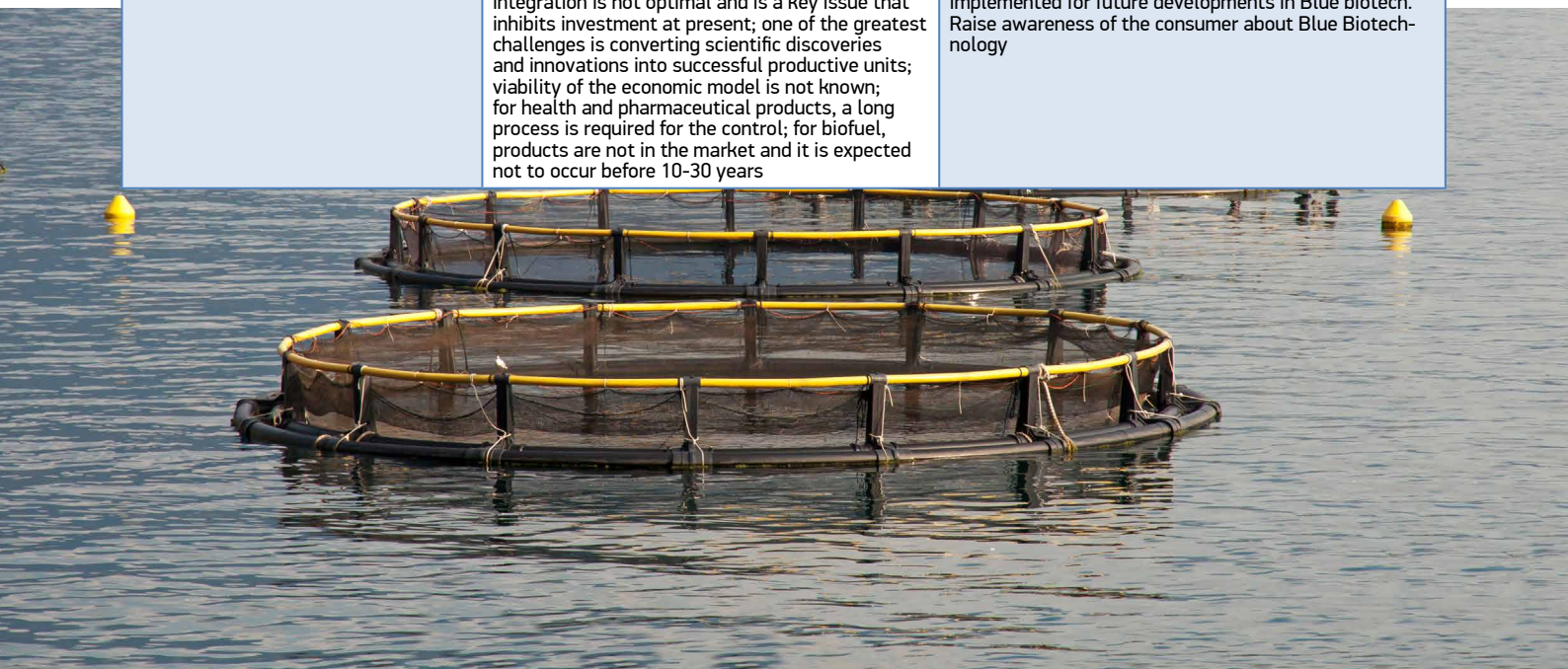
	OPPORTUNITIES	BENEFITS	KEY ENABLING FACTORS
General overview	The inorganic, organic or composite materials offer great opportunities being rich of high value molecules, macromolecules, and minerals. In addition, they have superior mechanical properties with respect to the similar synthetic ones.	These materials can stimulate aquaculture and generate a good example of circular economy. Unwanted catches and discards constitute a substantial waste and negatively affect the sustainable exploitation of marine biological resources and marine ecosystems and the financial viability of fisheries. Their utilization can limit environmental impacts of fishing activities, reduce high levels of unwanted catches and gradually eliminate discards. Moreover, when calcified they could contribute to the sequestration of carbon dioxide (Gtonnes/year for forams)	Development of dedicated policies.
			Art. 15 (1) of Regulation (EU) No 1380/2013 of the European Parliament and of the Council establishes the obligation to land all catches of species which are subject to catch limits and, in the Mediterranean, also catches of species which are subject to minimum sizes ('the landing obligation').
			Dissemination to stakeholders of the great value of natural products, being the result of millions of years of evolution.
			Generation of an integrated waste management scheme.
			Scale up at industrial level of laboratory protocols.
- Healthcare and Pharmaceuticals	Chitin derivatives, mainly chitosan, from waste sea shells are widely used in cosmetics. Biogenic calcium carbonate has potential use as drug delivery system	The consumers prefer to use materials of biogenic origin with respect to the synthetic ones.	Policies favouring the utilization of these products. Funding of research for the scale up of well established laboratory-scale protocols.
	The organic protein fraction of the waste/byproduct is valorized to bioactive peptides,		
	food ingredients or biopolymers while the lipid one is used for obtaining long-chain polyunsaturated fatty acids.		
- Industrial Processes and manufacturing	The ability to reduce, reuse and recycle mollusc shell waste for civil and construction engineering applications is an attractive component of integrated waste management scheme.	Valorization of a waste material that represent an environmental problem into biopolymers and biomaterial for construction	Recovery on market-scale.
	The organic fraction obtained from fish byproducts or by-catch can be exploited for biopolymer production		
Agriculture and Livestock	Grounded mollusc shells are used and marketed as buffer in acidic soils and feed additive.	These biogenic mineral have protein entrapped within their structure.	Recovery on market-scale.

Table 3 32 List of benefits and KEF for valorization of fishery

3.3.3.2 Gaps and enabling factors to address

Currently, the blue biotechnology sector in the MED area is in its infancy but it has great potential for development. This is owing to the availability in most countries of research groups, infrastructures and stakeholders. The sector needs support in terms of policies, national and regional funding and marketing operations besides of the investment for the development of specialized skills for cultivating novel microbes and isolate and characterize novel products as well as developing and optimizing large scale processes. Moreover, involvement of the companies/industry is strongly recommended in order to move from R&D stage to commercialization of innovative products.
Blue biotechnology sector is still in its infancy but potential of marine biotechnology to contribute to key societal challenges provides a strong driver for the sector that is also supported by the scientific advances related to sea ecosystem exploration and new products discovery. However, various barriers to the development of the sector still exist and include, among others, the technological limitations associated mainly to the limited capability to cultivate many microorganisms in the laboratory and/or to optimize the production/downstream processes at large scale. The following table 3-33 shows the identified gaps for each innovation potentials.

IPS	GAPS TO TACKLE	ACTIONS, APPROACHES AND SOLUTIONS
Micro and Macro Algae Farming and Exploitation (M&MAFE)	Policies	Policies
	Are not well developed and appropriate	Authorities should issue “ad hoc” regulation about different topics: microalgae cultivation and quality standards of algal biomass, access and use of genetic resources and sharing of benefits; decrease restriction concerning Novel Foods;
	Skills/human resources	Skills
	There is a need of interdisciplinary cooperation and of specific intersectorial training	Increase training course in each sector and at inderdisciplinary level
	Resource/funding	Resource/funding
	Resources are scarce at national level	Increase the calls on Blue Biotechnologies and bring them to the same level of fishing and aquaculture
	R&D (Knowledge and Technologies)	R&D (Knowledge and Technologies)
	Discovery of new species is necessary; PBR models or cultivation systems fit for very few algal species;	Implement business models based on the concept of Biorefinery: the establishment of regional pilot plants and small biorefineries could encourage and boost further investment.
	scale up is difficult and not performed until now in PBRs; growing conditions are difficult to control and the production is unstable and difficult to predict, the culture medium is submitted to external incursions: weather and temperature conditions, predator animals, zooplankton and macro algae, diseases and complex to understand and maintain; the biorefinery concept is completely missing and the extraction procedures are not optimized	Build the bridge between existing biotech entrepreneurs and environmental biotechnology and bring them closer to the enormous advancement of blue biotech, form alliances and mature the biotech clusters evolution. Create sectorial consortia.
	Marketing	Marketing
	The whole process is still costly; value chain integration is not optimal and is a key issue that inhibits investment at present; one of the greatest challenges is converting scientific discoveries and innovations into successful productive units; viability of the economic model is not known; for health and pharmaceutical products, a long process is required for the control; for biofuel, products are not in the market and it is expected not to occur before 10-30 years	Communication to stakeholders and publicity must be implemented for future developments in Blue biotech. Raise awareness of the consumer about Blue Biotechnology



IPS	GAPS TO TACKLE	ACTIONS, APPROACHES AND SOLUTIONS
MICROBES AND ENZYMES EXPLOITATION (M&EE)	Policies: In most of the countries, there is no policy/strategy dedicated to blue biotechnology including microbes and enzymes exploitation although there is high interest in the sector at R&D level.	Policies: development of policies/strategies for the support of the sector at national and European level and expecially to develop commercial applications.
	Skills/human resources: low availability of specialized skills for the development of innovative microbial cultivation; upscale and downstream process optimization as well as for rapid product identification/dereplication.	Skills/human resources: Knowledge on cultivation of new microbes and identification of new products requires integration of different expertise in order to support discovery and efficient large-scale production of bioactive molecules.
	Resource/funding: Funding resources specific to marine biotechnology are limited at national level in different countries like Italy, Cyprus, Croatia and/or are difficult to access	Resource/funding: need to increase the funding resources at regional and national level
	R&D (Knowledge and Technologies):In most countries, research activities are performed mainly by universities, spin-offs and research institutes. Marine microorganisms can be difficult to culture in laboratories due to specific conditions required and their production is often limited by low yields.	R&D: need of the support from industrial sectors
	Marketing: No/few marketing actions and communications about the application of blue biotechnologies in different sectors	Marketing: develop marketing actions for blue biotechnologies.
VALORIZATION OF FISHERIES AND AQUACULTURE BY-PRODUCTS AND WASTES	Policies	Policies
	In the next decade, stringent regulations should be implemented on the disposal, the classification and the storage of aquaculture by-products and wastes, while providing incentives for companies who use them.	Scientists should work out sustainable ways to refine by-products and wastes, and governments and industry should invest in using this abundant and cheap renewable resource.
	Skills/human resources	Skills/human resources
	Multidisciplinary skills are required to work in this blue biotechnology.	Chemical, biological and ecological expertise should be merged by specific courses.
	Resource/funding	Resource/funding and Marketing
	The funding is crucial for the realization of blue biotechnologies for the exploitation of aquaculture by-products and wastes. Actually there are not specific fund for applied researches.	Specific calls at regional, national and European level should be made.
	R&D (Knowledge and Technologies)	R&D (Knowledge and Technologies)
	Establishing a profitable, sustainable industry to exploit fisheries and aquaculture by-products and wastes is going to take creative chemistry and physics. It needs a sustainable fractionation method to separate proteins, enzymes, calcium carbonate and chitin — one that avoids corrosive or hazardous reagents and minimizes waste.	Policies on the definition of milestones for the exploitation of aquaculture by-products and wastes.
	Marketing	
	Every year, some 6 million to 8 million tonnes of aquaculture by-products and wastes are produced globally. The potential economic value is very high, by instance calcium carbonate can cost 100 € per tonne. Moreover, disposal of by-products and wastes can be costly — up to 150 $per tonne.	
	Transboundary cooperation	Transboundary cooperation
	Fishery and aquacultures are growing sectors. The blue biotechnologies necessary for the recovery and reuse of fisheries and aquaculture by-products and wastes, once acquired, can be implemented in all the countries having costs.	A cooperation among these countries, and not only, can speed up the achievements of specific scientific key targets.

Table 3 33 List of Gapsfor each IPs

3.4.4 Outlook and expected trends

Blue biotechnologies, defined as the use of marine organisms, part of them or their products, represent one of the 5 key sectors identified by the European Commission for the growth of the Blue Economy and a strategic line of research and development with different effects on productive sectors such as the pharmaceutical, cosmetic, nutraceutical and food sectors. In all the countries of the Med area, with exception of Albania (which did not deliver the fiche), the economy based on the Biotechnology sector is either well developed (e.g. Spain is second only to USA for the number of companies and Italy has 571 companies) or is increasing in importance, especially in the health and food sectors. Nevertheless, each country declares that the Marine, or Blue, Biotechnologies are less developed in comparison to the Red, Green and White Biotec; industrial level can be

summarized as follows. In Spain there is one innovative company, PharmaMar, one of the world leader companies in medicine production starting from marine micro-organisms, and other companies based on algae. In France the marine economy is mainly based on macro algae cultivation and on their transformation for food, cosmetics or phycocolloids extraction, but there are also companies based on cultivation/commercialization of microalgae, corals, sponges. In Italy there are companies of small and medium size as well as University spin off commercializing microalgae as nutraceuticals and there are few spin off on phytoremediation or pharmaceutical discovery and production;. There are several research groups working on the exploitation of marine microorganisms (bacteria) for the production of extremozymes, bioactive/antimicrobial compounds and in marine bioremediation but the activities are currently at low TRL. In Greece there are few companies using algae extracts or growing microalgae. In Croatia Blue Biotech are not developed however there are expertise, clusters and excellence centres in the biotech health sector which could boost the marine sector expansion; Cyprus is acquiring expertise through participation in EU funded projects.

All the countries could have access to funding deriving from the EU policies on the Bio economy and on Blue Growth, while national policies are at high level only in Spain, level is medium in Italy and France, low or absent in Greece, Croatia and Portugal, so that specific funding are generally declared to be scarce. Few countries have clusters or associations specifically dedicated to Blue Biotechnology but all have a number of them dedicated to the Bio economy.

Nearly all the countries can account on a high number of good-level expertise and human skills which were acquired in the course of many projects on the different aspects of marine biotechnologies (biofuel, bioremediation, microorganisms, algae or animal cultivation, biomaterials and so on). R&D level is therefore quite elevated and in most projects and studies a strong cooperation between research or academia centres and enterprises was accomplished. Facilities and equipment for marine-related researches are also well represented in all the countries and, although at the moment dedicated structure are not present, many of them could presumably host or contribute to development of biotechnology activities and pilot structures. The Med area thus appears ready to an expansion of the Blue Biotechnology sector given that the right policies and funding are provided and are adapted to the projects trends: important issues, coverage of a wide range of TRLs, multi-partner collaborative innovation

projects, increasingly significant budgets. The sector would need elaboration of coordinated national strategies at the Euro-Mediterranean level (cap, administrative simplifications, regulatory adjustment to facilitate the placing on the market of developments, investment incentives ...) and establishment of an observatory of the sector at the European level.

Key points to accelerate the commercial development of Blue Biotechnologies are:

- Improvement of genetic and biologic knowledge about marine biodiversity
- Improvement of technologies (bioactive molecules study, production process, molecule synthesis)
- Cost-effectiveness and energetic efficiency (reducing production costs)
- New applications (pharma, food, industry, energy...)
- Establishment of collaborations between companies and R&D institutions
- Legislation (especially on environmental impacts ofindustrial activities and products)
- Public knowledge and perception

The research and development activities on blue biotechnology have a great value to generate innovative products and processes. This occurs in the control and reduction of the environmental impact of production activities, the protection of the sea and the rehabilitation of contaminated marine areas, representing a total of strategic sector for the sustainable growth of economic value in harmony with the preservation of natural one.

Taking into account the strategies adopted and the needs identified, the high potential of innovation of blue biotechnological areas can be identified as follows:

- Development of new drugs from marine (micro)organisms;
- Use of marine products for the development of new food supplements;
- Use of marine products for the development of new cosmetic products;
- Development of biotechnological solutions for the control, protection and recovery of contaminated marine environments;
- Sustainable use of marine biomass and enhancement of waste utilization in the fishing chain for industrial applications.

These identified areas of blue biotechnology are characterized by different technology readiness levels (TRL). Therefore, the development strategy of these areas should include support for demonstration projects of innovation with the construction of prototype plants in key identified areas, on which they will then foresee the development of high innovation and technological innovation poles.

