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B-Blue

Building the blue biotechnology community in the Mediterranean

WP3 Studying

DELIVERABLE 3.2.3

Analysis of the connection of the BBt innovative solutions with RIS3, SDGs & innovation trends

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List of Abbreviations and Acronyms

Acronym	
EC	European Commission
EP	European Parliament
BBt	Blue Biotechnologies
SGDs	Sustainable Development Goals
KETs	Key Enabling Technologies
RIS3	Research and Innovation Strategies for Smart Specialization
RIS4	Research, Innovation and Social Strategy for Smart Specialization
BE	Blue Economy
MED	Mediterranean
POPs	Persistent Organic Pollutants
BPs	Best Practices
VC	Value Chain
IMTA	Integrated Multi-Trophic Aquaculture
R&I	Research and Innovation
UN	United Nations
BG	Blue Growth
MSFD	Marine Strategy Framework Directive
EP	European Parliament
CAP	Common Agricultural Policy
CEAP	Circular Economy Action Plan
BBI-JU	Bio-based Industries Joint Undertaking
BIC	Bio-based Industries Consortium
EMFAF	European Maritime Fisheries and Aquaculture Fund
EMFF	European Maritime and Fisheries Fund
SMEs	Small and Medium-sized Enterprises
CFP	Common Fisheries Policy
ERDF	European Regional Development Fund
OECD	Organization for Economic Co-operation and Development
LQ	Location Quotient
EARDF	European Agricultural Fund for Rural Development
CF	Cohesion Fund

About B-Blue project

Ten (10) partners with proved experience in the Blue Bioeconomy field from 8 Mediterranean (MED) countries and more than 300 Mediterranean (MED) stakeholders from universities, research centres, public authorities, business support organizations and MED multilateral organizations, working together for twenty-two (22) months to create the Blue Biotechnologies (BBt) community in the Mediterranean. The exploitation of marine bio-resources through biotechnological solutions is a field with massive potential for innovation and economic growth. This field is a relatively young discipline, so opportunities and key enabling factors need coordination. B-Blue project aims at gathering the key actors of the Med BBt sector and increase their innovation capacity and their coordination to unlock the innovation potential in the field through joint transnational initiatives, involving also organizations from the Southern Shore of the Mediterranean. The transnational coordination framework, the project aims to create, is based on an inclusive quintuple-helix approach always including the socio-environmental perspective in the decisional process and building on a common knowledge ground selected on the basis of its potential of addressing the Sustainable Development Goals (SGDs) at Med level. The B-Blue work towards to the implementation of a transnational coordination mechanism for the BBt community through the mutual interconnection the digital BBt community platform and a Med network of territorial based-collaborative space on selected BBt value chains (BBt HUBs).

About WP3 – Deliverable 3.2.3

The Mediterranean Basin is considered one of the world most important hot spot for marine biodiversity and benefits from a vast potential for the use of marine organisms. It could be a major blue biotechnology service provider for food, feed, bio-based materials, chemicals, cosmetics, pharmaceutical, agriculture, textile companies. Blue Bioeconomy is a growing area with the potential to replace the use of fossil resources, create new high-value products and at the same time create new jobs. Bio-economy extends across sectors and industries and includes the production of renewable biological resources as well as the utilization of side-streams and residual products for high added value products. Mediterranean marine and coastal wealth should be rationally used and protected from the increasing environmental pressures and climate change to sustain the full range of health and well-being benefits it provides. The development of BBt can mitigate the environmental impacts of several industries and create useful applications to address societal challenges in the Mediterranean regions.

Blue Biotechnology (BBt) is a new field in the EU-Mediterranean area with few pilot demonstrations therefore the monetary valuation of products, services and systems throughout the life- cycle is still in the early stages. This very promising and still under-exploited sector faces many challenges, including the industrialization of processes. The development of the BBt sector in the Mediterranean regions requires policy engagement, coalition-building between multiple stakeholders and government line departments and effective science communication for raising public and industry awareness.

The overall objective of WP3 is to create a project knowledge package in the Mediterranean BBt sector and provide useful insights in the development and characterization of the most promising value chains for the study area, as identified in D3.2.2. D3.2.3 aims to provide an easy-to-read document that: i) illustrates the benefits of BBt applications for the people and society, ii) analyses how these applications support the implementation of SDGs and other sustainability strategies, iii) correlate innovation potential, regional trends and Research and Innovation Strategies for Smart Specialization (RIS3) and iv) initiate a common vision for targeted interventions on regional level integration to accelerate entrepreneurship and innovation in the EU-Mediterranean BBt sector. D3.2.3 forms the basis to set out policy recommendations and strategic plans at regional level, identify joint initiatives and common approaches for knowledge transfer in support of WP6.

Blue biotechnology applications

Oceans and coasts serve critical needs of human development, such as nutritious and healthy diet, medicines, nutrient recycling and climate regulation. Through the fishing and aquaculture industry, marine renewable energy, shipbuilding, tourism and maritime transport, Blue Economy (BE) in Europe provides 4.5 million direct jobs and about €1.3 trillion to global gross value added, which could be double by 2030. However, the intensive use of the marine and coastal resources and land-based pollution runoffs destabilize marine ecosystems, cause biodiversity declines and, ultimately, threaten our future prosperity.

The main current R8I activities of blue biotechnology in MED area are associated with applications such as securing the food supply with marine-derived food products and nutraceuticals, alternative sources of energy, human and environmental health with the development of novel drugs, painkillers, antibiotics, anticancer drugs, and cosmetics from marine bioresources, directly or indirectly from marine flora and fauna and the production of enzymes, biopolymers, bio-adhesives, and biomaterials. On the other hand, there is an emerging development of biotechnological approaches, mechanisms, and applications to address key environmental issues such as marine-derived antifouling strategies, marine habitat restoration, bioremediation of marine ecosystems, and the use of high-resolution bio-sensing techniques to *in situ* monitor the marine environment.

Innovative products and services driven by blue bio-based research and development activities are opening new and diversified markets, while simultaneously improving the sustainable management of biological resources and conservation of ecosystem services. The first steps of the BBt value chains are associated with bioprospecting aquatic organisms, explore biodiversity and with biomass production and/or harvesting marine bioresources, from microorganisms, such as bacteria and microalgae, to macroorganisms, such as invertebrates, fish, macroalgae and plants.

In order to reflect the most effective and developed applications of blue biotechnology, which exist and can be established in the MED area, we took into consideration technology best practices (BPs) and frontrunners already listed in D3.2.1 and the four (4) value chains (VC) that can be commercially viable at scale by 2030 in MED area, as defined in D3.2.2.: the algae market (VC1), the valorization of organic wastes and by-products of fisheries and aquaculture (VC2), sustainable aquaculture and integrated multi-trophic aquaculture - IMTA (VC3) and, finally, the cross-sectoral value chain of marine environment conservation/restoration (VC4.)

VC1 VC2 VC3 VC4

Health benefit | Environmental benefit | Social benefit

Segments	VC	Example BBt applications	Benefits
Food and nutrional supplements	VC1	Algae biomass for raw salads, crisps, spaghetti, haute cuisine, meat substitutes and nutrional supplements	Source of essential nutrients for a healthy diet and child nutrition - significant amount of protein, amino acids, fatty acids, and vitamins
	VC1	Algae hydrocolloids (agar, sodium alginate, carrageenan) for gelatine substitutes and dairy products processing	Lower environmental footprint than land-based food sources/ less use of water resources and fertilisers restoring aquatic biodiversity
	VC2	Aquaculture/ fisheries by-products and discards valorisation for nutritional supplements	Climate resilient crops for reliable food supply, especially in insular and water-scarce areas, enables the creation of quality jobs and income in coastal regions
Pharmaceuticals and cosmetics	VC1	Bioactive compounds of algae for antioxidant, anti-tumor, antimutagenic, antibacterial, anti-inflammatory, neuroprotective, anticoagulant and antifungal medicines, moisturizers, UV sunscreens, toothpastes and body-scrubs	Dicease treatment and prevention, personal hygiene, healthy skin Bio-based, biodegradable and compostable materials Increase of human well being, ethical products and processes
Fish, crop, livestock production	VC1	Microalgae as feed supplement and immunostimulant in fish farming	Animal health and welfare
	VC1	Algae-based additives in plant biostimulants and agronomic fertilisers	Improvement in disease resistance with organic solutions
	VC2	Aquaculture/ fisheries by-products and discards valorisation as livestock feed supplements	Lower environmental footprint than other fertilizer alternatives
	VC2	Waste mussel shells as an enrichment and calcium source in poultry feed and agronomic fertilizers	Reduction in methane emissions from livestock, efficient resource use
	VC3	Integated multi-trophic aquaculture to improve productivity and environmental sustainability in aquaculture	Increase in agricultural productivity, income and jobs Circular business models
Bio-materials	VC1	Microalgae-based bioplastics for food packaging, disposable cups, straws, textiles and shoes	Bio-based, biodegradable and compostable materials
	VC2	Fish skin as substitute of leather in fashion fabrics	Less use of fossil fuels in products and processing
	VC2	Aquaculture/ fisheries by-products and discards valorisation for bio-plastics in food packaging	Lower environmental footprint than other leather alternatives Improvement in revenue and waste management
Biofuels	VC1	Macroalgae processing by-products for biofuels (biodiesel, biogas)	Reduction of air pollution health impacts
	VC2	Aquaculture/ fisheries by-products and discards valorisation for biodiesel, biogas and methane production	Lower environmental footprint than other energy sources Quality energy, less dependence on imported fuels
Ecosystem services	VC1	Breeding and cultivation of endemic species of seaweed for environmental conservation and adaptation to climate change	Prevents human diseases from contaminants
	VC1	Microalgal species for soil and wastewater bioremediation	Nature-based solutions to protect, sustainably manage, and restore natural or modified ecosystems
	VC1	Macroalgae forests to optimize carbon, nitrogen and phosphorus management	Increased sea food production and productivity Enables the creation of new jobs and income in coastal regions
	VC3	Marine biosensors and early-warning systems for water pollution research, monitoring and control	Increase of oxygen content in urban areas

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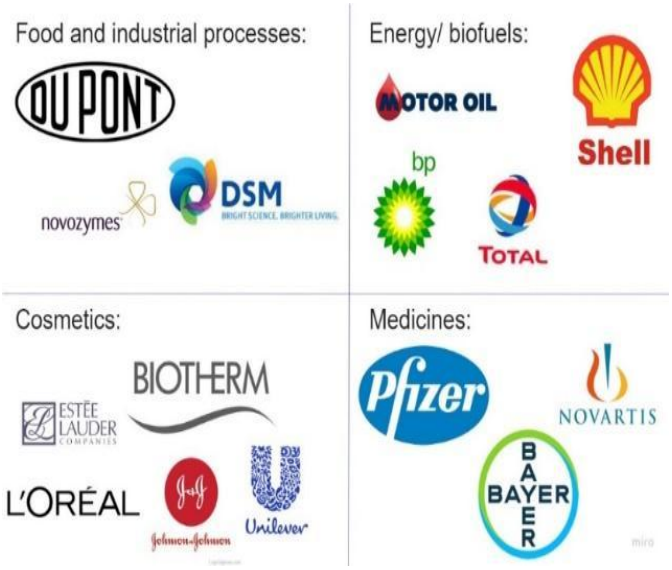
***Figure 1**: Example applications and benefits of BBt*



Blue biotechnologies (BBt) can offer key enabling technologies (KETs) towards the transition to resource-efficient and sustainable economies. The development of innovative technologies based on marine bio-resources could be considered as an opportunity to contribute towards greener production and consumption business models. Blue biotechnology could be a crucial source of revenue in the Mediterranean, targeting a global market, but it is still poorly explored. Figure 2 shows some examples of international corporations that invest in research and innovation (R&I) of BBt.

***Figure 2**: International corporations that invest in BBt*

Contribution to sustainable development goals

In 2015, United Nations (UN) Member States adopted the 2030 Agenda[2] for Sustainable Development to share a common vision on development for peace and prosperity for people and the planet, now and into the future. Comprehensive actions are proposed to countries - developed and developing - in a global partnership to meet seventeen (17) goals for sustainable development (SDGs) with 169 specific targets that cover the social, economic, environmental and institutional dimensions of sustainability. Each SDG is covered by five or six indicators, which have been selected to reflect the 2030 Agenda's broad objectives. BBt applications have a significant potential to contribute to the SDGs implementation, especially to serve Goal 14, which is dedicated to life below water and promotes actions to conserve and sustainably use the oceans, seas and marine resources. To enhance the narrative of this report and gathering the opinion of relevant experts, a matrix table created (ANNEX I) to illustrate which of the 241 indicators, and therefore SDGs, are affected directly or indirectly and positively from the above mentioned BBt applications. The value chains addressed in B-Blue as the most promising for MED area could have a positive impact on 62% of the indicators, while a direct impact on 32%. Figure 3 shows an overview of how BBt value chains drive solutions for the implementation of SDGs.

[2] *United Nations, General Assembly resolution 70/1, Transforming our world: the 2030 Agenda for Sustainable Development, A/70/L.1 (25 September 2015)-https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E.*

***Figure 3** : BBt support in the implementation of the UN's SDGs*

Relevant EU policies

4.1 Correlation of biotechnology areas with EU strategies

There is a growing focus on sustainability in Blue Bioeconomy as part of the production of food, energy, tourism, transport, etc. The need for research, management and monitoring of the sea's ecosystems grows in order to ensure that the exploitation takes place sustainably.

The Europe 2020 Strategy highlights the bio- and circular economy as key elements to achieve smart, inclusive and sustainable growth in Europe. The bio-economy strategy[3], adopted by the Commission in 2012, supports research activities in food, agriculture and forestry, fisheries, and aquaculture, and biotechnologies, but also the development of bioeconomy markets that improve EU's competitiveness. It supports actions for the transition towards resilient societies that rely on biological resources, including waste, to produce safe food and feed, bio-based materials and bio-energy. The biotechnology industry is the innovation driver of the bio-economy and contributes significantly to food security, climate and renewable energy targets and the UN SDGs. The development of biotechnology is linked to a wide range of European policies. The convergence of global and EU strategies and initiatives and coordination of territorial innovation systems may create

[3]Innovating for Sustainable Growth: a Bioeconomy for Europe', COM(2012)60, https://ec.europa.eu/research/bioeconomy/pdf/official-strategy_en.pdf

the proper business environment where socio-economic incentives could be provided to encourage investors to support new ventures focused on blue biotechnology innovations.