Specialization, integrating research activities and feasibility studies to verify the industrial impact of the new skills should be implemented. Another key is the support to industrial and experimental research in such a way to make operational a large number of researches that have real repercussions on the business world responding to the need to increase European and national competitiveness in the international arena, activating activities to support the industrialization of innovative technologies. Blue biotechnologies also require the provision of incentive mechanisms of development through:

- The enhancement of existing blue biobanks i.e. collections of marine (micro) organisms as well as metagenomes/genes and their implementation;
- Greater harmonization and standardization in the methods of data generation resulting from high-throughput technologies, currently available;
- The improvement of the automation of screening procedures for marine products and compounds;
- The development of new data mining tools and exploitation of research results in terms of technology transfer and creation of spin-offs and start-ups.

3.5 COASTAL AND MARITIME TOURISM

3.5.1 Introducing the sector and its subsectors

The Coastal and Maritime Tourism sector is very wide, since it potentially includes a variety of activities, products and services, both onshore and offshore. The sector is highly relevant for most of the basin, with expected increasing trends and a challenging sustainability issue. It includes different subsectors, as coastal and maritime tourism offer and products, improved sustainability of coastal and maritime tourism, leisure boating, yachting and cruising, underwater cultural heritage, recreational fisheries, coastal protection and adaptation to climate change, or environmental monitoring addressing tourism uses of coastal areas.

MISTRAL analysis focused on the following subsectors:

- Coastal & Maritime Tourism Offer and Products (C&MTOP)
- Improved Sustainability of Coastal & Maritime Tourism (ISC&MT)
- Leisure Boating, Yachting and Cruising (LBYC)
- Underwater Cultural Heritage (UCH)
- Recreational Fisheries (RF)
- Coastal Protection and Adaptation to Climate Change (CP&CCA)
- Environmental Monitoring addressing tourism uses of coastal areas (EM)

Coastal and Maritime Tourism Offer and Products (C&MTOP): include all activities to develop and manage the wide range of tourism offer and products in place and of interest for future developments.
The Improved Sustainability of Coastal and Maritime Tourism (ISC&MT): sub-sector identifies specific activities, services and technologies aimed at making coastal and maritime tourism more sustainable (e.g., reduction of carbon footprint, consumption of resources, water and energy, reduction in waste production, monitoring and management of tourism fluxes, etc.). Under such sub-sector, the use of Big Data analytics and Information and Communication Technologies can be highly relevant.
Leisure Boating, Yachting and Cruising (LBYC), Underwater Cultural Heritage (UCH) and Recreational Fisheries (RF) refer to specific types of tourism and offer. LBYC shall include also activities related to the construction and/or preparation of leisure boats. The recreational craft sector crucially depends upon sea quality, access to marinas and availability of repair and maintenance services. According to estimates of the European Boating Industry, 36 million of Europeans participate in boating activities. Cruising is the fastest growing sector of the European maritime economy and it currently employs almost 350.000 people in Europe. The cruise industry is composed by large enterprises due to economies of scale and the need for laboratories and testing facilities. UCH is also very important. Following the definition by UNESCO "underwater cultural heritage encompasses all traces of human existence that lie or have lain underwater and have a cultural or historical character". The main issues and research trends concerning underwater cultural heritage are technological developments for underwater activities, preservation of archaeological artefacts and the creation of censuses and museum for knowledge dissemination. Then, RFare considered among the services delivered by marine ecosystems that can create employment opportunities and generate economic income and revenues, particularly in the most marginalised coastal area (FISA 2015). RF comprise activities that exploits marine living aquatic resources for leisure or sport purposes, from which it is prohibited to sell or trade the catches obtained (FAO 2017). The amateur and the sport angler is typically a customer, which contributes to coastal economies by purchasing fishing supplies, travelling to fishing sites and relate customs (FISA 2015). In addition to economic connotations, recreational fisheries have significant psychological health and social benefits (Griffiths et al. 2017), such as non-use value (altruistic, bequest and existence values) and option value (potential for future use). Moreover, RF fulfils a valuable role in raising environmental awareness of wildlife and the environment (Hickley et al. 1998). Another category close to RF is the tourism fishing, exercised by professional fishers, a promising scenario for diversification of fishing communities into tourism-related activities (EU 2014). Therefore, RF are attractive touristic activities with high social, economic and environmental potential.
last two sub-sectors refer to activities, services and technologies aimed at allowing and safeguarding the possibility to have and maintain tourism activities in a certain area, protecting the coast from flooding and erosion, Coastal Protection and Adaptation to Climate Change (CP&CCA), and monitoring the environmental quality (water, habitats, also through Earth Observation techniques). In them, the use exerts its pressure, Environmental Monitoring addressing tourism uses of coastal areas (EM). Last one may be connected and complementary to OSME under Maritime Surveillance. The European experience in the implementation of legislation aimed at protecting the sea and (Boyes and Elliott, 2014) is long standing. Currently, EU issued more than 200 directives, regulations and other forms of marine-related policies (Beunen et al., 2009). These include the Marine Strategy Framework Directive (MSFD) and the Maritime Spatial Planning Directive (MSP), whose goals should be to improve marine environmental sustainability by promoting sustainable growth in industry. Particularly, these two directives aim at creating, an operating framework for achieving the Good Environmental Status (GES) (Boyes et al., 2016; Maccarrone et al., 2015; Schaefer and Barale, 2011), thus contributing to the promotion of a coordinated decision-making process, as envisaged by the Integrated Maritime Policy (Meiner, 2010).

3.5.2 Coastal and Maritime Tourism in the MED area.

The level of maturity of the sector is here described for each country. A detailed description of single attributes (Research infrastructures, Funding agencies, Target groups and stakeholders, Relevant Projects, etc.) has been collected at country/regional level by MISTRAL partners and here summarized.

3.5.2.1 Albania

Albania is a rather new tourism destination. It has 427 km of seacoast, with the Adriatic running from the Montenegro border south to the Bay of Vlora, where the Ionian Sea begins. Thanks to its impressive natural environment and a variety of attractions, Albania offers opportunities for very different types of tourism including cultural and natural tours, hiking, biking, rafting and many other activities in the frame of rural tourism, sports and adventure tourism, nature tourism, coastal tourism, etc. Albanian tourism is characterized by complex administrative and legislative framework, as well as the lack of reinforced state level co-ordination and poor statistical data. Any one of these is challenging, but combined represent real obstacles to potential growth.

3.5.2.2 Croatia

The total surface area of the Republic of Croatia is 87.661 km2, out of which 56.594 km2 covers land area and 31.067 km2 the sea. The Croatian islands situated in front of the eastern Adriatic coast represent the second largest island group of the Mediterranean. In total, there are 1.185 of them, out of which 47 inhabited; 651 uninhabited; 389 rocks and 78 reefs. The islands occupy 3.259 km2, i.e. 5.8 % of the Croatian territory total surface and contribute significantly to the increase of the territorial sea area. Adriatic Sea is a major and important area of the Republic of Croatia covering up to 35.4 % of the total surface, both in terms of nature and environment protection, as well as the preservation of biodiversity and ecosystem.

In relation to a large number of diverse activities operating in it such as maritime transport; tourism and nautical tourism; economic activities related to fisheries and energy production; cross-sectoral and interdisciplinary approach is a necessity. The most important difficulties of environmental protection, and thus the sustainable development of the Adriatic are lack of urban and industrial waste water treatment facilities, surplus and operational marine pollution from sea structures, oil and oil refinery crashes, foreign marine microorganisms and pathogens entering marine environment, fishing and overfishing, and above all exaggerated construction on the coastal area. The Republic of Croatia, along with other member states of the Mediterranean Action Plan (MAP), has adopted the Mediterranean Sustainable Development Strategy, which pays special attention to the sustainable development of the Mediterranean with its sustainable management of seas, coastal areas and marine resources.

The population of the Republic of Croatia (Census 2011) is 4.284.889 out of which 33 % dwells on the coastal line occupying seven coastal counties out of 21. The spatial utilization rate is considerably higher in the continental (68% of the population – 94.40 inhabitants/km2) than in the coastal part (32% of the population – 57.76 inhabitants/km2). The new settlements, which are under a continuous process of building, occupy nearly 15% of the total coastline.

The diversity of the coast relief, favourable climate and biodiversity of the mountainous regions, on which slopes the inhabitants of the Adriatic coast live, are very attractive to domestic and foreign tourist whose visiting numbers are constantly growing year after year, for the centuries. However, developmental constraints and increase of building objects for touristic accommodation have emerged with new challenges for legal regulation improvement, primarily aimed at protecting species and habitats and preserving the uniqueness of the world biosphere reserve such mountain Velebit and protected sites of nature and cultural heritage. Therefore, the value, diversity and uniqueness of Croatia exceed its local and national frameworks. There are nine categories of protection of nature and environment in the Republic of Croatia. In 2015, there are 417 areas in different categories protected which accounts for 8.58% of the total area of the Republic of Croatia, i.e. 12.25% of the land territory and 1.94% of the territorial sea. The majority of protected areas are nature parks (4.56% of total state territory).

Up to 36.67% of land territory and 16.39% of the coastal sea is under NATURA 2000 protection. The network consists of 571 polygon conservation areas important for species and habitat types (POVS), 171 points sensitive conservation areas of species and habitat types (mostly caves) (POVS) and 38 polygon conservation areas important for birds (POPs).

Due to the mentioned attractants in a combination with clean Adriatic Sea and plenitude of islands, Croatia has a large potential for touristic development increase. The development difficulty of the economy in the Croatia, in general, is poor diversification of the activity of small and medium entrepreneurship. Existing ones, in majority of cases, are not strong enough to trigger economic development. Unlike that, tourism, which involves not just a significant number of SMEs, but also a large proportion of residents, contains the potential that can prevent the trend of job losses and attract professional workforce in the area of need. The uniqueness and tourist attractiveness of the coast and the hinterland can be directed to the extension of the tourist season as well as to the diversification of activities within the tourist sector. As a guide to the development of tourism, the Strategy of Tourism Development supports numerous economic activities through development priorities and measures.

3.5.2.3 Cyprus

TTourism market, one of the largest economic sectors in Cyprus, has experienced substantial growth over the last five years, with tourists reaching 3.2 million in 2016. It is noteworthy that whenever tourism in Cyprus is examined, the overwhelming majority of the tourist product of Cyprus is of coastal and maritime nature. As eloquently put in the 2017 Cyprus Tourism Strategy Final Report by THR “Cyprus’ beaches constitute one of the highest value tourist assets of the country, with 350 kilometres of coastline and the cleanest water in Europe.” The European Commission has awarded 59 Cyprus beaches with Blue Flags. Nonetheless, it is true that Cyprus shows a wide array of historical and cultural attractions, of which 125 are easily accessible due to the country’s size. UNESCO has recognized three of them as World Heritage Sites.

Cyprus’ tourism industry has been honoured with numerous prestigious awards, spanning the sustainable Destinations Global Top 100, an initiative of Travel-

Mole.com, VISION on Sustainable Tourism, Totem Tourism and Green Destination titles bestowed to Limassol and Paphos in December 2014. In addition, the Cyprus Tourism Organisation is proud to be the winner of the Silver Award as the 'Best Destination for Responsible Tourism', which was announced at the prestigious World Responsible Tourism Awards ceremony. This event was held on the 4th of November 2015 at the World Travel Market, the leading global event for the travel industry.

3.5.2.4 France

In France, the coastal tourism represents 7.1% of the GDP and Sud PACA and Occitanie regions provide a significant contribution to this part. These two regions have an important potential of attractiveness mainly thanks to their coastal areas. They have not the same dynamics; indeed, in Occitanie region tourism is more of national provenance than Sud PACA region where it is more an international tourism. They have many attractive features with Marine Protected Areas, significant cultural heritage, many marine activities that could be developed in these territories (with already some strengths well exploited such as boating or water sports depending on the region).
To sum up, the recently trend in the coastal tourism is due to the public awareness to preserve the environment and the desire to strengthen the knowledge about cultural heritage. The technology can provide an answer to the trend by providing new services and offers.
These last few years the importance of the environmental preservation increase in the tourist strategies, the coastal area needs to be attractiveness with a good water quality, ecological amenities for tourist infrastructures and a wide variety of activities to attract more and reduce the pressure on the coastal ecosystem.

3.5.2.5 Greece

As shown by the World Tourism Organization, tourism is one of the key components of economic growth. An overall view of the course of international tourism, despite any seasonal and local fluctuations, shows remarkable resilience and shows a steady increasing trend. It is estimated that this long-term trend will not change, and tourism will continue to grow throughout this century contributing to the communication and understanding of the societies and cultures. Particularly for Greece, the analysis of temporal data reveals the long-term stability of tourist revenues, which showed resilience during the great economic recession, suggesting that tourism is a promising investment of "low risk" for the country's economic development.
Coastal and maritime tourism is a significant sub-sector of both the wider tourism sector and the Blue Economy. Many coastal economies are dependent upon their tourism activities. In addition to the direct income and employment that tourism brings to coastal communities, it can provide additional benefits that include investment and infrastructure (EU, 2016a). Greece is a country blessed with 16.000 km of coastline and over than 3.000 amazingly unique islands. Her idyllic climate and friendly seas make this country an ideal destination for yachting and water sports of all kinds[26]. The intensity of tourist activity seems to be in line with the natural landscapes and the geographical distribution of its cultural resources throughout the country. This spatial patchiness requires actions for its balanced development in a regional development context. Besides, Greece must quit from the annual time limits of April to October, taking advantage of its archaeological sites, its cultural heritage, history, religious tourism, traditional tastes and more, in order to stimulate the market, especially in the islands. This would benefit the activity of the entire grid of the terrestrial and maritime tourism, the employment of workers and the national economy in general.
Coastal tourism is massive, however, derived from laissez-faire market forces. Nevertheless, a framework for Spatial Planning and Sustainable Tourism, as a means for improving decision-making in relation to the use of natural resources and space and their allocation between different sectoral or user's interests on the basis of clear assessments of maximum carrying capacity, after two failed attempts (2009, 2013), is notably missing today. The high and increasing volumes of visitors, against a limited carrying capacity of facilities and environment, are often putting pressure on local systems (e.g. waste, water, energy). Furthermore, local management systems are often not equipped to manage such stress, resulting in even greater negative environmental externalities and severe damage of the sustainability of the sector's performance in the future.
In recent years, there is an increasing interest in alternative forms of vacations compared to the mass tourism type having less negative consequences on reception destinations without any reduction in the positive financial results. Modern tourism is influenced by changes in human values, lifestyle and consumption patterns, and is characterized by a shift from "the service economy to the economy of experience", while being at the same time strongly influenced by the technological rapid development.
Despite, however, the massive modes of coastal tourism and the above changing

[26]https://greek-marinas.gr/en/gma-profile/

values and new capabilities, maritime tourism in the form of recreation and tourism in Marine Protected Areas (MPAs) and nautical tourism remain underdeveloped, although they are ideal for Greece. MPAs are unique places established with different purposes, namely to protect the environment, preserve a cultural, historic or archaeological site such as ancient shipwrecks, or ensure sustainable production of a resource. Recreation and tourism in MPAs, nature and cultural, combined with nautical tourism are an important niche market with a large potential for sustainable jobs and growth. The upgrading of maritime tourism in Greece requires enhanced skills, technology and innovation, accessibility, quality and environmental sustainability.

3.5.2.6 Italy

Coastal and maritime tourism offer and products involves all the economic activities related to offers and products in coastal regions of the European Union such as nautical sports, green tourism, courses for underwater excursions. Italy has a coastal extension of 7.600 kilometres and it is among the top five world tourism destinations and the second tourism destination in maritime areas in the European Union after Spain. Almost two thirds of total tourist arrivals in the Adriatic and Ionian regions are in Italy. Coastal and maritime tourism has historically been mass-type, especially in the Northern-Adriatic region. Coastal and maritime tourism in Italy is characterized also by a high degree of seasonality. A crucial issue of this subsector is that its development heavily depends upon the quality of the seawater. At the same time, uncontrolled tourism could be a threat to the integrity of the sea environment because mass tourism deteriorates bathing water quality. Italian public and private research institutions actively participate in research projects and technological innovations in the fields of sustainable growth and the analysis of the externalities of coastal and maritime touristic activities on the environment and landscape.