Some of the main EU policies, according to the different areas of biotechnology[4] are listed below.

Marine and fresh-water biotechnology (blue biotechnology)

The EU Strategy for Marine and Maritime Research[5] in the framework of the Integrated Maritime Policy[6], and the Blue Growth (BG) Strategy[7] in the framework of the Europe 2020 Strategy, identify blue biotechnology as one of the key sectors for achieving sustainability in the marine and maritime economy. Research priorities in this area align with, and contribute toward, the objectives of the Marine Strategy Framework Directive (MSFD)[8], the Water Framework Directive (WFD)[9] and the common fisheries policy (CFP)[10]. In 2021, the EU Green Deal[11] set out the roadmap for bio-economy, integrating specific priorities of BG strategy. In 2021, a new approach[12] for the transition to a sustainable blue economy proclaimed by the European Parliament (EP) to support the implementation of EU Green Deal targets, as a complement to BG strategy. This new approach highlights the need for development of a low-impact aquaculture (such as low-trophic, multi-trophic and organic aquaculture), algae production for bio-based products and biofuels, seaweed forests restoration for ecosystem services conservation, mitigation of unwanted catches and discards through more selective fishing techniques. Responsible for the implementation of BE strategy is the Commission's Directorate-General for Maritime Affairs and Fisheries (DG MARE). In 2017, the United Nations proclaimed a Decade of Ocean Science for Sustainable Development[13], to be held from 2021 to 2030, to implement initiatives and various forums that aim to capitalize on ocean science and knowledge to achieve the SDGs which mentioned before. BBt applications contribute to a variety of strategic EU missions that address major societal challenges like climate changes

[4]see FP7 Cooperation Work Programme: Food, Agriculture and Fisheries, and Biotechnologies https://ec.europa.eu/research/participants/data/ref/fp7/132093/b-wp-201301_en.pdf

[5]A European Strategy for Marine and Maritime Research, Brussels, 3.9.2008. COM(2008) 534 final, https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0534:FIN:EN:PDF

[6]https://ec.europa.eu/info/research-and-innovation/research-area/environment/oceans-and-seas/integrated-maritime-policy_en

[7] *COMMUNICATION FROM THE EU COMMISSION (2012) Blue Growth opportunities for marine and maritime sustainable growth COM/2012/0494 final - https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52012DC0494*

[8]Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0056

[9]Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, Current consolidated version: 20/11/2014, ELI: http://data.europa.eu/eli/dir/2000/60/oj

[10] Common Fisheries Policy (CPF): https://ec.europa.eu/oceans-and-fisheries/policy/common-fisheries-policy-cfp_el

[11]*COMMUNICATION FROM THE EU COMMISSION (2019) The European Green Deal COM/2019/640 final - https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF.*

[12] *COMMUNICATION FROM THE EU COMMISSION (2021) on a new approach for a sustainable blue economy in the EU Transforming the EU's Blue Economy for a Sustainable Future COM/2021/240 final - https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0240&from=EN.*

[13] *UN Decade of Ocean science for sustainable development - https://oceandecade.org/*

adaptation including societal transformation, cancer treatment, healthy oceans, seas and inland water, greener cities, soil, health and food security[14].

Novel sources of biomass and bio-products for sustainable bio-economy

Research priorities are in line with, and contribute toward, the objectives of the Common Agricultural Policy (CAP)[15] the Biodiversity Strategy for 2030[16], the Farm to Fork strategy[17], which was adopted in 2020 to support the global transition to sustainable agri-food systems by mitigating or minimizing the environmental impacts of food industry, promoting climate resilient crops, reversing the loss of biodiversity and ensuring food security, nutrition and public health. Furthermore the new circular economy action plan (CEAP)[18], which proposes concrete and ambitious actions towards a circular economy, with measures covering the whole life cycle of products and services (from production and consumption to waste management and the market for secondary raw materials), for accelerating the transition towards a regenerative growth model that gives back to the planet more than it takes. Connected to the EU Green Deal and the circular economy plan, EU supports activities for sourcing, labelling and use of bio-based plastics and the use of biodegradable and compostable plastics to address the impact of certain plastic products on the environment[19] and activities for waste management in an environmentally sound manner promoting the use of the secondary materials they contain.

Industrial biotechnology: novel high added-value bio-products and bio-processes

Industrial biotechnology has been identified as one of five KETs in the context of Industrial Technologies Programme (NMP) and aligns with the objectives of the European industrial strategy[20]. The new industrial strategy for Europe, presented by EC in 2020, aims to support the twin transition

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[14] *Missions in Horizon Europe - https://ec.europa.eu/info/research-and-innovation/funding/horizon-Europe*

[15] European Commission (2018 and 2019) CAP briefs on the nine CAP specific objectives, https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/new-cap-2023-27/key-policy-objectives-new-cap_en

[16] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, EU Biodiversity Strategy for 2030 Bringing nature back into our lives, COM/2020/380 final, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0380&from=EN

[17] *COMMUNICATION FROM THE EU COMMISSION (2020) A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system COM/2020/381 final - https://eur-lex.europa.eu/resource.html?uri=cellar:ea0f9f73-9ab2-11ea-9d2d-01aa75ed71a1.0001.02/DOC_1&format=PDF*

[18] *COMMUNICATION FROM THE EU COMMISSION (2020) A new Circular Economy Action Plan For a cleaner and more competitive Europe) COM/2020/98 final - https://eur-lex.europa.eu/resource.html?uri=cellar:9903b325-6388-11ea-b735-01aa75ed71a1.0017.02/DOC_1&format=PDF*

[19] *European Council (2019) 'Directive (Eu) 2019/904 of the European Parliament and of the Council on the reduction of the impact of certain plastic products on the environment', pp. 1–19.*

[20] Communication "Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery", Brussels, 5.5.2021 COM(2021) 350 final, https://ec.europa.eu/info/sites/default/files/communication-industrial-strategy-update-2020_en.pdf

to a green and digital economy, make EU industry more competitive globally, and enhance Europe's open strategic autonomy[21]. The industrial strategy favors capacity building and strategic alliances within the BBt sector, as it represents a key sector to drive EU industry towards sustainable competitiveness and green economy. The Bio-based Industries Joint Undertaking (BBI-JU), which is a €3.7 billion partnership between the EU and the Bio-based Industries Consortium (BIC), has funded 123 bio-based innovation projects expecting to generate 3.6 million jobs and around €700 billion turnover in the EU. New funding opportunities are expected to open for the period 2021-2017[22].

Biorefinery

Research priorities in this area are closely related to those in the area of industrial biotechnology. Biorifineries are integrated processing facilities for the optimised use of biomass for the production of bio-based materials, chemicals, fuels, energy applications, and food or feed. Current biorefinery research focuses on the production of biofuels, chemical monomers and building blocks for bioplastics, contributing to the objectives of the EU's climate action, the strategic plan for investing in the development of Low Carbon Technologies (SET-Plan) and the EU's mission for plastic pollution and marine litter.

Environmental biotechnology

Deployment of environmental biotechnology will be key for the achieving the SDGs in Europe and globally. This area can significantly contribute to European Green Deal, in particular to the EU action plan towards zero pollution for air, water and soil[23], which adopted in 2021 by the European Commission (EC) within the framework of EU Green Deal, by substituting polluting chemical processes by cleaner bio-processes or by mitigating air, water and soil pollution. Research activities in this area are in line with the goals of the Water Framework Directive and the EU Soil policy[24]. Novel tools in environmental biotechnology such as metagenomics, proteomics, metabolomics improves the knowledge base on biodiversity, in line with the objective 10 (policy area 4) of the EU Biodiversity Action Plan.

Emerging trends in biotechnology

This area concerns a wide range of emerging technologies, such as bioinformatics, nanobiotechnologies and synthetic biology. Research priorities in this area are mostly driven by health, environment and competitiveness policies. Emerging trends in biotechnology can deliver the

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[21] *Keifer, G. and Effenberger, F. (2021) 'Building a stronger Single Market for Europe's recovery', Communication From the Commission To the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, 6(11), pp. 951–952.*

[22] *Bio-based Industries Joint Undertaking (BBI-JU) - https://www.bbi.europa.eu/*

[23] *COMMUNICATION FROM THE EU COMMISSION (2021) Pathway to a Healthy Planet for All EU Action Plan: 'Towards Zero Pollution for Air, Water and Soil' - https://eur-lex.europa.eu/resource.html?uri=cellar:a1c34a56-b314-11eb-8aca-01aa75ed71a1.0001.02/DOC_1&format=PDF*

[24] See the EU Soil Thematic Strategy, https://ec.europa.eu/environment/soil/soil_policy_en.htm

full potential of the industrial biotechnology and nanotechnologies, which have been identified as KETs) in the context of the EU Industrial Strategy. The synergetic effect of nano- and bio-technologies is highlighted in the Communication document Towards a EU Strategy for nanotechnology[25]. Emerging trends in biotechnology, such as bioinformatics and synthetic biology, are also driving innovation in the areas of environmental biotechnology and novel sources of biomass and bio-products and they are indirectly affected by European policies in these areas. However, the use of nano- and bio- materials raises safety and standardization challenges, which need to be addressed in the European regulatory framework. The report on Ethics in Synthetic Biology by the European Group on Ethics in Science and New Technologies (EGE) address the potential ethical and societal challenges arising from synthetic biology. such as interaction of nanomaterials with biological systems

4.2 BlueInvest grants

The European Maritime Fisheries and Aquaculture Fund (EMFAF), former European Maritime and Fisheries Fund (EMFF), is a key supporter of innovative services and technologies, start-ups, early-stage businesses and small and medium-sized enterprises (SMEs) for the blue bio-economy, through the BlueInvest grants[26]. EMFAF supports the EU common fisheries policy (CFP), the EU maritime policy, the EU agenda for international ocean governance[27]. For the period 2021-2027, the BlueInvest equity fund will commit at least €140 million per year to fund early-stage innovative ventures of SMEs and start-ups that are relevant for the Mission[28]. Over the period 2014-2020, the EMFAF has allocated an overall budget of €5,654,992,028 to EU Member States for marine and maritime projects, 51% of which concerns the competitiveness of SMEs and 33% the protection of the environment and resource efficiency. Between 2014 and 2019, the EU has allocated around €130 million to 80 BBt projects under the H2020 program, mostly through BG, mainly through calls for proposals dedicated to BG and BBI-JT initiatives and around €171 million under the European Regional Development Fund (ERDF) for the years between 2014-2018. The average EU contribution per member state is estimated at €297,000 and €247,000 respectively[29]. In 2019-2020, EMFAF provides, through BlueInvest grants, additional €42.5 million to blue economy SMEs for developing new innovative and sustainable products, technologies and services and bring them to the market. Concerning EU-Mediterranean regions, Spain receives the highest budget allocation, followed by Italy, Greece and Croatia.

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[25] Communication from the Commission - Towards a European strategy for nanotechnology, COM_2004_388, https://op.europa.eu/en/publication-detail/-/publication/0c0b7b1f-bd96-43e5-8f63-b26b2398b908/language-en

[26] *Blue Invest platform - https://webgate.ec.europa.eu/maritimeforum/en/frontpage/1451*

[27] *European Maritime Fisheries and Aquaculture Fund (EMFAF) - https://ec.europa.eu/oceans-and-fisheries/funding/emfaf_en*

[28] *Mission, H. O. (2021) 'Smart Specialisation for Sustainable Blue Economy Workshop'- https://s3platform.jrc.ec.europa.eu/documents/20125/*

[29] *Doussineau, M., Gomez, J., & Holstein, F. (2020). Smart Specialisation and Blue biotechnology in Europe. http://doi.org/10.2760/19274*

4.3 Macro-regional and sea basin R&I initiatives

In 2012, the Organization for Economic Co-operation and Development (OECD) and the European Marine Board established a pan-European platform to develop common priorities[30], advance marine research, and bridge the gap between science and policy to meet future marine science challenges and opportunities, promote the sustainable production of biological resources and their conversion into food, feed, bio-based products and bioenergy. Within the study area, there are sevelar other initiatives that fooster innovative and multi-disciplinary research in marine, maritime and coastal economy and they highlight the BBt sector as an important sector for sustainable growth. In 2015, the Euro-Mediterranean Ministerial Declaration on the Blue Economy[31] endorsed by the Union for the Mediterranean (UfM). The WestMED initiative[32] follows up on this declaration to coordinate actions in five EU Member States (France, Italy, Portugal, Spain and Malta), and five Southern partner countries (Algeria, Libya, Mauritania, Morocco and Tunisia) for the development of R&I in six focus areas: Maritime safety and the fight against marine pollution; Maritime cluster development; Skills development and circulation; Sustainable consumption and production; Biodiversity and marine habitat conservation and restoration; Development of coastal communities and sustainable fisheries and aquaculture. The EU Strategy for the Adriatic and Ionian Region (EUSAIR)[33] is another strategy that could benefit the development of BBt in MED area. EUSAIR is a macro-regional strategy adopted by the European Commission, in 2014, to address common challenges of the countries facing the Ionian and Adriatic sea, contributing to the achievement of economic, social and territorial cohesion in EU. Two of the main pillars of EUSAIR are the blue economy and the environmental quality. To achieve the objectives of the abovementioned pillars, EUSAIR focuses on five related areas, namely marine environment, blue biotechnologies, fisheries and aquaculture, maritime and marine governance and services, transnational terrestrial habitats and biodiversity. The strategic R&I Agenda BlueMed[34] is a joint developed and agreed between Cyprus, Croatia, France, Greece, Italy, Malta, Portugal, Slovenia, and Spain and facilitated with the support of the EC in 2014 to promote blue economy-related R&I activities, blue jobs and growth in the Mediterranean area. Finally, the Mediterranean Blue Economy Stakeholder Platform (MedBESP)[35] is a regional platform for networking and knowledge sharing and for supporting the sustainable development of the blue economy in MED area.