Another important sector of coastal and maritime tourism is leisure boating and yachting. Italy is the third Member State for recreational crafts - after Sweden and Finland - and one of the main destinations for leisure boating along with Spain, Croatia and Greece. Numerous technical and manufacturing maritime districts have operated in Italy since the XIX century in both the Adriatic and Tyrrhenian coasts. Most of the firms have small-medium dimensions, with the exception of the district of Genoa, and the sector produces almost 20 billion euros in annual revenues.

Concerning cruising,Fincantieri, whose operability dates back to the end of the XVIII century, is a leader shipbuilder in Europe and among the largest shipbuilders in the world. The Italian group is a recognized world leader in cruise ships design and construction with approximately 19.000 employees in Italy and abroad. Almost 32 million passengers disembark every year in Europe, and Greece and Italy are the top two destinations. Thanks to its milder weather, the cruise sector in Southern Europe is characterized by less seasonality with respect to both traditional coastal and maritime tourism and the segment of the Baltic Sea. The main issues at the European and national level are the considerable ecological pressure of cruises on water pollution and litter production: environmental issues related to the cruise sector are indeed the main topics of scientific and technological research in the field.

At national level, an important reference for the transport sector represented by the National Technology Cluster for surface mobility “Trasporti Italia 2020”. Some of its territorial institutions, such as for example mare FVG, include maritime tourism among its activities.

Underwater cultural heritage is also very important. Italy has a great potential of attractiveness and the Ministries of Cultural Heritage and Education, University and Research finance several university degrees in underwater archaeology and national and international research projects on the preservation and promotion of the national underwater heritage.

The last two sub-sectors refer to activities, services and technologies aimed at allowing and safeguarding the possibility to have and maintain tourism activities in a certain area, protecting the coast from flooding and erosion (Coastal Protection and Adaptation to Climate Change (CP&CCA)) and monitoring the environmental quality (water, habitats, also through Earth Observation techniques).

In Italy, 13.000 potentially contaminating sites have been identified. Among the marine-coastal areas characterized by the greatest anthropogenic impact, some particularly polluted sites (so-called national interest sites) are established, covering about 1.800 square kilometres where the pollution of soil, sub-soil, surface water, groundwater and marine waters is so extensive and serious to represent a dramatic hazard for both public health and environment. The management of sediments in these sites is particularly complex, mainly due to the large volumes of polluted soils/sediments, the relative high level of contamination, and the lack of an appropriate legislation and specific guidelines, as well as the considerable economic costs required to operate remediation procedure.

A further, and generally underestimated

specific aspect of risk associated to these highly contaminated territories is that of natural hazards (earthquakes, landslides, hydrological instability, etc.) which could provoke additional effects on mechanisms of widespread re-distribution of contaminant and impact on a wider range of environmental compartments with unforeseen effects on the ecosystem and human health safety.
The remediation of marine-coastal environment characterized by the presence of pollutants of anthropogenic origin is therefore of strategic interest for the Italian blue growth system. And this is not only in relation to the enormous extent of marine-coastal spaces currently unavailable for the development of blue economies directly related to the marine system, but also with reference to significant damage to the health of populations living in neighbouring areas.
However, the interest in the sustainability issue for contaminated historical sites has not been limited to the sole initiative of each Member State. European Union has strongly contributed to the development and dissemination of the sustainability approach both by prescribing the adoption of shared and "sustainable" solutions in some of the most recent Environmental Directives[27] and by promoting and financing many research projects on contaminated sites and brownfields.
These projects contributed to create a network of knowledge and transnational research that helped to focus on the problems and to influence the European environmental policy. An updated estimate (Confindustria, 2016) indicates that the remediation phase of the most polluted sites requires an investment of about 10 billion €. In addition, re-industrialization processes, following the remediation phase, would lead to an increase in the production level of more than 20 billion € over a period of five years and in the total added value of about 10 billion € linked to a planned increase of about 200,000 standard work units, i.e. jobs, (Confindustria, 2016). Investments on direct and indirect (conversion of uses after remediation) environmental remediation could then provide a definitely positive economic impact with an estimated doubling of incomes and important impact on divers job sectors.
When considering the current economic crisis and the evolving political, social and environmental conditions in the Mediterranean Region and in Italy in particular, it becomes apparent that all the multidisciplinary actors from different countries need to build an ideal environment for constructive dialogue. It also lay the groundwork for conditions that allow societies, economics and policies to attract investments while, reconciling tensions and balancing economic growth, social implications and environmental conservation.
Tackling climate change, Italy coasts is one of the global hotspots for global warming, understanding ecosystem function, managing sustainability, all require the most effective initiatives and strategies. Hence, the EU Blue Growth initiative represents a long-term strategy to support growth in the maritime sector as a whole by harnessing the untapped potential of Europe's oceans, seas and coasts for the creation of "blue" jobs and economic growth.

3.5.2.7 Spain

More than 82 million international tourists visited Spain during 2017, a year that closed with an increase of 8.9% in the number of visitors and a total expenditure of 87.000 million euros, that is, 12.4% more compared to previous year. According to data provided by the National Institute of Statistics (INE) and Turespaña, Spain occupies the second international position in the number of tourist arrivals, overtaking the United States and having France as a leader.
Not only has the number of visits improved. The 82 million tourists in 2017 have spent 12.4% more than they have spent their predecessors, with a total of € 87.000. It is estimated that each tourist increased their expenditures by more than 3%, which represents an average expenditure of € 1.061 during the stay.
During the first half of 2018, Spain has already surpassed 28.5 million tourists. This figure, compared to the previous year, represents an increase of 6% according to the latest FRONTUR figures.
Concerning just the MED area of Spain, figures are quite significant about tourism importance. We are talking about more than 21.300 lodging establishments, of which about 5.000 are hotels, ready to accept almost one million travellers. In fact, there have been 185, million nights contracted, for average stay of 5 days. There are 1.637 beaches in MED zone, of which only 329 have no infrastructure on the beach, and about 500 have all the infrastructures already in place. There are 160 areas appropriate for diving and another 113 for surfing. Sport ports are 174, for more than 80.000 vessels, but we have to add almost 800 beaches where anchoring is possible. Recreational fishing licenses grow up to 455.000.
Finally, we have in Spanish Mediterranean coast 2.210 cruising ships that give leisure to almost 6 million people every year.
These figures indicate a very mature touristic sector, and it is true that is growing continuously since many years ago. Lately even faster, due to the situation of North African countries which instability in terms of security and services is benefiting Spanish destinations, but under these circumstances lies a continuous improvement and growth of infrastructures. Nevertheless, there is still margin to improve, in special with new businesses, new packages and new activities that up to now have not been enough put in value. Activities like fishing-tourism, packages including "sun & beach" and cultural and ethnological tours or businesses like navigate for photographing dolphins can strongly improve the quality and quantity of tourism in these areas.

3.5.2.8 Portugal

In 2017, the number of international tourist arrivals was 1.323 million in the world, corresponding to an increase of 84 million when compared with the previous year, according to the data available from the World Tourism Organization. This outcome stood for a 6.8% increase in 2017, reinforcing the growth in previous years (+3.7% in 2016). Europe kept being the preferred destination of international tourists, concentrating the majority (50.7%) of arrivals (671.1 million), benefiting from an 8.4% increase in 2017, i.e. 6.1 p.p. above the rate recorded in the previous year[28].
Portugal is a coastal nation in south-western Europe, located at the western end of the Iberian Peninsula, bordering the North Atlantic Ocean and Spain (on its northern and eastern frontiers: a total of 1.214 kilometres). The Portuguese territory also includes the archipelagos of Azores and Madeira), which are strategic islands along the North Atlantic. The extreme south is not too far from the Strait of Gibraltar, leading to the Mediterranean Sea. In total, the country occupies an area of 92.090 square kilometres of which 91.470 square kilometres is land and 620 square kilometres water. Portugal has a coastline of 1.793 km[29] .
In 2017, Portugal was considered the 14th (13th in 2016) most competitive country within the tourism sector according to the Travel and Tourism Competitively Index (from the World Economic Forum). As for 2017, tourism indicators support that, showing a growing trend. In 2017, there were 20.6 millions of guests, an increase of 8.9% in comparison to 2016. In addition to this and for the first time foreigners outnumbered the Portuguese population since Portugal received 12.7 million of foreign visitors. As usual, the main inbound market was the United Kingdom (9.3 million of non-residents overnight stays), growing by 2.8%30. The German market (5.6 million) grew by 11.3% while the French and the Spanish markets (each one around 4.0 million) grew by 5.2% and 7.0% respectively . This increase has also translated into revenues, with an increase of 19.5%, totalling 15.2 billion euros. Main markets being United Kingdom, France and Spain.

[27]Water Framework Directive 2000/60 / EC, Directive 2004/35 / EC
[28]INE (2018). Estatisticas do Turismo 2017. Retrieved 27 October 2018. www.ine.pt
[29]Central Intelligence Agency (2018). "Portugal: CIA World Factbook". Retrieved 28 October 2018. https://www.cia.gov/library/publications/the-world-factbook/geos/po.html
[30]INE (2018). Estatisticas do Turismo 2017. Retrieved 27 October 2018. www.ine.pt

3.5.3 Identifying innovation potentials and key enabling factors

3.5.3.1 Opportunities and benefits

In the Mediterranean, tourism is often considered as a mono-activity for many territories. This has brought to a rapid economic development in those destinations but it has also dramatically influenced social and environmental assets. Today it is urgent to link and harmonize tourism activities up with other sectors as an instrument to mitigate the impacts of crises in the territories while ensuring economic growth.
The development of tourism requires many issues. These last few years the importance of the environmental preservation increase in the tourist strategies, the coastal area needs to be attractiveness with a good water quality, ecological amenities for tourist infrastructures and a wide variety of activities to attract more and reduce the pressure on the coastal ecosystem.

MISTRAL analysis found the following Innovation Potentials as opportunities for a sustainable implementation of the sector. Innovation Potentials, IPs, are here summarized in Table 3-34.

1. **Big Data, digitalization and ICT services for active living in coastal area**
2. **Sustainableleisureboating**
3. **Smart management of the coastal infrastructure and extreme events**
4. **Integrated and Sustainabletourism**

IP NAME	IP DESCRIPTION	CHALLENGES AND BENEFITS
Big Data, digitalization and ICT services for active living in coastal area	big data and ecosystem services for a sustainable exploitation and monitoring of the marine environment;	In Coastal maritime tourism offer and products, tourism a mono-activity in many territories. This led to a rapid economic development in those destinations, as well as negative social and environmental impacts.
	virtual and augmented reality (enriches the tourist experience) when diving, when visiting a museum, etc., smartphone applications (linked to participatory science), etc.	The tourism offer is becoming more diversified and digitalized to include new segments while, at the same time, being sustainable and inclusive for the resident population. Great efforts are on their way concerning networking through social networks that looks to be very important in the near future. New data have been obtained regarding brand building elements in tourism destination management through Facebook groups and pages
	Robotics: monitoring of coastal zones, acquiring data, collecting waste, etc.	
Sustainable leisure boating	Technology trends in the leisure boating and cruise sectors point to the development of equipment machineries and materials to prevent and reduce the negative effects of human activities on the natural environment	Research in the tourism sector is tackling environmental issues, in particular waste reduction, soil erosion and sea pollution due to the increased flows of tourists and coastal and maritime activities.
Smart management of the coastal infrastructure and extreme events	This IP includes aspects aimed at protecting the environment, at the border between coast and sea, following a holistic approach. Aspects:	Because the potential for tourism development is high, public policies and private actors have made it is essential to link and harmonize tourism activities up with other sectors. This complementarity between various sectors must be sought to mitigate the impacts of crises in the territories. Thus, such a process would decrease the relative share of tourism in local economies, allowing tourism to continue to grow.
	from defence of coastal system to geological settings; from development policy of inland regions to monitoring nets of flowing basins, transitional environments and coastal waters; from quality control of pollutants loading to coastal system to depuration and management of second-hand waters; from control in maritime transports to the protection of coastal habitats and defence of marine biodiversity through the establishment of Marine Protected Areas (MPA); Including Monitoring and Observing Sensors and Systems for effective planning and management	
Integrated and Sustainable tourism	· Regarding hospitality, research trends are connected to environmental concerns through water and litter cycles, reduction of food waste, reduction of plastic bottles, soaps etc, linked to Circular Economy principle;	Nowadays more than ever, the Mediterranean tourist destinations often suffer from overcrowding, exerting too much pressure on land and natural resources, whether from an environmental or social point of view. A new type of tourism needs to be defined in a more eco-friendly manner and with more consideration for local populations.
	· Reducing the seasonality;	
	· By designing products that both preserve the local areas' authenticity and take into consideration their populations	

Table 3 34 List of Innovation Potentials among MISTRAL consortium

3.5.3.2 Gaps and enabling factors to address

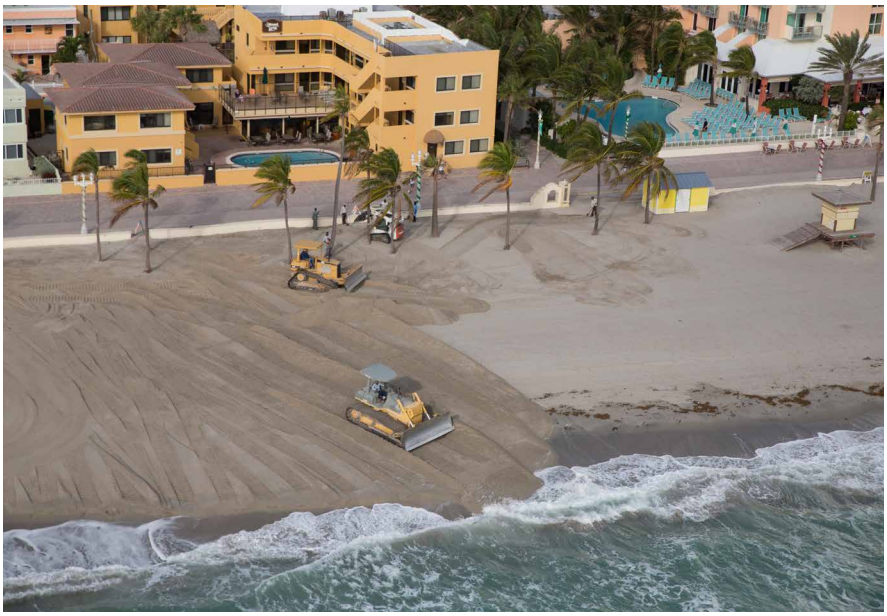
The table below summarizes the key elements associated to the implementation of the Innovation Potential in the Mediterranean scenario. Main aspects are related to political framework, technological readiness and social acceptance. Funding remains a critical aspect in all the innovation potentials as well as transboundary cooperation.