Connectivity with regional RIS3

For the purposes of this report, the regional investment priorities, the regional specialization (technological and policy) and the societal challenges addressed in already implemented

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[30] *Calewaert, J.-B. (2012) 'The role of Marine Biotechnology in the Bioeconomy', OECD Global Forum on Marine Biotechnology: Enabling Solutions for Ocean Productivity and Sustainability, (May), p. 39.*

[31] *Union for the Mediterranean (UfM), Euro-Mediterranean Ministerial Declaration on the Blue Economy - https://www.westmed-initiative.eu/wp-content/uploads/2021/06/2015-11-17-declaration-on-blue-economy_en.pdf*

[32] *WestMED initiative - https://www.westmed-initiative.eu/*

[33] *EU Strategy for the Adriatic and Ionian Region (EUSAIR) - https://www.adriatic-ionian.eu/about-eusair/*

[34] *BlueMed initiative-http://www.bluemed-initiative.eu/*

[35] *Mediterranean Blue Economy Stakeholder Platform (MedBESP) (UFM)-https://medblueconomyplatform.org/*

biotechnology projects are being correlated, taking into consideration the participating (B-Blue) regions. The main purpose is to **highlight the current interest and potential of the private sector in each Region**. The data used to perform the analysis were extracted from EC services' data sources in mid-July 2021 and they are structured as follows.:

5.1 Regional investment priorities (according to RIS3)

The related investment priorities or sub-priorities, according to the RIS3 2014-2020 of the selected Regions, have been reviewed (see ANNEX II), sourced by the JRC Eye@RIS3 database (update September 2018)[36]. The Region of Emilia Romagna has presented the revised RIS3 for the programming period 2021-2027 thus the new priorities have been considered. It worth mentioning that most of the Regions adopt RIS3 at regional level, except the selected Regions of Croatia and Montenegro which adopt the national RIS3. The selected RIS3 show *a common interest in developing a bio-economy approach but the major challenges and opportunities in biotechnology, BBt or BE have not been captured yet in most cases*. Among the participating regions, only the Region of Attica (GR), the Central region of Portugal and lately the Emilia-Romagna Region have a clear focus on blue economy in their S3 Strategies. The Central region of Portugal and the Region of Murcia mention biotechnology as a priority domain, while the Central region of Portugal and the Region of Attica mention water biotechnology as a sub-domain of the sustainable blue economy. However, the development of BBt applications can complement several investment priorities and enhance the performance of different economic domains. The relevant investment priorities can be categorized in six (6) major thematic areas, such as:

- → Agrofood and bioeconomy: fish, crop production, technologies for bio-economy, sustainable agriculture, fisheries, aquaculture food, nutritional supplements and agrofood chains.
- → Health and medicines: pharmaceuticals, cosmetics, biomedicines, quality of patient's life, nutritional supplements, hygiene, healthy diet.
- → Advanced materials, manufacturing and processing: bio-plastics/polymers, natural and synthetic fibres, biorefineries.
- → Smart energy systems: low carbon technologies, bio-fuels, smart systems for energy saving and GHG mitigation, biorefineries.
- → Environmental management and protection: environmental monitoring, protection and restoration mechanisms, direct link to agrofood, advanced materials, nanotechnologies and tourism, ecosystem services protection and restoration.
- → Green nanotechnologies: biomass-based nanotechnologies, bio-sensors, ecosystem services protection. Direct link to advanced materials, manufacturing and processing, environmental management and protection: environmental monitoring, protection.

[36] *Eye@RIS3 database (JRC) - https://s3platform.jrc.ec.europa.eu/map*

5.2 Matchmaking with topics address in R&I biotechnology projects

Number of participations in already implemented biotechnology R&I projects (funded by ERDF, Interreg and H2020 for the years 2014-2021) by selected Region and matchmaking with the relevant RIS3 thematic areas (technological and policy). Data sourced by the EU H2020-Interreg Synergies Mapping tool (update 2020)[37].

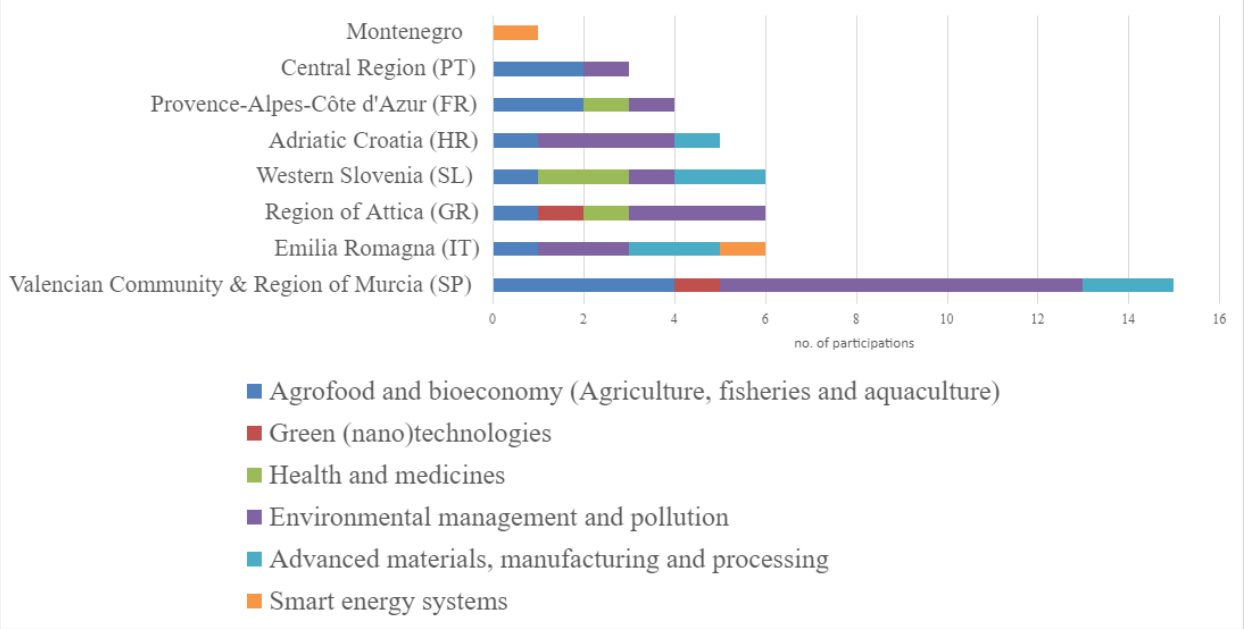

Figure 4 *:Priority sectors addressed in R&I biotechnology projects*

5.3 Actual technological and policy specialization

The thematic distribution and comparison of the received funding from ERDF is shown through the Location Quotient (LQ) to highlight the current development focus of the public and the private sectors in each Region in relation to RIS3 priorities, whenever is possible (e.g. there are no data for ERDF expenditures in Montenegro). LQ is a way of quantifying how the public funding, in this case the received funding from ERDF, is concentrated in a particular area (technological or policy) of a Region, compared to all European Regions. An indicator >1 shows a concentration of funding in a given thematic priority. A notable difference between private and public sector funding lies in health and, in some cases, the agro-food sector, showing the emerging priority domains of the regional economic ecosystems (need for technology transfer activities and collaboration between public and private sector). Data sourced by the Joint Research Centre (JRC) R&I Regional Viewer tool (update October 2019)[38] and they were filtered for the BBt related areas.

[37] see https://webgate.ec.europa.eu/dashboard/sense/app/984fb9e1-b5ad-44ee-b380-c7da695cfd6e/overview
[38] *R&I Regional Viewer tool (JRC) - https://s3platform.jrc.ec.europa.eu/synergies-tool*

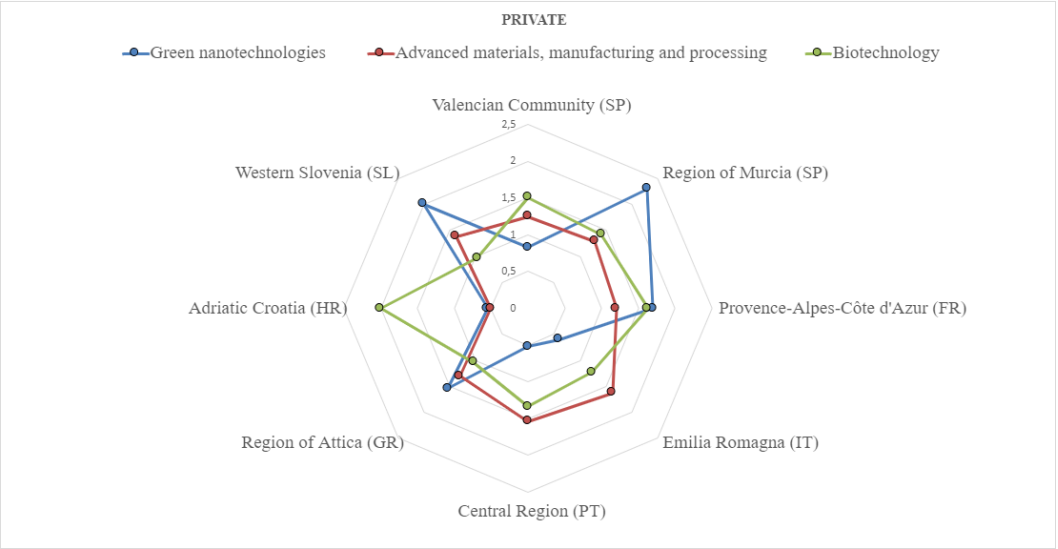

***Figure 5** :Thematic distribution of ERDF funding in the private sector (technological areas)*

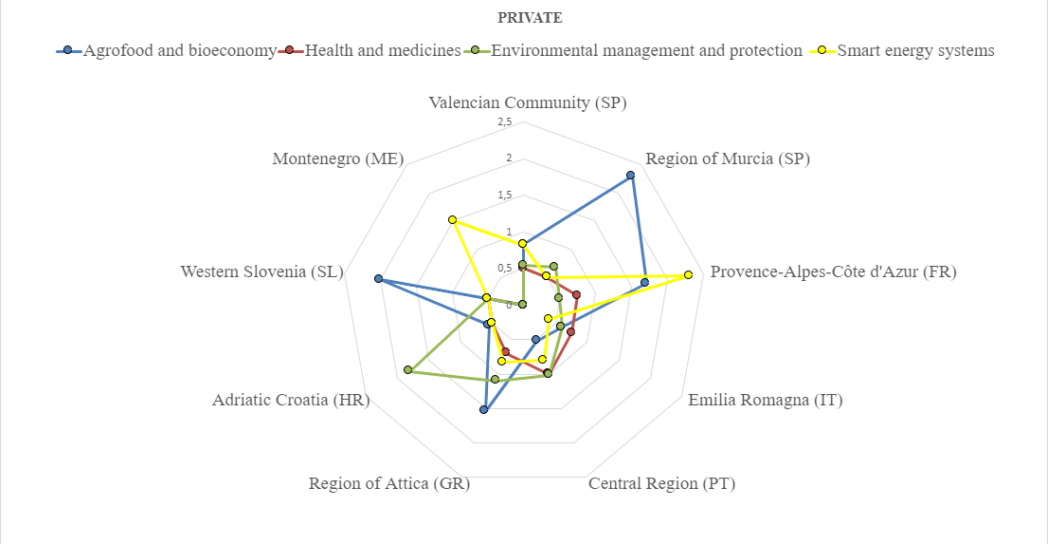

***Figure 6** :Thematic distribution of ERDF funding in the private sector (policy areas)*

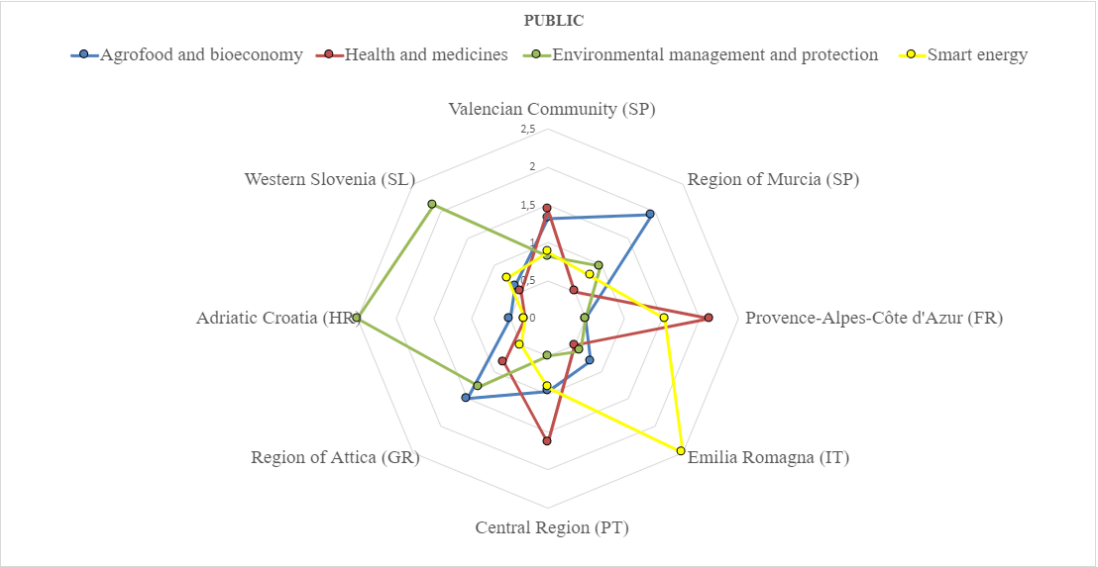

***Figure 7** :Thematic distribution of ERDF funding in the public sector (technological areas)*

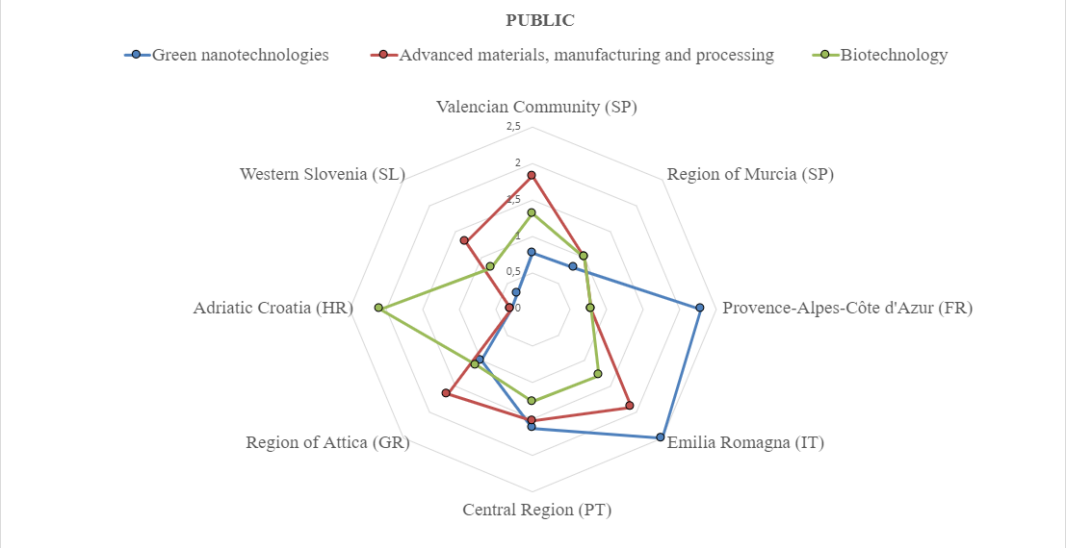

***Figure 8** :Thematic distribution of ERDF funding in the public sector (policy areas)*

5.4 Biotechnology development potential

A correlation of the related RIS3 priority domains, the received funding and the topics of the already implemented biotechnology projects, indicates a rough estimation of the current regional interest for investments in biomass-based technologies in accordance with the relevant thematic areas. The correlation shows that there is a great interest in the fields of environmental protection, agrofood and bioeconomy with the Regions of Spain, Attica (Greece) and Croatia presenting the highest potential. More than 50% of the regions focus in the fields of advanced materials, manufacturing and processing with the Region of Emilia Romagna being the 'frontier'. The Regions of France, Greece and Slovenia have a potential to develop