IP NAME	ENABLING FACTORS
Big Data, digitalization and ICT services for active living in coastal area	R&D: development of artificial intelligence capable of identifying human users, learning their behaviours and creating representations of their environment; mobilize innovations around the digital (smartphone application development, augmented or virtual reality, etc.).
	Policy: action plans and cooperation for Sustainability and Environment Protection
	Market and Social acceptance: contribute to strengthen the value of the territory with a wide offer more attractive for different kind of tourism; Digital platforms to promote and commercialize tourist destination and tourist experiences;
	Skills: need of a better integration of competencies between tourism and digital technologies
Sustainable leisure boating	Policy: harmonisation of rules and regulations relating to licenses and boat safety equipmen; sustainable zoning and common technical standards for marinas (e.g. operational, safety and security standards), end-of-use boat (EUB) management practices and resource efficiency and circular marina and boating concepts of various types (a first concept consists of increasing renewable energy sources in marinas and on board yachts);
	Need for a framework for Spatial Planning and Sustainable Tourism, as a means for sustainable zoning and embedding marina developments into the surrounding socio-economic-environmental context;
	Transboundary cooperation: Protection of maritime areas is a challenge in a cross-border and highly frequented touristic area;
	Skills: Need for training, certification and licence of professional and private skippers in harmonisation and mutual recognition across EU Member States and third countries;
	R&D: In terms of offer, facilitate navigation to novices, with easy-to-navigate or even autonomous vessels and the adaptation to current consumption patterns with boat sharing or offers for the boater via digital applications are interesting levers; increasing use of ecological moorings, sometimes including systems having a positive effect on reduction of atmospheric pollution of cruise ships (LNG, dock connection, use of scrubbers, etc.); new designs for marinas, boats, equipment and marina services integrating eco-design and adapted both to meet the needs of older boaters and to attract younger people and families, other innovative coastal facilities and maritime routes as well as networking.
Smart management of the coastal infrastructure and estreme events	Policy: use of Marine Protected Areas to foster the frequency of environmental monitoring to preservation; improve and innovate the cooperation in coastal observatories in Europe by implementing the coastal part of a European Ocean Observing System; harmonize regulation for the good quality of waters, habitats and biodiversity ; include specific climate plans;
	Skills and Social acceptance: integration between different skills and disciplines (such as engineering, chemistry, biologists and survey companiespromote data analysis and management;
	R&D: The transformation from data to knowledge is essential to engage non-technical end users that generally are not able to use raw data. It is important to implement in the Marine Observatories some feedback mechanisms between support technicians and the scientists team (and vice versa) to keep the Marine Observatories functioning and efficient;
	Resource founding: Funds come from public authorities. New business models might be investigate to finance the monitoring of the environment, by incomes of tourist activities for instance.
Integrated and Sustainable tourism	Policy: Policies and regulation, at local, national or regional level, are essential to support the development of sustainable tourism (i.e. through sustainable destination management, environmental taxes, climate and biodiversity plans, etc.); to implement laws and regulations to frame and reduce the potential impact of tourist activities at International, European or national level and to reach a good environmental status (MSFD, Barcelona convention, etc.);
	Funding: all tourism actors could be involved to finance the development of new products and services less impacting for the environment;
	R&D: need to study carrying capacity: assessment of tourism attendance, flows, socio-economic impacts, ecological disturbances, etc.; implement water-related technologies (reuse, treatment, etc.) and waste reduction (new materials to reduce the impact in the environment, collection at sea, recovery of waste, etc.) are indeed carriers of innovation.
	Use the participatory sciences are more and more used to involve tourists in the management actions of the environment and supports the work of coastal managers.
	Social acceptance: raising awareness as measure to mitigate the impacts;

Table 3 35Enabling factors for the development of Coastal and Maritime Tourism Sector

3.5.4 Outlook and expected trends

Growth of tourism has been intense in the near past for the Mediterranean region according to MISTRAL Countries, with rates well above those of the general economy for arrivals and receipts. The sector has become a pushing force for regional economies, perhaps one of the few activities with significant growth since the 2009 economic crisis shock. In general, it has been identified that tourism contributes a relevant share on country GDPs, around 10-15%, creating significant employment levels. It also opens job opportunities for woman and young people, all above the mean of the economy. Anyway, the unscheduled economical growth led to a negative social and environmental impact, given to the increasing overcrowding of coastal areas and resorts, or to a non-adequate management of activities, resources and territories. In the future tourism-based economies may collapse in too degraded areas in terms of environmental quality and services provided by ecosystems, or because those destinations no longer possess the natural and landscape assets that made them attractive to be visited by the tourists and afford the correspond expenditure. But, as a feedback effect, coastal and maritime tourism highly depend on good environmental conditions and in particular on good water quality (fresh and seawater). For all these considerations, new trends have to be implemented to maintain the sector productive while answering to environmental and social requirements. Thetransition will focus on the relationship between the ecosystem and tourist activities by developing an adapted tourist offer based on cultural heritage and natural assets. Today researches are oriented on the carrying capacity of the coastal ecosystems in order to help the improvement of the activities distribution. Technology is considered necessary to provide solutions to reduce the impacts and diversify the activities. The use of ICT is an important vehicle to develop new offers, for instance it allows to enhance the experience and sometimes to involve tourists in collecting information (participatory science) and foster enhance raise awareness. Protection and Monitoring is gaining a central role giving the future shape of the sector. Additionally, main efforts should be centred on formative actions defined at official secondary and university levels.
Tourism activities show important interconnections with other sectors of the economy, thus multiplying effects, direct plus indirect, of tourism demand important for MED economies, and particularly for the related industries. For instance,



the action undertaken by the European Commission on Single Use Plastic (that ban on selected single-use products made of plastic) as part of the EU Plastics Strategy, will set the basis for a fast change in approaching both coastal and Maritime Tourism. Pilot actions have been already undertaken to test the economic feasibility of new touristic models in response to the new directive. In 2019, the BLUEMED Initiative introduced the pilot action “BLUEMED Pilot for a plastic-free, healthy Mediterranean”with the aim to facilitate the exchange of new good practices also useful for the Touristic Sector. Concluding, the management of tourism is crucial and requires multiple synergies. Research trends are supporting different aspects in coastal sustainability and are aiming to the implementation of integrated plans for the protection of the coastal marine environment, following a holistic approach. These plans usually include a wide set of aspects: from the protection of the coastal ecosystem to the corresponding local geological settings; from the quality control of the pollutants load to the coastal system recovery; from the control in the maritime transports to the protection of the coastal habitats and the preservation of the marine biodiversity.

4 CROSS-SECTOR ANALYSIS

This chapter presents all the Innovation Potentials (IPs) identified for the five Mistral Blue Growth sectors (marine renewable energy, maritime surveillance, fisheries and aquaculture, blue biotechnologies, coastal and maritime tourism) and develops a cross-sector analysis to discuss mainly:

- Spatial variability;
- Conflicts and synergies among sectors;
- Differences and commonalities on Key Enabling Factors (KEFs).

4.1 Innovation Potentials identified and their spatial distribution

A total of 25 IPs have been identified, as summarized fromTables 4-1 to 4-5. Depending on the characteristics of the sector, IPs correspond to sub-sectors (e.g. for Marine Renewable Energies - MRE) or to more specific activities / products / services (e.g. maritime surveillance and fisheries & aquaculture).

SECTOR	MARINE RENEWABLE ENERGIES (MRE)	
Code	MRE1	MRE2
Innovation Potential (IP)	**Floating Offshore Wind Energy (FOWE)**	**Wave Energy & Tidal Energy**
Description	Floating offshore wind is a breakthrough innovation market, as opposed to offshore wind with fixed foundations, whose development potential is limited mainly by the bathymetry of the oceans and seas - 40-50 meters deep being the threshold commonly accepted by the players of the market. As floating wind farms can be deployed in deeper waters, it permits to exploit areas further offshore which offer better wind resources (offshore wind corridors being more productive) and to improve the social acceptability of the location of farms projects. It is particularly adapted to the Mediterranean as practically no important installations of wind turbines with fixed foundations are possible (continental shelf and deep water even in coastal areas). The development of floating offshore wind turbine market responds on the one hand to specific characteristics arising from the technologies currently being developed and, on the other hand, to the market potential of the offshore wind laid on sea floor, which is technologically more mature and therefore in the short term economically more attractive.	Technology in wave energy is still being proven. The optimum technological model is yet to be defined. Several pioneering players have built up prominent positions while new entrants are arriving to the market. The segment is regarded by the European Commission as entering the introductory market stage. Sea waves and swell are present in the Mediterranean, but the motions generated are not favourable enough for the production of energies in large quantities (not important fetch = short waves) and not very sustainable over the time. However, production systems can be deployed locally, particularly for insular territories in order to provide them with additional energy, as the import of fossil fuels is expensive, but also in addition to other renewable energies such as solar or wind. The potential is however very limited in the Mediterranean. Tidal current technology is still in its early stages of development, several tidal and in-stream current turbine applications are near commercialization. These devices take advantage of the daily tidal cycles in near-shore ocean environments, or steady water flow from freshwater rivers. To allow a realistic implementation of systems, tidal turbines need a stream speed of at least 1.5-2 m/s - in order to be effectively operating. In Mediterranean, some areas like Dardanelles, Gibraltar and the strait of Messina could have a potential for the exploitation of tidal energy (current). However, some more research and measurement are needed and expected.
Variability in space	IPs are strongly affected by the uneven distribution in the basin of wind, wave and current energy potentials and other suitability factors and sea uses in place. Wave and tidal energy could be notably adapted to insular territories. Research in the MRE sector is very well developed in some of the Mediterranean countries under study in this report, such as France and Greece, and fairly developed in Italy, Portugal and Spain. However, in Albania and Cyprus there are only very few research groups and networks active in the research field of MRE, and they usually are not specialised in MRE.	
Conflicts with other sectors	Potential conflicts with other sectors may regard, either during the construction and the operating phases: - Maritime transport (e.g. routes and communication / navigation aid systems) - Fisheries and aquaculture (e.g. subtraction of suitable areas, other obstacles to fishery activities) - Coastal tourism (e.g. visual impact) - O&G (platforms and sealines) - Sea mining (e.g. marine aggregates, minerals) - Protected areas	
Synergies with other sectors	Industrials from Mediterranean countries that are less favoured by natural conditions (wind, current etc...) are still very much interested in participating to the analysis and construction of MRE farms in countries where such technologies are being developed. It mainly concerns industries such as shipyard, mechanics, oil & gas, marine survey services, offshore construction and maintenance. In addition, the other sectors (and covered by MISTRAL project) are Maritime surveillance with the security and safety and the protection of critical infrastructures, the aquaculture with the various current and past projects related to Multi use offshore platform. To a lesser extent, tourism could be positively impacted with "industrial tourism" which is defined as visits to sites which showcase a particular type of expertise from the past, present or future to the general public. Synergies with conservation, biodiversity and protected areas are also possible (e.g. increase of biodiversity, restrictions to other impacting uses).	

Table4 1 Marine Renewable Energies

SECTOR	MARITIME SURVEILLANCE (MS)					
Code	MS1	MS2	MS3	MS4	MS5	MS6
Innovation Potential (IP)	**Integrated and interoperable maritime situational awareness platforms and services**	**Strengthening EU Capability in observing the marine environment**	**Interactive and Dynamic Atlas of Maritime Risk Maps**	**Operative system for Search and Rescue Planning**	**Development of Intelligent Vessels Monitoring Systems**	**Monitoring solutions for illegal fisheries control**
Description	The integration of platforms and services for maritime surveillance is one of the basic steps towards the Common Information Sharing Environment (CISE) promoted by EU. This action requires the sharing of data between the existing EU platforms in order to better monitoring the maritime information covering all the aspects of this sector: data on traffic, risks, illegal actions and migration.	The need of monitoring the marine environment is fundamental for the maritime surveillance sector development in order to control all the flux in MED area in term of traffic, migration and illegal actions for security reasons.	The creation of an interactive MED Atlas is fundamental to map all the risks in the maritime environment, especially related to the oil spill control. Real-time satellite imageries can be assessed in order to locate and track vessels, monitor beaches and ports, and detect unlicensed fishing and illicit oil discharges. Sea climate monitoring and forecasting systems can also be integrated in order to provide services like automate early warning solutions informing for extreme weather conditions. The social and economic relevance is high because it permits to preserve the marine resources, controlling pollution and preserving biodiversity with positive impact on fisheries and tourism activities.	It includes the implementation of new algorithms providing rapid and accurate predictions about tracking/backtracking of drifting objects and missing persons at sea. It is the first step to realize a plug and play platform able to support the decision making in the planning of Search and Rescue operations. It also is the first step to design an information flow management tool that is activated when the Search and Rescue operation starts. The social relevance is connected to the safeguard of the life and facilities at sea, meanwhile, the economic relevance is connected to optimization of the search time and means used for the operations.	This innovation potential presents an advanced-level Research and technology trends. An array of well-known and established research interacts with stakeholders in production system support the development of an innovative and competitive sector in maritime security through artificial intelligence and machine learning applications for enhanced monitoring performance of VMS radars.	The control of illegal fishing and even more the respect of the quantities fished, and the periods consecrated constitute major concerns for the European Union efforts.
Variability in space	Applicable and relevant for the whole basin and all countries. The relevance of all the Maritime Surveillance subsectors for most Mediterranean countries is demonstrated by the presence of specific national strategies and funding, the large participation of companies, research organizations and public bodies in different EU projects and by the significant number of stakeholders. Also affected by the distribution of main target for surveillance, i.e. maritime traffic and fisheries. Strongly affected by non-EU countries and their marine waters.					
Conflicts with other sectors						
Synergies with other sectors	For the innovation potentials “Integrated and interoperable maritime situational awareness platforms and services”, “Strengthening EU Capability in observing the marine environment” and “Interactive and Dynamic Atlas of Maritime Risk Maps” data can be shared for different purposes or similar methodologies can be applied to share information for different scopes and applications. Few examples are: intermodal transportation and logistics, tourism. For the potential “Operative system for Search and Rescue Planning” it has impact on the safety and security at sea, either in term of life saving and in term of navigation security and migration. The “Development of Intelligent Vessels Monitoring Systems” has a positive impact on maritime transport, tourism, migration, fisheries and aquaculture, trade and marine protection. Moreover, “Monitoring solutions for illegal fisheries control” impacts mainly on the environmental analysis of marine habitats, marine protected areas and on fish stocks.					

Table 4 2 Maritime Surveillance

A) SECTOR IP MACRO GROUP	FISHERY AND AQUACULTURE (FA) SMALL SCALE FISHERIES – SSF				
Code	FA1	FA2	FA3	FA4	FA5
Innovation Potential (IP)	**Control and monitoring of SSF activities**	**Geographical designations/ Branding and Eco-certification of products**	**Co-management with other uses and activities**	**Valorization of underutilized species/ waste or by-products**	**Diversification of fishing activities from the traditional activity**
Description	SSF is important to local communities, with high social relevance. The SSF fleet poses the higher percentage of the fishing vessels. Fishermen try to sell their products directly to consumers. This procedure attracts tourists and is the main income source for the fishermen indicating that SSF activities can be profitable but still not sustainable. Decreasing fishing effort, reducing capacity-enhancing subsidies and only improving monitoring and management can lead to economic viability of SSF.Control and monitoring of SSF activities is of vital importance for the assessment of the corresponding fishing effort which by now is totally unreported. The traceability of SSF vessels can be achieved using technologies/ methodologies developed, or under-development, for large-scale fisheries based on radio frequencies, satellites and/or internet applications, as well as methodologies for data gathering and manipulation.	The SSF post-harvest subsector (including buyers, processors, and market linkages) is part of the fishery system, as well as its governance system plays a central role in the related value chain as fishers are directly connected with other local actors such as public and private institutions and consumers.	Co-management can be an effective approach for developing innovative solutions for the management of SSF. Markets are ready to receive SSF products that are firmly rooted in local communities. However, the major challenge is the change in mentality of fishermen. An individual fisher will not be able to access the market directly, apart from some possibilities to sell directly to restaurants or customers over the dockside, since SSF industries are typically local based. Furthermore the co-existence of SSF with different uses and activities and the creation of new organizations through co-management (e.g. aquaculture, renewable energy for fishing boats and/or onshore processing facilities) would generate new business and might result in the better exploitation of new technologies.	Within the context of a more sustainable use of fishing resources, the valorisation of underutilised species (e.g cephalopods) can increase the profitability of the value chain, help fishermen to be more competitive and it could impact the profit margins of restaurants and fishers (connection with hospitality industry).	Diversification of fishing activities from the traditional activity to other fields (e.g. tourism-related activities as Pesca tourism, ichtyo-tourism, recreational fishing (wildlife observation, direct sales to tourists-promotion in local restaurants, and festivals/ workshops/museums/thematic villages that raise awareness of the area's fishing activity and products), diving and underwater cultural heritage valorization) that offers the potential to contribute to job creation, social inclusion as well as the revitalization of fisheries-dependent communities. Starting multifunctional activities also means an effort reduction and a turn to sustainability, reducing environmental impact and improving the environmental status of the whole ecosystem.
Variability in space	SSF is per se a coastal activity, which is presently diffused, and can actually exploit its IPs, in almost all Mediterranean countries and coasts.				
Conflicts with other sectors	Potential conflicts may arise with other types of fisheries, namely bottom and pelagic trawling.				
Synergies with other sectors	Synergies of fishing with marine aquaculture provide common employment and service sector opportunities: fishers provide services to aquaculture units, or become fish farmers in their own rights. Aquaculture can potentially benefit wild fisheries by creating structures that could be utilized as habitat by target species or their prey, and by adding food and nutrients to the ecosystem, which could increase productivity or be consumed directly by target fishes. After all, synergies between different aquaculture productions are available through Integrated Multi-Trophic Aquaculture, with potential for increasing the production and reducing the environmental impact.Besides, synergies can be developed with other blue growth sectors such as tourism, renewable energy production, biotechnology as well as environmental protection. Fishing and aquaculture-related activities can be included as part of the touristic offer in coastal areas (pesca-tourism and recreational fishing), particularly in areas where both operate from multi-function local ports.Aquaculture activities can be developed in combination with offshore wind farms which at the same time offer synergies through the introduction of hard substrate for fishing species depending on reef or gravel structures.Blue Biotechnology can play pivotal role in promoting productivity, boosting efficiency and ensuring sustainability in aquaculture. Marine farming production cycle, including breeding, growth, nutrition and health can be optimized through biotechnological applications (enhancement of feed conversion efficiency, stress modulation, vaccination, disease diagnostics and resistance, cryopreservation, genetic selection).Fisheries can benefit from an increase in Marine Protected Areas (MPAs) and their recovering fish stocks, while sustainable aquaculture activities can be developed within or in the vicinity of MPAs.				