breakthrough bio- products and technologies in the sector of health and medicines, while the Region of Emilia Romagna and Montenegro in energy systems. Finally, the regions of Spain and Attica have an interest in developing bio-based companies in the emerging field of green nanotechnologies.

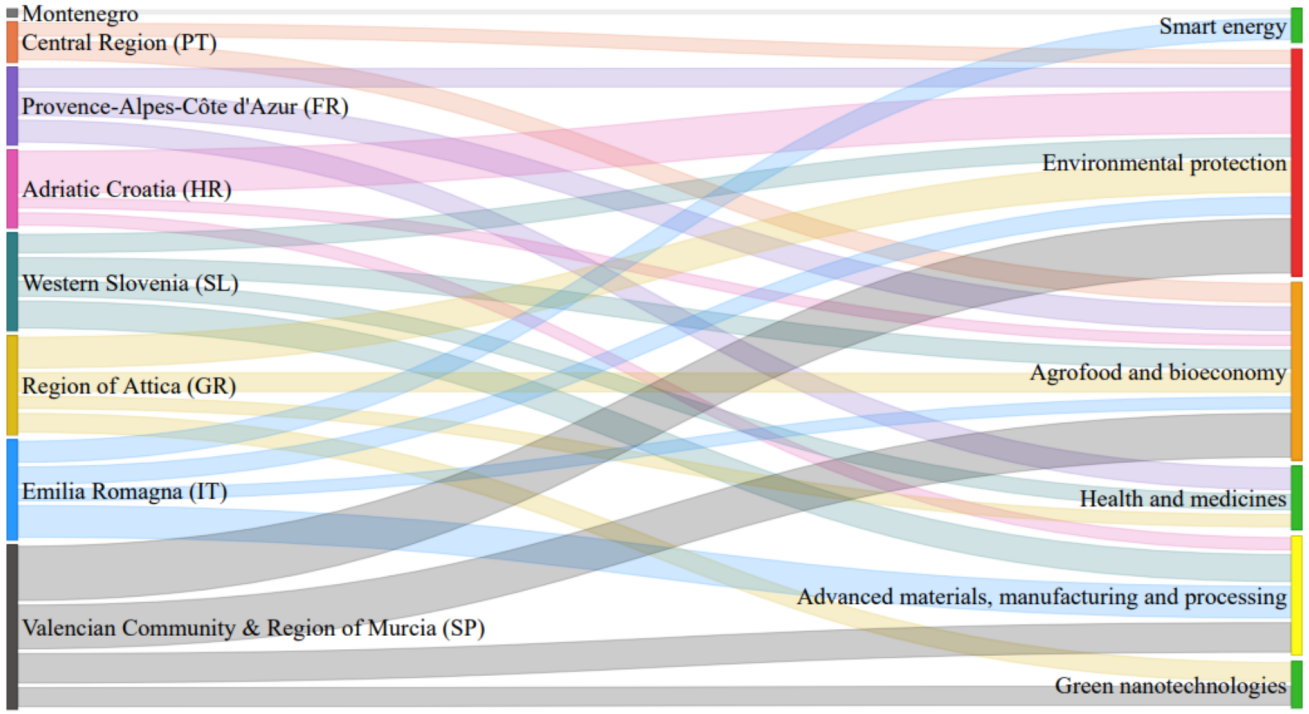

Figure 9 *:Territorial development potential in priority domains of RIS3*

General comments

Using biotechnology to exploit the valuable products and services offered by marine and ocean biological resources can “unlock” a significant innovation potential to build more resilient and competitive regions in the Mediterranean Sea. The European Green Deal, the Biodiversity Strategy, are the key strategic frameworks that propose targeted actions for the development of BBt, empower and protect coastal communities and reverse the impacts of economic and environmental crisis. For example, with the increasing degradation of land-based ecosystem services, there is an urgent need for underwater reforestation initiatives that can support marine ecosystem and biodiversity restoration and protection, secure or even increase local seafood production and professions, address several impacts of climate changes on the marine and inland water environment and coastal resources, store the excess CO2, while growing a valuable marine raw material for high-added value products. This section concentrates general overviews on the Mediterranean RIS3 and blue biotechnology, arising from BBLUE meetings and activities.