Table 4 3Fischery and Aquaculture – A) SSF, B) MA

B)SECTOR IP MACRO GROUP	FISHERY AND AQUACULTURE (FA) MARINE AQUACULTURE - MA				
Code	FA6	FA7	FA8	FA9	FA10
Innovation Potential (IP)	**Reduction of feed costs combined with feed improvements**	**Diversification with larger-size, higher-value-added finfish species**	**Sustainability certifications and labeling**	**Development of floating multi-use platforms adapted to deeper waters**	**Integrated multi-trophic aquaculture - IMTA**
Description	There is a need for high quality sustainable feed, reduction of fish meal/fish oil use as a major protein source (it has several disadvantages, including high cost and instability of supply) and a lowering of nitrogen and phosphorous in effluent.	New product development with a consumer focus, as demand has dropped for sea bass and sea bream, which are the most popular species currently farmed in the Mediterranean. Species chosen tentatively that given their large size and/or fast growth, they provide for high dress-out and fillet yield, short time to market and suitability Product diversification and development of value-added products as well as the potential to be reared in sea cages -especially offshore, where the future expansion of marine aquaculture may lie.	Live organisms of aquaculture suffer large stress during transportation to long distance destinations with a significant mortality. In order to reduce their loss, it is advisable to develop more sophisticated transport and better monitoring system. The development of certification schemes in collaboration with established international certification bodies is a key issue in order to certify freshness, traceability and animal welfare so that more people will choose the products, more retail chains will stock them and more farmed animals will have a better life.	There is growing interest in moving coastal farming to offshore sites, because it would reduce constraints related to competition for space with other activities and reduce environmental and aesthetical impacts significant advantages. They can be feasible systems shared with other facilities like offshore wind turbines, platforms for maritime transport and innovations in the leisure sector and oceanic observation activities.	Establishing integrated cultivation systems can increase productivity, profitability and sustainability as a tool for an ecosystem approach to the marine farming sector.
Variability in space	The objective for EU marine finfish aquaculture is to increase production to 480 ktons by 2020, a 60% increase compared to the 2012 production levels. In the Mediterranean, this growth objective is shared by all the MISTRAL member countries. From the other, the objective for EU marine shellfish aquaculture is to increase production from 550 ktons to 680 ktons by 2020, a 25% increase compared to the 2012 baseline. Such a moderate, compared to finfish, growth objective, is similarly expressed in the Mediterranean and shared by all the MISTRAL member countries. All MISTRAL member countries are focusing on re-organizing production sites to optimize the use of available space and foresee a possible expansion in offshore areas.				
Conflicts with other sectors	Potential conflicts may arise with fisheries (bottom and pelagic trawling in particular), tourism (for finfish farms in particular) and protected areas.				
Synergies with other sectors	Synergies of fishing with marine aquaculture provide common employment and service sector opportunities: fishers provide services to aquaculture units, or become fish farmers in their own rights. Aquaculture can potentially benefit wild fisheries by creating structures that could be utilized as habitat by target species or their prey, and by adding food and nutrients to the ecosystem, which could increase productivity or be consumed directly by target fishes. After all, synergies between different aquaculture productions are available through Integrated Multi-Trophic Aquaculture, with potential for increasing the production and reducing the environmental impact. Besides, synergies can be developed with other blue growth sectors such as tourism, renewable energy production, biotechnology as well as environmental protection: Fishing and aquaculture-related activities can be included as part of the touristic offer in coastal areas (pesca-tourism and recreational fishing), particularly in areas where both operate from multi-function local ports. Aquaculture activities can be developed in combination with offshore wind farms which at the same time offer synergies through the introduction of hard substrate for fishing species depending on reef or gravel structures. Blue Biotechnology can play pivotal role in promoting productivity, boosting efficiency and ensuring sustainability in aquaculture. Marine farming production cycle, including breeding, growth, nutrition and health can be optimized through biotechnological applications (enhancement of feed conversion efficiency, stress modulation, vaccination, disease diagnostics and resistance, cryopreservation, genetic selection,). Fisheries can benefit from an increase in Marine Protected Areas (MPAs) and their recovering fish stocks, while sustainable aquaculture activities can be developed within or in the vicinity of MPAs.				

Table 4 3Fischery and Aquaculture – A) SSF, B) MA

SECTOR	BLUE BIOTECHNOLOGIES (BB)		
Code	BB1	BB2	BB3
Innovation Potential (IP)	**Micro and Macro Algae Farming and Exploitation**	**Microbes and enzymes exploitation**	**Valorization of fisheries and aquaculture by-products and wastes**
Description	The IP offers several opportunities and benefits. High biodiversity, cultivability and high productivity per unit area, use of non-agriculture soil, low level of pollution in productive sites, base technologies quite advanced, good acceptability for many products, qualified human resources in the area, increasing demand of related products. Atmosphere and water pollution decrease, possible source of health-promoting molecules or of new medicines, employment increase, link with other sectors, help to protect the resource upon which marine-related economic and social activities depend, meet actual societal challenges in food energy and health, connection between researchers and entrepreneurship investment.	The IP offers several opportunities and benefits. Currently, microbes and their derived products have been well studied and exploited mainly from terrestrial environments. Only few microorganisms from marine origin have been obtained in culture and very few of them are being exploited. However, the marine environment is characterised by a very high biodiversity that needs to be studied, characterized and exploited. Development of the green chemistry and bioeconomy Discovery of novel compounds for the development of new bioproducts to be used in cosmetics, pharmacy or medicine. Improvement of the industrial processes through the use of biocatalysts (enzymes) Improvement of the environmental health as a result of the reduction of the use of chemical compounds from synthetic origin and through the application of non-toxic biodegradable compounds .	The IP offers several opportunities and benefits. The inorganic, organic or composite materials offer great opportunities being rich of high value molecules, macromolecules, and minerals. In addition, they have superior mechanical properties with respect to the similar synthetic ones. These materials can stimulate aquaculture and generate a good example of circular economy. Unwanted catches and discards constitute a substantial waste and negatively affect the sustainable exploitation of marine biological resources and marine ecosystems and the financial viability of fisheries. Their utilization can limit environmental impacts of fishing activities, reduce high levels of unwanted catches and gradually eliminate discards. Moreover, when calcified they could contribute to the sequestration of carbon dioxide (Gtonnes/year for forams).
Variability in space	In all the countries of the Med area, with exception of Albania (which did not deliver the fiche), the economy based on the Biotechnology sector is either well developed (e.g. Spain is second only to USA for the number of companies and Italy has 571 companies) or is increasing in importance, especially in the health and food sectors. Nevertheless, each country declares that the Marine, or Blue, Biotechnologies are less developed in comparison to the Red, Green and White Biotec. The Med area thus appears ready to an expansion of the Blue Biotechnology sector given that the right policies and funding are provided and are adapted to the projects trends: important issues, coverage of a wide range of TRLs, multi-partner collaborative innovation projects, increasingly significant budgets.		
Conflicts with other sectors			
Synergies with other sectors	The sector has economic relevance and could have positive impact on a number of different sectors. The use of microalgae for blue bioenergy could be merged with the blue energy sector for the sustainable production of renewable and clean energy. Moreover, other commercialized products from microalgae consist in preparations (solutions, dry or frozen biomass) to be used as feed for small farmed marine organisms, supporting the aquaculture sustainability. The blue biotechnology applications in the marine environment includes environmental biomonitoring and bioremediation. The availability of biomonitoring technologies can provide the necessary information helping to manage industrial activities as aquaculture in a more efficient manner and to decision-making processes before or at initial step during contamination events. The valorization of fisheries and aquaculture by-products (generated from fish processing) and/or wastes (fish by-catch and/or algal proliferation) as feed streams for the development of chemical and/or biotechnological process for the production of compounds and materials to be applied in different industrial sectors (aquaculture, chemical, pharmaceutical, cosmeceutical, nutraceutical as well as building sectors) would impact the fisheries and aquaculture sector.		

Table4 4 Blue Biotechnologies

SECTOR	COASTAL AND MARITIME TOURISM (CMT)			
Code	CMT1	CMT2	CMT3	CMT4
Innovation Potential (IP)	**Big Data, digitalization and ICT services for active living in coastal area**	**Sustainable leisure boating**	**Smart management of the coastal infrastructure and estreme events**	**Integrated and Sustainable tourism**
Description	big data and ecosystem services for a sustainable exploitation and monitoring of the marine environment; virtual and augmented reality (enriches the tourist experience) when diving, when visiting a museum, etc., smartphone applications (linked to participatory science), etc.; Robotics: monitoring of coastal zones, acquiring data, collecting waste, etc.	Technology trends in the leisure boating and cruise sectors point to the development of equipment machineries and materials to prevent and reduce the negative effects of human activities on the natural environment	This IP includes aspects aimed at protecting the environment, at the border between coast and sea, following an holistic approach. Aspects: from defence of coastal system to geological settings; from development policy of inland regions to monitoring nets of flowing basins, transitional environments and coastal waters; from quality control of pollutants loading to coastal system to depuration and management of second-hand waters; from control in maritime transports to the protection of coastal habitats and defence of marine biodiversity through the establishment of Marine Protected Areas (MPA); Including Monitoring and Observing Sensors and Systems for effective planning and management	• Regarding hospitality, research trends are connected to environmental concerns through water and litter cycles, reduction of food waste, reduction of plastic bottles, soaps etc, linked to Circular Economy principle; • Reducing the seasonality; • By designing products that both preserve the local areas' authenticity and take into consideration their populations
Variability in space				
Conflicts with other sectors			possible conflict with RE and F&A for overlapping of activities	
Synergies with other sectors	synergies with Surveillance(robotics, autonomous vehicles)		synergies with protection and monitoring activities (Surveillance IP); synergies with CMT4 and FA IPs; Synergies bring to mutual amplification among IP with a strong emphasis on environment. The establishment of an innovation potential may therefore favourite the outcome of another.	

Table 4 5 Costal and Maritime Tourism

Their spatial variability within the Mediterranean basin, which is also presented and discussed for each sector in the previous chapters and figures, is related to three main factors:

A. Availability of the primary resources to be potentially exploited ("Resource-oriented IPs");

B. Distribution of the activities on which the IP is based on ("Activity-oriented IPs");

C. Distribution of the capacities (e.g. research infrastructures, skills, industries) needed to exploit the IP ("Capacities-oriented IPs").

While bio resources at the base of the Fisheries & Aquaculture (only Small Scale Fishery is addressed in the IPs) and Blue Biotechnologies can be considered substantially ubiquitously at meso and macro scale, and among countries, and the same consideration can be applied to Coastal and Maritime Tourism (i.e., areas without tourism potentials in the Mediterranean are definitely rare), wind and wave potentials to generate MREs varies significantly within the basin (Fig. 4.1 and 4.2). This spatial distribution unavoidably affects the distribution of the related IPs.

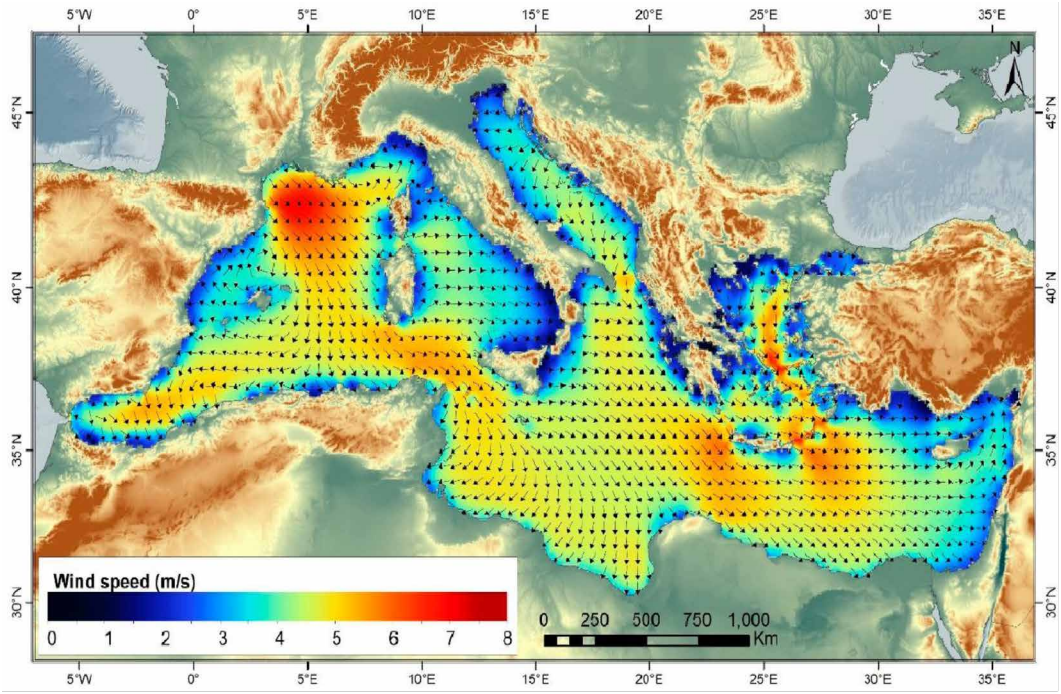


Fig. 4.1Mean annual wind climate (at 10 m above sea level) in the Mediterranean Sea according to the ETA model. Arrows indicate the mean annual wind direction (Boero et al., 2017; Soukissian et al., 2017).

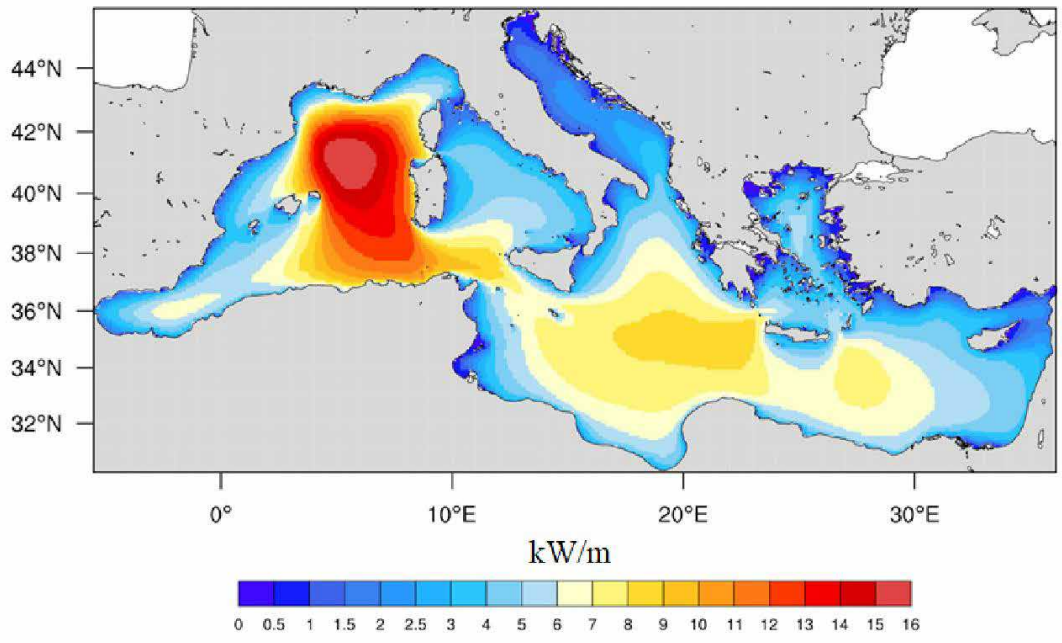


Fig. 4.2 Mean Wave Energy flux over the Mediterranean for years 2001-2010 (Sannino and Pisacane, 2017).

Maritime Surveillance generally applies to the whole basin and all countries, but significant variability is due to the distribution of main target for surveillance, i.e. maritime traffic and fisheries (Fig. 4.3). Moreover, the sector and their IPs is strongly affected by non-EU countries, including southern and eastern Mediterranean countries, and their marine waters.

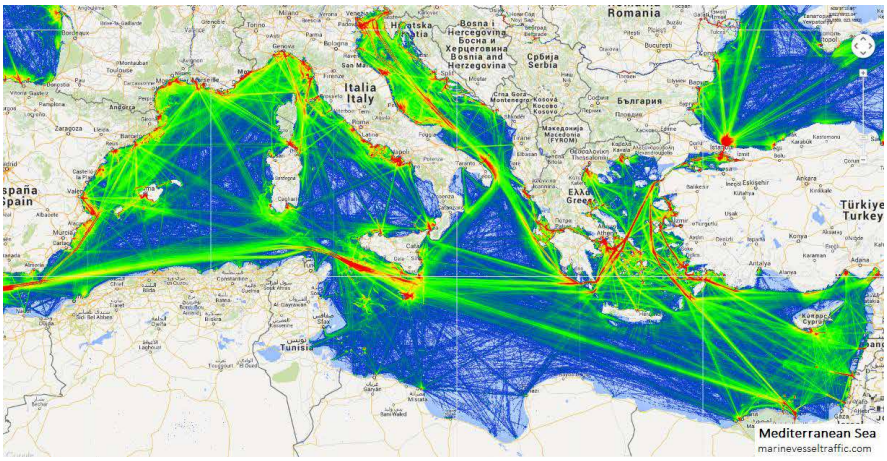


Fig. 4.3 Ship Traffic Density Map of the Mediterranean Sea (www.marinevesseltraffic.com, 2019).

A third factor of spatial variability depends on the distribution of the capacities (e.g. research infrastructures, skills, industries) needed to exploit the IP. This applies in particular to emerging sectors such as MREs and Blue Biotechnologies. With respect to the emerging sectors related to the bio-resources, there is a wide array of drivers of the bioeconomy in European regions that depends on the way bioeconomy is perceived at local level. These may include local resources and assets, value chains, supply chains, or external factors as environmental or territorial challenges or population's dynamics[31]. Certainly, there is a huge interest in developing Bioeconomy in European countries and regions in the next years.

As indicated in the report Bioeconomy development in EU regions 2017[32], almost all EU regions (98.6%) foresee R&I in at least some bioeconomy related area in their RIS3 2014-2020. There is a large variety in bioeconomy related thematic areas, but activities concerning Blue Bioeconomy (defined as those activities that concern the exploitation of marine living resources, including capture/fishing, processing to consumption, and include aquaculture, processing, marine biotechnologies and marine-related health products[33]) are still limited ("Fisheries and aquaculture" and "marine resources" represents respectively 21% and 15% of the total).

Territorial distribution of Bioeconomy maturity across MED regions(Fig 4.4) gives an overview of the potential scenario to give support or to be implemented with the aim to align positive factors and found synergies for further development.

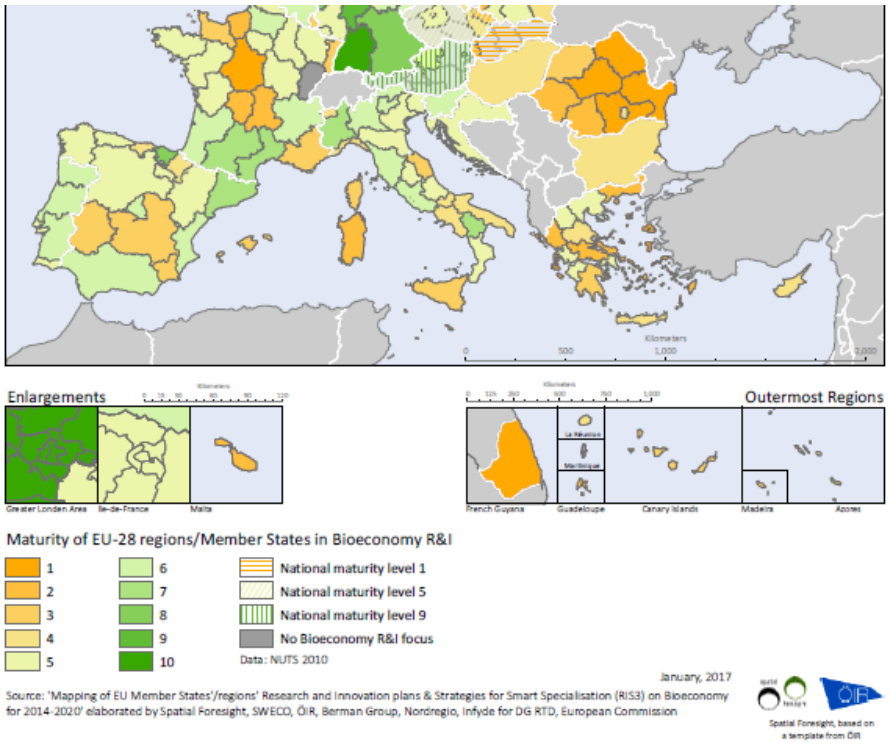


Fig. 4.4 Territorial distribution of regions according to bioeconomy maturity. Adapted from Spatial Foresight, SWECO, ÖIR, t33, Nordregio, Berman Group, Infyde (2017): Bioeconomy development in EU regions. Mapping of EU Member States'/regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy for 2014-2020.

[31]COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Blue Growth opportunities for marine and maritime sustainable growth; 2012

[32]Spatial Foresight, SWECO, ÖIR, t33, Nordregio, Berman Group, Infyde (2017): Bioeconomy development in EU regions. Mapping of EU Member States'/regions' Research and Innovation plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy for 2014-2020.

[33]CPMR (2016). The Maritime Dimension in Smart Specialisation Strategies. Results and key messages. CPMR Technical Paper. October 2016. www.crpm.org

4.2 CONFLICTS AND SYNERGIES AMONG SECTORS AND INNOVATION POTENTIALS

Most sectors and IPs have potential interactions with other sectors and IPs considered in this analysis, same as with other sectors of the wider Blue Growth arena. Interactions can be negative (named here as "conflicts") or positive (named here as "synergies) and can regard different aspects such as the use of space, of resources, of infrastructures, of human resources and skills, of financial resources, in different parts of the value chains. They are briefly reported in Tablesfrom 4-1 to 4-5 and graphically presented in Fig. 4.5, showing how synergies are potentially more frequent than conflicts.

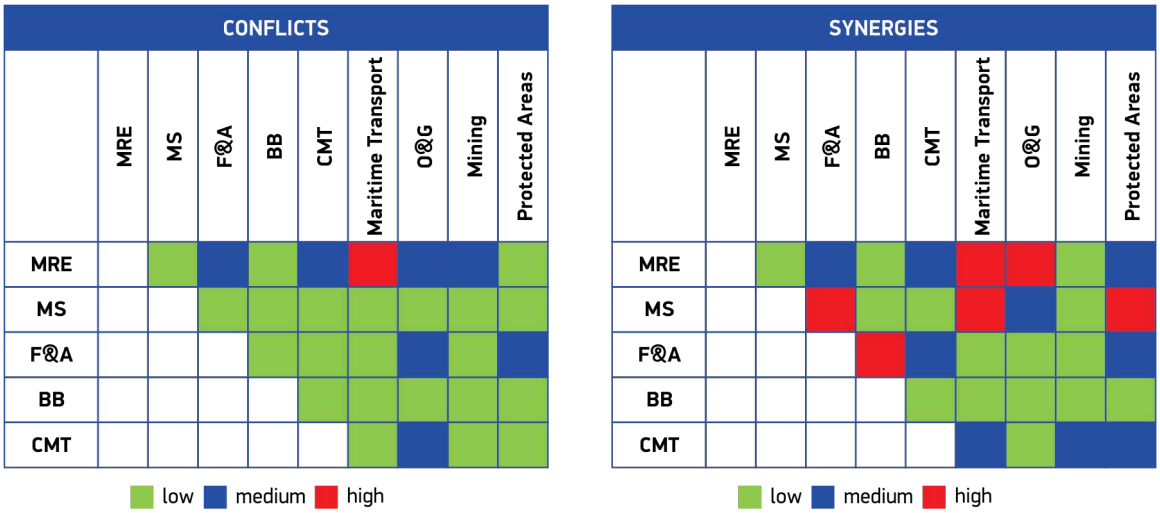


Fig. 4.5Matrices showing main potential conflicts and synergies among Mistral sectors and IPs and other sea uses.

Maritime Spatial Planning (MSP) can support the above synergies by stimulating the spatial allocation and co-existence of the different uses and activities, and even a co-management approach, which looks at the specificities (social, economic and environmental) of their spatial area and manages to reduce those risks that might happen whilst optimizing economic benefits.

4.3 DIFFERENCES AND COMMONALITIES ON KEY ENABLING FACTORS (KEFS)

Tables from 4-6 to 4-12 summarise the KEFs found for each of the IPs identified. Common and distinct needs can be recognised.
Harmonization of national policies and full implementation of EU policies is an overall common feature of almost all IPs, Specific policies presently missing or partially lacking are required for MRE, Blue Biotechnology and Small Scale Fisheries IPs. In several cases, namely in Maritime Surveillance, transboundary cooperation is key, and should be stimulated through policy decisions and instruments.

Efforts on the development of appropriate skills, training and capacity building are recognised as very important in almost all sectors and IPs, with a specific emphasis on blue biotechnologies. Capacity building on fisheries and aquaculture is mainly oriented towards economic operators, mainly on entrepreneurial competences.
Public and private resources to support the development of IPs, their transfer to the market and their long term sustainability are, again, common to all sectors, but do not appear to be the "ultimate KEF".
Different types of research needs have been identified, defining a sort of continuous flow of knowledge feeding the exploitation of the IPs. EU-funded research projects represent the backbone of this joint effort.
Marketing actions seems to be important in particular for IPs related to Fisheries & Aquaculture, while other sectors (i.e. MRE, Maritime Surveillance, and Blue Biotechnologies) stress the role and the importance of clusters to connect different actors along the value chains.

SECTOR	CODE	INNOVATION POTENTIAL (IP)	KEY ENABLING FACTOR (KEF) POLICIES
MARINE RENEWABLE ENERGIES (MRE)	MRE1	**Floating Offshore Wind Energy (FOWE)**	The general EU and national context is favorable to foster the development of renewable energies. There are very few policies specific to MRE at national level and administrative burdens remain a key issue. The national and European regulators could also work on defining ways of solving potential conflicts about use of maritime space. Governments should provide a clear view on their capacity ambition, project pipeline and supporting policies in their National Energy and Climate Plans (NECPs) to 2030.
	MRE2	**Wave Energy & Tidal Energy**	
MARITIME SURVEILLANCE (MS)	MS1	**Integrated and interoperable maritime situational awareness platforms and services**	Many EU strategies finalized mainly to the integration of different systems. National strategies are also needed to improve the communications between this information at EU level. The national policies must be applied also for all those EU countries that now do not have specific national strategies.
	MS2	**Strengthening EU Capability in observing the marine environment**	In this moment specific policies are absent in most EU countries. There is an evident gap between the strategies at EU level and the national one. New policies must be created for each MED country according to the EU strategic decision.
	MS3	**Interactive and Dynamic Atlas of Maritime Risk Maps**	
	MS4	**Operative system for Search and Rescue Planning**	
	MS5	**Development of Intelligent Vessels Monitoring Systems**	
	MS6	**Monitoring solutions for illegal fisheries control**	Political will of each country is needed to enforce international rules on illegal fishing.
FISHERY AND AQUACULTURE (FA) - Small Scale Fisheries -SSF	FA1	**Control and monitoring of SSF activities**	Although small-scale fisheries management plans are deliberately promoted by the GFCM in order to establish specific rules designed to ensure, in particular, preferential access for small-scales fishers along the coastal band (GFCM, 2018b), the multiannual plans proposed by the European Commission, under the CFP, for this sea basin do not reserve any special conditions or exclusions. On the contrary, small-scale fisheries continue to show signs of reduced performance with negative trends due to higher space conflicts with conservation measures (Habitats and Birds Directives requirements) as well as with other coastal marine uses (mainly intensive coastal tourism, aquaculture and marine aggregated extraction) (Stoberup et al, 2017; EASME, 2018). In the framework of the implementation of the Maritime Spatial Planning, spatial effort allocation based on the individuation of relevant areas for fishing and for fish species according to life stages, could have a high potential for an ecosystem based approach of the fisheries management including SSF. Support the creation of clear and comprehensive legislation for pescatourism and other interactions between SSF and other sea uses, using best practices from different countries.
	FA2	**Geographical designations/ Branding and Eco-certification of products**	
	FA3	**Co-management with other uses and activities**	
	FA4	**Valorization of underutilized species/ waste or by-products**	
	FA5	**Diversification of fishing activities from the traditional activity**	

SECTOR	CODE	INNOVATION POTENTIAL (IP)	KEY ENABLING FACTOR (KEF) POLICIES
FISHERY AND AQUACULTURE - Marine Aquaculture - MA	FA6	**Reduction of feed costs combined with feed improvements**	Public policies on fishing and aquaculture should be strengthen, as an answer to the food issue the Mediterranean is facing. Aquaculture should be better fostered and promoted from public authorities, and this can be achieved through the harmonization of national and regional interventions. Strategic National Plans 2014-2020 proved to be ambiguous strategies with weak exemplification so far in all countries. All MISTRAL member countries are focusing on re-organizing production sites, also in the framework of the MSPD implementation, to optimize the use of available space and foresee a possible expansion in offshore areas.
	FA7	**Diversification with larger-size, higher-value-added finfish species**	
	FA8	**Sustainability certifications and labeling**	
	FA9	**Development of floating multi-use platforms adapted to deeper waters**	
	FA10	**Integrated multi-trophic aquaculture - IMTA**	
BLUE BIOTECHNOLOGIES (BB)	BB1	**Micro and Macro Algae Farming and Exploitation**	Policies at different level are not well developed and appropriate. Authorities should issue "ad hoc" regulation about different topics: microalgae cultivation and quality standards of algal biomass, access and use of genetic resources and sharing of benefits; decrease restriction concerning Novel Foods.
	BB2	**Microbes and enzymes exploitation**	In most of the countries, there is no policy/strategy dedicated to blue biotechnology including microbes and enzymes exploitation although there is high interest in the sector at R&D level.
			Development of policies/strategies for the support of the sector at national and European level and expecially to develop commercial applications.
	BB3	**Valorization of fisheries and aquaculture by-products and wastes**	Development of dedicated policies favouring the utilization of these products.
			Art. 15 (1) of Regulation (EU) No 1380/2013 of the European Parliament and of the Council establishes the obligation to land all catches of species which are subject to catch limits and, in the Mediterranean, also catches of species which are subject to minimum sizes ('the landing obligation').
			Generation of an integrated waste management scheme.
			In the next decade, stringent regulations should be implemented on the disposal, the classification and the storage of aquaculture by-products and wastes, while providing incentives for companies who use them.
COASTAL AND MARITIME TOURISM (CMT)	CMT1	**Big Data, digitalization and ICT services for active living in coastal area**	Action plans and cooperation for Sustainability and Environment
	CMT2	**Sustainable leisure boating**	Harmonization of rules and regulations relating to licenses and boat safety equipment; sustainable zoning and common technical standards for marinas (e.g. operational, safety and security standards), end-of-use boat (EUB) management practices and resource efficiency and circular marina and boating concepts of various types; Need for a framework for Spatial Planning and Sustainable Tourism, as a means for sustainable zoning and embedding marina developments into the surrounding socio-economic-environmental context;
	CMT3	**Smart management of the coastal infrastructure and extreme events**	Use of Marine Protected Areas to foster the frequency of environmental monitoring to preservation; improve and innovate the cooperation in coastal observatories in Europe by implementing the coastal part of a European Ocean Observing System; harmonize regulation for the good quality of waters, habitats and biodiversity; include specific climate plans
	CMT4	**Integrated and Sustainable tourism**	Policies and regulation, at local, national or regional level, are essential to support the development of sustainable tourism (i.e. through sustainable destination management, environmental taxes, climate and biodiversity plans, etc.); implement laws and regulations to frame and reduce the potential impact of tourist activities at International, European or national level and to reach a good environmental status (MSFD, Barcelona convention, etc.).

Table 4 6Key Enabling Factor (KEF) - Policies

SECTOR	CODE	INNOVATION POTENTIAL (IP)	KEY ENABLING FACTOR (KEF) SKILLS/HUMAN RESOURCES
MARINE RENEWABLE ENERGIES (MRE)	MRE1	Floating Offshore Wind Energy (FOWE)	There are no or very few training courses focusing on marine renewable energies themselves all over the MED area. Highly-specialized scientists and engineers are adequately provided in the countries under study. Skills for welders or electricians needed for constructing or maintaining reliable and safe floating, offshore and underwater machinery, require specific training. The technical expertise and technologies derived from the general offshore field, mechanical engineering, and robotics (etc.) are available in the area, and this constitutes a real chance for the MRE sector. Adequate experiences, scientific know-how, knowledge sharing and skilled human resources as well as longstanding University education (bachelor's and master's degrees) targeting more specifically the exploitation of MRE and sustainable management of ports is however needed.
	MRE2	Wave Energy & Tidal Energy	
MARITIME SURVEILLANCE (MS)	MS1	Integrated and interoperable maritime situational awareness platforms and services	In fact, it is necessary the conversion of the current technical skills in all the EU countries to form operators able to manage this complex platform systems and deal with the big data processing. New specialized technical training courses are required in EU.
	MS2	Strengthening EU Capability in observing the marine environment	Training courses by research organizations are necessary to form professional skills in this field. Investments on the creation of technical and professional figures capable to understand and to process the data from monitoring systems should be necessary.
	MS3	Interactive and Dynamic Atlas of Maritime Risk Maps	Specialized skills are required to develop this technology. Training courses by research organizations are necessary in each EU countries.
	MS4	Operative system for Search and Rescue Planning	Specialized skills are required to work in this sector. Training courses by research organizations are necessary.
	MS5	Development of Intelligent Vessels Monitoring Systems	Research organizations should acquire the appropriate skills to effectively use it in the future.
	MS6	Monitoring solutions for illegal fisheries control	
FISHERY AND AQUACULTURE (FA) - Small Scale Fisheries -SSF	FA1	Control and monitoring of SSF activities	
	FA2	Geographical designations/ Branding and Eco-certification of products	Entrepreneurial training of fishermans.
	FA3	Co-management with other uses and activities	Markets are ready to receive SSF products that are firmly rooted in local communities. However, the major challenge is the change in mentality of fishermen. An individual fisher will not be able to access the market directly, apart from some possibilities to sell directly to restaurants or customers over the dockside, since SSF industries are typically local based. Furthermore, the co-existence of SSF with different uses and activities and the creation of new organizations through co-management (e.g. aquaculture, renewable energy for fishing boats and/or onshore processing facilities) would generate new business and might result in the better exploitation of new technologies.
	FA4	Valorization of underutilized species/ waste or by-products	Vessels upgrade considering the new targets; development of new collaborations among commercial chains
	FA5	Diversification of fishing activities from the traditional activity	Fishers often lack experience and skills regarding safety issues, entrepreneurship, permits and customer care, and language skills needed to work with tourists, amongst other challenges of marketing and managing this type of business opportunity.
FISHERY AND AQUACULTURE - Marine Aquaculture - MA	FA6	Reduction of feed costs combined with feed improvements	Improving current knowledge of the key performance indicators (KPI) of the principal Mediterranean species - growth rates, mortality and feed efficiency- as well as of the performance of fish species, by developing sustainable and cost-effective feeds are required skills to make Mediterranean aquaculture sustainable, and, possibly, change the perception of aquaculture. The development of new technologies, new products and new business models has to be duly supported by ad-hoc training processes that can generate new professional skills and job opportunities. Despite the fact that different training courses exist with competences and expertise already available, they are few training courses concerning professional lifelong learning. There is a lack of professional courses and qualifications, although specialized skills are needed for specific technologies and infrastructures.
	FA7	Diversification with larger-size, higher-value-added finfish species	
	FA8	Sustainability certifications and labeling	
	FA9	Development of floating multi-use platforms adapted to deeper waters	
	FA10	Integrated multi-trophic aquaculture - IMTA	
BLUE BIOTECHNOLOGIES (BB)	BB1	Micro and Macro Algae Farming and Exploitation	Human skills require training courses now limited but implementable.
			Need of interdisciplinary cooperation and of specific inter-sectorial training.
	BB2	Microbes and enzymes exploitation	Low availability of specialized skills for the development of innovative microbial cultivation; upscale and downstream process optimization as well as for rapid product identification/dereplication. Knowledge on cultivation of new microbes and identification of new products requires integration of different expertise in order to support discovery and efficient large-scale production of bioactive molecules.
	BB3	Valorization of fisheries and aquaculture by-products and wastes	Chemical, biological and ecological expertise should be merged by specific courses.
COASTAL AND MARITIME TOURISM (CMT)	CMT1	Big Data, digitalization and ICT services for active living in coastal area	Need of a better integration of competencies between tourism and digital technologies
	CMT2	Sustainable leisure boating	Need for training, certification and license of professional and private skippers in harmonization and mutual recognition across EU Member States and third countries
	CMT3	Smart management of the coastal infrastructure and extreme events	Integration between different skills and disciplines (such as engineering, chemistry, biologists and survey companies promote data analysis and management;
	CMT4	Integrated and Sustainable tourism	Raising awareness as measure to mitigate the impacts;

Table 4 7Key Enabling Factor (KEF) - Skills/human resources

SECTOR	CODE	INNOVATION POTENTIAL (IP)	KEY ENABLING FACTOR (KEF) RESOURCE/FUNDINGS
MARINE RENEWABLE ENERGIES (MRE)	MRE1	**Floating Offshore Wind Energy (FOWE)**	European Union, through its various funding agencies and subsidy programs is a key financing player supporting the development of the marine renewable energy in the Mediterranean area. At national level, only France, Greece, Portugal and Spain seem to have a significant national funding scheme focused on the MRE sector. More expensive energy sources will face strong difficulties to take a significant part in the energy mix. In fact, this 60€/MWh target cost has been more quickly reached than it was expected by experts only 10 or even 5 years ago. This is due to the high number of installed plants, which has contributed to an economic learning curve that may only be experienced by other types of energy provided that governments make great efforts to implement voluntary policies, that is, public financing. However, are governments ready to provide such an effort? If the energy mix needed other energy sources, then yes, they would be ready, undoubtedly. However, is this really necessary? Certainly, in very specific locations: isolated territories among which overseas territories, islands... as in these areas, energy is costly. However, in developed countries where electricity networks are interconnected, it is not that obvious.
	MRE2	**Wave Energy & Tidal Energy**	
MARITIME SURVEILLANCE (MS)	MS1	**Integrated and interoperable maritime situational awareness platforms and services**	Funding strategies are active at national, regional and EU level. Many Ministries and other public administrations are directly involved in the financing on this topic, especially for Italy and France.
	MS2	**Strengthening EU Capability in observing the marine environment**	Funding strategies for each EU country need to be aligned according to common strategies at EU level. In fact, only in France, Italy and Greece there are funding supported by national of regional institutions, meanwhile the other EU countries have as financial support only the EU funding agencies.
	MS3	**Interactive and Dynamic Atlas of Maritime Risk Maps**	Funding strategies at national level need to be aligned according to common strategies at EU level.
	MS4	**Operative system for Search and Rescue Planning**	
	MS5	**Development of Intelligent Vessels Monitoring Systems**	
	MS6	**Monitoring solutions for illegal fisheries control**	
FISHERY AND AQUACULTURE (FA) - Small Scale Fisheries -SSF	FA1	**Control and monitoring of SSF activities**	
	FA2	**Geographical designations/ Branding and Eco-certification of products**	
	FA3	**Co-management with other uses and activities**	
	FA4	**Valorization of underutilized species/ waste or by-products**	
	FA5	**Diversification of fishing activities from the traditional activity**	Allocate specific funding schemes to train fishers. Moreover, fishers need particular infrastructure, incentives, logistics, and platforms such as fishing vessels, marinas and microcredit facilities to be able to diversify their activities to include tourism and market their products. Funding and initiatives to create a pescatourism-enabling environment are critical.
FISHERY AND AQUACULTURE - Marine Aquaculture - MA	FA6	**Reduction of feed costs combined with feed improvements**	Partner countries' National Operational Programs "Fisheries and Maritime 2014-2020", funded by EMFF, support the competitiveness and the environmental and economic sustainability of aquaculture, mainly through the promotion of productive investments and new forms of aquaculture with high growth potential, investments that enhance quality and increase added value for aquaculture products, provide measures for public health and animal welfare, boost innovation and provide advisory services of a technical, scientific, legal or economic nature. These programs can also contribute to the competitiveness of the aquaculture sector by promoting marketing actions, Producers Organizations and actions undertaken through Community-Led Local Development (CLLD).
	FA7	**Diversification with larger-size, higher-value-added finfish species**	
	FA8	**Sustainability certifications and labeling**	
	FA9	**Development of floating multi-use platforms adapted to deeper waters**	
	FA10	**Integrated multi-trophic aquaculture - IMTA**	
BLUE BIOTECHNOLOGIES (BB)	BB1	**Micro and Macro Algae Farming and Exploitation**	Funding at national level are scarce.
			Increase the calls on Blue Biotechnologies and bring them to the same level of fishing and aquaculture.
	BB2	**Microbes and enzymes exploitation**	Funding resources specific to marine biotechnology are limited at national level in different countries like Italy, Cyprus, Croatia and/or are difficult to access. Need to increase the funding resources at regional and national level.
	BB3	**Valorization of fisheries and aquaculture by-products and wastes**	The funding is crucial for the realization of blu biotechnologies for the exploitation of aquaculture by-products and wastes. Actually there are not specific fund for applied researches.
			Specific calls at regional, national and European level should be made.

SECTOR	CODE	INNOVATION POTENTIAL (IP)	KEY ENABLING FACTOR (KEF) RESOURCE/FUNDINGS
COASTAL AND MARITIME TOURISM (CMT)	CMT1	**Big Data, digitalization and ICT services for active living in coastal area**	
	CMT2	**Sustainable leisure boating**	
	CMT3	**Smart management of the coastal infrastructure and extreme events**	Funds come from public authorities. New business models might be investigate to finance the monitoring of the environment, by incomes of tourist activities for instance.
	CMT4	**Integrated and Sustainable tourism**	All tourism actors could be involved to finance the development of new products and services less impacting for the environment.

Table 4 8Key Enabling Factor (KEF) - Resource/fundings

SECTOR	CODE	INNOVATION POTENTIAL (IP)	KEY ENABLING FACTOR (KEF) R&D (KNOWLEDGE AND TECHNOLOGIES)
MARINE RENEWABLE ENERGIES (MRE)	MRE1	**Floating Offshore Wind Energy (FOWE)**	Main research topics still to be tackled are: 'The onshore wind energy sector is developed, which can favour the emergence of the offshore wind energy through technology transfer.
			R&D activity around MRE is well developed in most of the Mediterranean countries under study.
			Main research topics still to be tackled are:
			- Wind and ocean resources assessment;
			- Floating concepts, mooring systems, cables, substations, energy storage and interconnections with onshore energy grid;
			- Environment interactions and impacts.
	MRE2	**Wave Energy & Tidal Energy**	Wave power is an emerging technology but there are no developed systems under commercial operation. These innovations are either not ready for commercial development or limited to very particular sites.
MARITIME SURVEILLANCE (MS)	MS1	**Integrated and interoperable maritime situational awareness platforms and services**	There is a gap between the existence of technologies related to this field and the realization of real sharing data systems. R&D is fundamental to fill this gap.
	MS2	**Strengthening EU Capability in observing the marine environment**	The increase of the participation of all Mediterranean countries in EU research projects is necessary in order to share the knowledge in R&D and technologies to homogenize the experience among all EU countries.
	MS3	**Interactive and Dynamic Atlas of Maritime Risk Maps**	An improvement of research activities in each EU nations is fundamental, increasing the participation in specific EU research projects.
	MS4	**Operative system for Search and Rescue Planning**	
	MS5	**Development of Intelligent Vessels Monitoring Systems**	Transfer of technologies to this maritime monitoring application from other sectors.
	MS6	**Monitoring solutions for illegal fisheries control**	
FISHERY AND AQUACULTURE (FA) - Small Scale Fisheries -SSF	FA1	**Control and monitoring of SSF activities**	Although SSF is the major part of the fishing activity, is actually uncharted and the main source of illegal fishing. Control and monitoring of SSF activities is of vital importance for the assessment of the corresponding fishing effort, which by now is totally unreported. The traceability of SSF vessels can be achieved using technologies/methodologies developed, or under-development, for large-scale fisheries based on radio frequencies, satellites and/or internet applications, as well as methodologies for data gathering and manipulation.
	FA2	**Geographical designations/ Branding and Eco-certification of products**	
	FA3	**Co-management with other uses and activities**	Co-management can be an effective approach for developing innovative solutions for the management of SSF.
	FA4	**Valorization of underutilized species/ waste or by-products**	
	FA5	**Diversification of fishing activities from the traditional activity**	Better understanding of social and economic benefits associated with this diversification.

SECTOR	CODE	INNOVATION POTENTIAL (IP)	KEY ENABLING FACTOR (KEF) R&D (KNOWLEDGE AND TECHNOLOGIES)	
FISHERY AND AQUACULTURE - Marine Aquaculture - MA	FA6	**Reduction of feed costs combined with feed improvements**	Continued advancement in several areas will facilitate future success in the marine farming sector. Production costs reduction and production technology of new species need to be addressed by research. Therefore, the research and development plans are targeted at improving production technologies, especially energy efficiency (carbon footprint), waste water treatment, the efficiency of feeds, improving the growth trajectory of new species and reducing the susceptibility of the animals to diseases and viruses. Specific environmental conditions causing algal blooms, and the spread of biotoxins with links to human and aquatic organism health also have a strong interest.	
			Intensify research on climate change likely to be a primary driver for change in the MED aquaculture industry over the next 50 years.	
	FA7	**Diversification with larger-size, higher-value-added finfish species**	Needed are robust national plans for research and technology development for established and new cultured/farmed species, sustainable feed production, new farming technologies, new biotech products, processing, and environmental management and policy.	
	FA8	**Sustainability certifications and labeling**	Offshore aquaculture requires new technologies. Highly specialized, remote control and monitoring capabilities via leading-edge telemetry systems are a major component of the operating methodology along with the feasibility to feed and observe the fish regardless of whether staff is present on site. This applies also to Multi-Use Platforms.	
	FA9	**Development of floating multi-use platforms adapted to deeper waters**	Application of Blue Biotechnology provides powerful tools to introduce new technical knowledge/practices and opens up new horizon for farming high performing novel species.	
	FA10	**Integrated multi-trophic aquaculture - IMTA**	The main obstacle preventing IMTA to be commercially adopted is the lack of scientific information on choosing compatible species, knowing the carrying capacity of a production area and interactions between species feeding at different trophic levels, as well as its socio–economic impacts. Technological improvements related to farming and harvest methods need to be developed and conventional inshore technologies will be necessary.	
BLUE BIOTECHNOLOGIES (BB)	BB1	**Micro and Macro Algae Farming and Exploitation**	There are KEFs cross-cutting to all IPs:	The sector is still in development and the main part of the efforts are concentrated in R&D activities, apart fromalgae for which the Technology Readiness Level is higher. Despite this, commercial products already exist, especially in high added value area such as pharmaceutical industry, and not only based on algae organisms.
			- The enhancement of existing blue biobanks and their implementation;	Discovery of new species is necessary; PBR models or cultivation systems fit for very few algal species; scale up is difficult and not performed until now in PBRs; growing conditions are difficult to control and the production is unstable and difficult to predict, the culture medium is submitted to external incursions: weather and temperature conditions, predator animals, zooplankton and macro algae, diseases and complex to understand and maintain; the biorefinery concept is completely missing and the extraction procedures are not optimized.
			- Greater harmonization and standardization in the methods of data generation resulting from high-throughput technologies, currently available;	
	BB2	**Microbes and enzymes exploitation**	- The improvement of the automation of screening procedures for marine products and compounds;	In most countries, research activities are performed mainly by universities, spin-offs and research institutes. Marine microorganisms can be difficult to culture in laboratories due to specific conditions required and their production is often limited by low yields.
	BB3	**Valorization of fisheries and aquaculture by-products and wastes**	- The development of new data mining tools and exploitation of research results in terms of technology transfer and creation of spin-offs and start-ups.	Establishing a profitable, sustainable industry to exploit fisheries and aquaculture by-products and wastes is going to take creative chemistry and physics. It needs a sustainable fractionation method to separate proteins, enzymes, calcium carbonate and chitin — one that avoids corrosive or hazardous reagents and minimizes waste.

SECTOR	CODE	INNOVATION POTENTIAL (IP)	KEY ENABLING FACTOR (KEF) R&D (KNOWLEDGE AND TECHNOLOGIES)
COASTAL AND MARITIME TOURISM (CMT)	CMT1	**Big Data, digitalization and ICT services for active living in coastal area**	Development of artificial intelligence capable of identifying human users, learning their behaviors and creating representations of their environment; mobilize innovations around the digital (smartphone application development, augmented or virtual reality, etc.).
	CMT2	**Sustainable leisure boating**	Facilitate navigation to novices, with easy-to-navigate or even autonomous vessels and the adaptation to current consumption patterns with boat sharing or offers for the boater via digital applications are interesting levers; increasing use of ecological moorings, sometimes including systems having a positive effect on reduction of atmospheric pollution of cruise ships (LNG, dock connection, use of scrubbers, etc.); new designs for marinas, boats, equipment and marina services integrating eco-design and adapted both to meet the needs of older boaters and to attract younger people and families, other innovative coastal facilities and maritime routes as well as networking.
	CMT3	**Smart management of the coastal infrastructure and extreme events**	The transformation from data to knowledge is essential to engage non-technical end users that generally are not able to use raw data. It is important to implement in the Marine Observatories some feedback mechanisms between support technicians and the scientists team (and vice versa) to keep the Marine Observatories functioning and efficient.
	CMT4	**Integrated and Sustainable tourism**	Need to study carrying capacity: assessment of tourism attendance, flows, socio-economic impacts, ecological disturbances, etc.; implement water-related technologies (reuse, treatment, etc.) and waste reduction (new materials to reduce the impact in the environment, collection at sea, recovery of waste, etc.) are indeed carriers of innovation. Use the participatory sciences are more and more used to involve tourists in the management actions of the environment and supports the work of coastal managers.

Table 4 9Key Enabling Factor (KEF) - R&D (Knowledge and Technologies)

SECTOR	CODE	INNOVATION POTENTIAL (IP)	KEY ENABLING FACTOR (KEF) MARKETING
MARINE RENEWABLE ENERGIES (MRE)	MRE1	**Floating Offshore Wind Energy (FOWE)**	There is a lack of marketing actions in the different countries and a lack of awareness about Marine Renewable energies in general and this concerns the different stakeholders: Industries, Research and academics actors, Policy makers and the civil society.
	MRE2	**Wave Energy & Tidal Energy**	
MARITIME SURVEILLANCE (MS)	MS1	**Integrated and interoperable maritime situational awareness platforms and services**	
	MS2	**Strengthening EU Capability in observing the marine environment**	An important gap is the absence of market actions in European countries. A solution of this problem could be a more involvement in EU market of the principal industrial companies, improving new technologies in this field and increasing the global market of them.
	MS3	**Interactive and Dynamic Atlas of Maritime Risk Maps**	
	MS4	**Operative system for Search and Rescue Planning**	Now only single components are available, more effort is needed to have products ready for the market.
	MS5	**Development of Intelligent Vessels Monitoring Systems**	
	MS6	**Monitoring solutions for illegal fisheries control**	
FISHERY AND AQUACULTURE (FA) - Small Scale Fisheries -SSF	FA1	**Control and monitoring of SSF activities**	The Marine Stewardship Council (MSC) fisheries certification standard can support the sustainability of the fishing sector and the promotion of certified, high-quality products to consumers (STECF, 2018).
	FA2	**Geographical designations/ Branding and Eco-certification of products**	The SSF post-harvest subsector (including buyers, processors, and market linkages) is part of the fishery system, as well as its governance system plays a central role in the related value chain as fishers are directly connected with other local actors such as public and private institutions and consumers. Due to a growing interest in sustainable and eco-friendly products, SSF products, if well processed and promoted, could perfectly integrate in a new market dynamic (e.g. as Km0 products).
	FA3	**Co-management with other uses and activities**	Strengthening the role of fisheries communities through co-management of resources, co-creation of projects, and co-ownership of local development, facilitating their engagement with pescatourism and environmental conservation. Valorisation and dissemination of sustainable fishery activities and products within the tourism sector through regional /programmes and pilot projects in association with the fishers. Regional and local tourism operators, restaurant owners and chefs, fisheries associations, local authorities, and NGOs.
	FA4	**Valorization of underutilized species/ waste or by-products**	Strengthen collaborations between key players for commercial purposes.
	FA5	**Diversification of fishing activities from the traditional activity**	

SECTOR	CODE	INNOVATION POTENTIAL (IP)	KEY ENABLING FACTOR (KEF) MARKETING
FISHERY AND AQUA-CULTURE - Marine Aquacul-ture - MA	FA6	**Reduction of feed costs combined with feed improvements**	There is a general distrust on aquaculture products which need to be deleted. Knowledge on production process and traceability have to increase.
	FA7	**Diversification with larger-size, high-er-value-added finfish species**	In each country national market requires targeted informative and marketing activities in order to increase the consumption of farmed products and improve the consumer perception on the farmed products. Furthermore, it is necessary to promote in cooperation with producers the importance of the creation of producers organisations, determine the minimum quality stan-dards, develop marketing channels within the sector, as well as a marketing strategy, while at the same time taking into account the regional and cultural particularities.
	FA8	**Sustainability certifications and labeling**	Strategic marketing plans are important for the promotion of prod-uct development and commercialization in both traditional and new markets.
	FA9	**Development of floating multi-use platforms adapted to deeper waters**	The social relevance of finfish/shellfish aquaculture has to be devel-oped by raising awareness on aquaculture and processes.
	FA10	**Integrated multi-trophic aquaculture - IMTA**	Supporting efforts for the development and market replication of inno-vative solutions is defined highly significant in particular in the fields of aquaculture and marine biotechnology related technologies and services. Furthermore appropriate economic and regulatory incentives could alleviate, through a synergistic approach, the high cost of produc-tion for feeds alternatives that makes them infeasible commercially for several farmed species.
BLUE BIOTECH-NOLOGIES (BB)	BB1	**Micro and Macro Algae Farming and Exploitation**	Marketing of nutraceutical/cosmetic products is ready and it has an increasing trend; pharmaceuticals are far from being produced and only in vitro assays have been performed.
			Market ready for a new generation of food product, good acceptability of natural products.
			Implement business models based on the concept of Biorefinery: the establishment of regional pilot plants and small biorefineries could encourage and boost further investment.
			Create sectorial consortia.
			The whole process is still costly; value chain integration is not optimal and is a key issue that inhibits investment at present; one of the greatest challenges is converting scientific discoveries and innovations into successful productive units; viability of the economic model is not known; for health and pharmaceutical products, a long process is required for the control; for biofuel, products are not in the market and it is expected not to occur before 10-30 years.
			Communication to stakeholders and publicity must be implemented for future developments in Blue biotech.
			Raise awareness of the consumer about Blue Biotechnology.
	BB2	**Microbes and enzymes exploitation**	Marketing of microbial enzymes/enzyme-based formulations is ready and it has an increasing trend. No/few marketing actions and com-munications about the application of blue biotechnologies in different sectors.
	BB3	**Valorization of fisheries and aquacul-ture by-products and wastes**	Scale up at industrial level of laboratory protocols.
COAST-AL AND MARITIME TOURISM (CMT)	CMT1	**Big Data, digitalization and ICT ser-vices for active living in coastal area**	Contribute to strengthen the value of the territory with a wide offer more attractive for different kind of tourism; Digital platforms to pro-mote and commercialize tourist destination and tourist experience
	CMT2	**Sustainable leisure boating**	
	CMT3	**Smart management of the coastal infrastructure and extreme events**	
	CMT4	**Integrated and Sustainable tourism**	

Table 4 10Key Enabling Factor (KEF) - Marketing

SECTOR	CODE	INNOVATION POTENTIAL (IP)	KEY ENABLING FACTOR (KEF) CLUSTERS, TECHNOLOGY PLATFORMS
MARINE RENEWABLE ENERGIES (MRE)	MRE1	Floating Offshore Wind Energy (FOWE)	All countries think they have a high or almost high readiness level in terms of clusters and technology platforms active on these IPs.
	MRE2	Wave Energy & Tidal Energy	
MARITIME SURVEILLANCE (MS)	MS1	Integrated and interoperable maritime situational awareness platforms and services	The industrial EU partners are large groups and some SMEs are very active in the market of maritime surveillance. Clusters and TPs can sustain the effort towards a better integration of public and private research and fast deployment and exploitation of innovation at all levels.
	MS2	Strengthening EU Capability in observing the marine environment	
	MS3	Interactive and Dynamic Atlas of Maritime Risk Maps	
	MS4	Operative system for Search and Rescue Planning	
	MS5	Development of Intelligent Vessels Monitoring Systems	
	MS6	Monitoring solutions for illegal fisheries control	
FISHERY AND AQUACULTURE (FA) - Small Scale Fisheries -SSF	FA1	Control and monitoring of SSF activities	
	FA2	Geographical designations/ Branding and Eco-certification of products	In connection with marketing actions, the creation of competitive economic clusters can foster the development of coastal communities. In this context, best practices for value creation could be implemented in the fields of labeling, direct sale, processing, diversification, inter-sectoral integration, and vertical coordination.
	FA3	Co-management with other uses and activities	Strengthen links to local agro-food sectors (land and sea products) by promoting innovative fishery products/processing, creating networks with local tourism, and organising fish festivals, education programs (children and adults), local gastronomy experiences and environmental protection associations/NGOs.
	FA4	Valorization of underutilized species/ waste or by-products	
	FA5	Diversification of fishing activities from the traditional activity	Support twinning, partnerships and interregional cooperation among pilot projects to further develop or aggregate into a regional bioeconomy value chain. Create mechanisms (e.g. networks, clusters) that can further support stakeholder interaction, upstream (process initiation) and downstream (end user/process output) of the value chain, and promote knowledge transfer and communication.
FISHERY AND AQUACULTURE - Marine Aquaculture - MA	FA6	Reduction of feed costs combined with feed improvements	There is a general distrust on aquaculture products which need to be deleted. Knowledge on production process and traceability have to increase.
	FA7	Diversification with larger-size, higher-value-added finfish species	In each country national market requires targeted informative and marketing activities in order to increase the consumption of farmed products and improve the consumer perception on the farmed products. Furthermore, it is necessary to promote in cooperation with producers the importance of the creation of producers organisations, determine the minimum quality standards, develop marketing channels within the sector, as well as a marketing strategy, while at the same time taking into account the regional and cultural particularities.
	FA8	Sustainability certifications and labeling	Strategic marketing plans are important for the promotion of product development and commercialization in both traditional and new markets.
	FA9	Development of floating multi-use platforms adapted to deeper waters	The social relevance of finfish/shellfish aquaculture has to be developed by raising awareness on aquaculture and processes.
	FA10	Integrated multi-trophic aquaculture - IMTA	Supporting efforts for the development and market replication of innovative solutions is defined highly significant in particular in the fields of aquaculture and marine biotechnology related technologies and services. Furthermore appropriate economic and regulatory incentives could alleviate, through a synergistic approach, the high cost of production for feeds alternatives that makes them infeasible commercially for several farmed species.
BLUE BIOTECHNOLOGIES (BB)	BB1	Micro and Macro Algae Farming and Exploitation	Build the bridge between existing biotech entrepreneurs and environmental biotechnology and bring them closer to the enormous advancement of blue biotech, form alliances and mature the biotech clusters evolution.
	BB2	Microbes and enzymes exploitation	
	BB3	Valorization of fisheries and aquaculture by-products and wastes	
COASTAL AND MARITIME TOURISM (CMT)	CMT1	Big Data, digitalization and ICT services for active living in coastal area	
	CMT2	Sustainable leisure boating	
	CMT3	Smart management of the coastal infrastructure and extreme events	
	CMT4	Integrated and Sustainable tourism	

Table 4 11Key Enabling Factor (KEF) - Clusters, Technology Platforms

SECTOR	CODE	INNOVATION POTENTIAL (IP)	KEY ENABLING FACTOR (KEF) TRANSBOUNDARY COOPERATION
MARINE RENEWABLE ENERGIES (MRE)	MRE1	**Floating Offshore Wind Energy (FOWE)**	
	MRE2	**Wave Energy & Tidal Energy**	
MARITIME SURVEILLANCE (MS)	MS1	**Integrated and interoperable maritime situational awareness platforms and services**	
	MS2	**Strengthening EU Capability in observing the marine environment**	
	MS3	**Interactive and Dynamic Atlas of Maritime Risk Maps**	Considering the transnational character of maritime surveillance this product can be shared with other countries that do not have the same prevention system or with countries that must enforce their knowledge in this field. In fact, the integration between EU nations is one of the basic steps towards the Common Information Sharing Environment (CISE) promoted by EU. Since 2008 MSFD obliges the member States the overlook the same marine region to elaborate together plans finalized to guarantee the good ecological state of the own sea area.
	MS4	**Operative system for Search and Rescue Planning**	There is not enough cooperation connected to development of operational systems for marine Search and Rescue.
	MS5	**Development of Intelligent Vessels Monitoring Systems**	
	MS6	**Monitoring solutions for illegal fisheries control**	
FISHERY AND AQUACULTURE (FA) - Small Scale Fisheries -SSF	FA1	**Control and monitoring of SSF activities**	
	FA2	**Geographical designations/ Branding and Eco-certification of products**	
	FA3	**Co-management with other uses and activities**	
	FA4	**Valorization of underutilized species/ waste or by-products**	
	FA5	**Diversification of fishing activities from the traditional activity**	
FISHERY AND AQUACULTURE - Marine Aquaculture - MA	FA6	**Reduction of feed costs combined with feed improvements**	Addressing aquaculture-related transboundary issues is key for the promotion of the sector so that it is globally more competitive, sustainable, productive, profitable and equitable. Compliance of non-EU countries with the EU acquis and alignment to common standards are essential for long-term sustainability.
	FA7	**Diversification with larger-size, higher-value-added finfish species**	
	FA8	**Sustainability certifications and labeling**	
	FA9	**Development of floating multi-use platforms adapted to deeper waters**	
	FA10	**Integrated multi-trophic aquaculture - IMTA**	
BLUE BIOTECHNOLOGIES (BB)	BB1	**Micro and Macro Algae Farming and Exploitation**	The sector would need elaboration of coordinated national strategies at the Euro-Mediterranean level (cap, administrative simplifications, regulatory adjustment to facilitate the placing on the market of developments, investment incentives ...) and establishment of an observatory of the sector at the European level
	BB2	**Microbes and enzymes exploitation**	
	BB3	**Valorization of fisheries and aquaculture by-products and wastes**	A cooperation among these countries, and not only, can speed up the achievements of specific scientific key targets.
COASTAL AND MARITIME TOURISM (CMT)	CMT1	**Big Data, digitalization and ICT services for active living in coastal area**	
	CMT2	**Sustainable leisure boating**	Protection of maritime areas is a challenge in a cross-border and highly frequented touristic area.
	CMT3	**Smart management of the coastal infrastructure and extreme events**	
	CMT4	**Integrated and Sustainable tourism**	

Table 4 12Key Enabling Factor (KEF) - Transboundary cooperation

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