- For the period 2014-2020, there were no comprehensive regional specialization strategies in MED Regions specifically on Blue Biotechnology R&I, except from the Regions of Attica, Murcia and Centro. However, for the period 2021-2027, more Regions mention the blue biotechnology sector as a priority area of RIS3, such as the Emilia Romagna and Provence-Alpes-Côte d'Azur Regions.
- There is a need to facilitate investment in Blue Biotechnology, health services, pharmaceutical research and cosmetics, education and other related sectors by *providing the required infrastructure and policy framework (motives instead of legal barriers to entry the market) for the benefit of the private sector*; considering that the Mediterranean economy is based on SMEs that do not have the financial ability over time to overcome the "valley of death". The valley of death refers to financial risks that start-ups face as they struggle to grow from small teams to going ventures.[39].
- Advanced level policy examples for the development of biotechnology solutions are the Blue Bioeconomy Roadmap for Portugal, which was presented in 2019 as a result of a joint work of CIIMAR, BLUEBIO ALLIANCE and Fundação Oceano Azul and the Strategic Plan for Innovation and Technological Development Fisheries and Aquaculture in Spain for the 2014-2020 programming period.
- Spain, Portugal and Italy are running cross-border networking and knowledge transfer projects in the field of BBt, focusing on national and international multi-stakeholder coordination and collaboration.
- There is a need, especially for the eastern Mediterranean regions, to interact with organizations and experts from the Atlantic coast, with a view to promoting the biotechnology policy for the development of innovative products and services, enhancing the value of the Mediterranean as a blue biotechnology destination.
- Horizon Europe's Mission budget, the BlueInvest fund and programmes such as LIFE, ERDF, EMFAF, European Agricultural Fund for Rural Development (EARDF) and Cohesion Fund (CF) can be mobilized to enhance R&I capacity and collaborative activities for setting out suitable operation and monitoring systems in MED area.
- Considering the new opportunities that arise from the agreement on maritime zones in Ionian Sea, Greece and Italy can join expertise and infrastructures increasing capacities in the area and the possibilities of autonomy, adaptability and safe interaction with other human activities.
- A coalition between the EUSAIR and WestMed initiatives could enhance technological and policy specialization in the Mediterranean area.

[39] *Into the Valley of Death, A. Hargadon, 2011 University of California at Davis - https://andrewhargadon.typepad.com/*

Suggestions for next steps

7.1 How to include the blue biotecnology objectives in RIS3 development

The MED area hosts many centres of excellence in science, technology and innovation in the fields of BBt and BE and a significant number of knowledge-based SMEs and large companies. Although there is a high level of research activity in the area, there is still a complexity in blue biotechnology production processes and gaps in legislation that adds to the difficulty of scaling-up pilot actions and operations. There is an urgent need to organize a collaborative action to assess the monetary and non-monetary value of the marine and coastal ecosystem services throughout the MED region, as well as the interaction between them in order to address the existing gaps in investment, knowledge and legislation, unlocking the full potential of BBt and secure the sustainable exploitation of the marine biological resources. Following the analytical framework adopted by JRC[40], the below figure illustrates the important objectives of BBt according to the thematic priorities of RIS3 (soon to be transformed to RIS4) and SDGs.

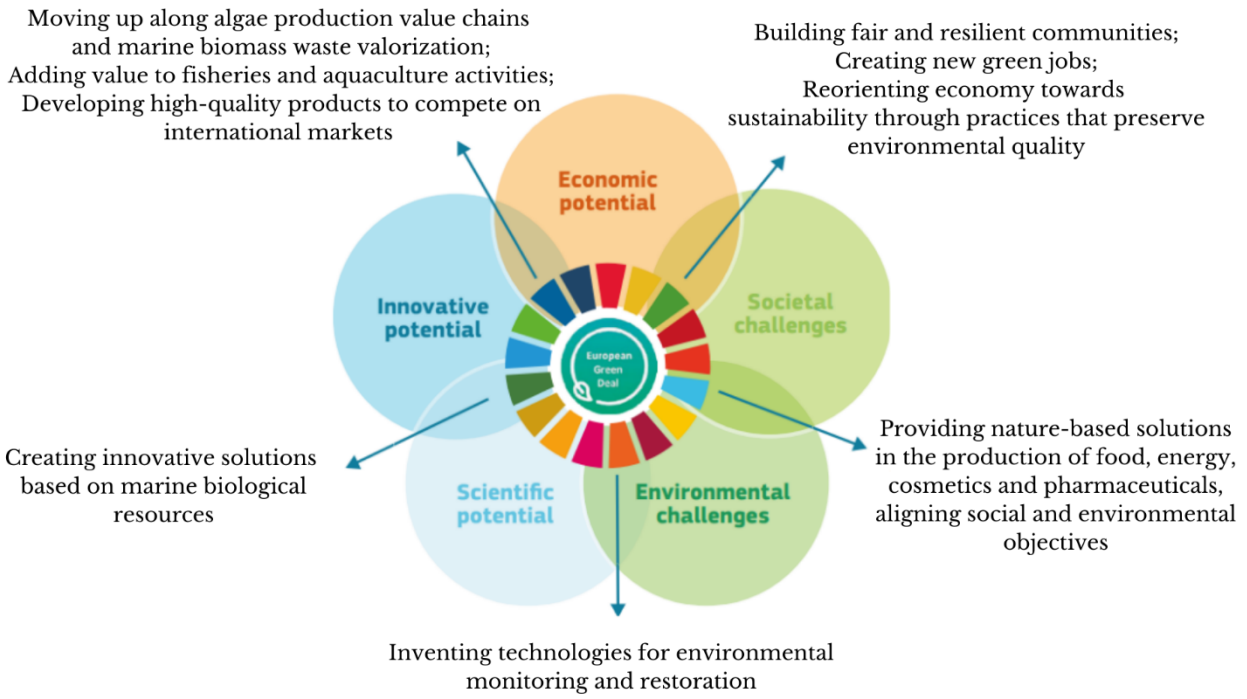

***Figure 10**: Important objectives of BBt according to the thematic priorities of RIS3 and SDGs (adopted by JRC)*

[40] Smart Specialisation, Sustainable Development Goals and Environmental Commons https://s3platform.jrc.ec.europa.eu/w/smart-specialisation-sustainable-development-goals-and-environmental-commons

7.2 Policy recommendations to accelerate the development of BBt

There is a need for more research in this field of BBt to characterize the biochemical content of candidate marine organisms to fully understand the potential benefits and possible concerns. Especially due to the sensitive biotechnology ethics, there is a need to promote scientific cooperation in order to ensure the sustainability of stock and create common protocols for quality management and assurance of BBt products and services at MED level. There is a need to facilitate biotechnology ventures of all kinds in the MED area including research projects capitalization, educational and training projects in the field of bio-sciences, marketing projects etc. In order to initiate a common vision for targeted interventions on regional level integration to accelerate entrepreneurship and innovation in the EU-Mediterranean BBt sector, according to the current capacities and regional investment priorities, the common issues that need to be addressed in RIS3 actions are summarized in the below table.

Priority sector/ supported activities	Research and innovation activities in the public sector	Innovation activities in the private sector (SMEs and large enterprises)
Environmental management and pollution	Cross financing under the ERDF; cross-boarder collaboration	Economic development incentives (e.g. tax credits and exemptions), advanced support services for enterprises; cross financing under the ERDF
Agrofood and bioeconomy (Agriculture, fisheries and aquaculture)	Accreditation and standardisation activities for marine biomass products, development of integrated waste management schemes in fisheries and aquaculture	Certification activities for marine biomass products, cluster support and business networks; Support to social enterprises (SMEs)
Advanced materials, manufacturing and processing	Accreditation and standardisation activities, material quality assessment	Investment in infrastructure, certification activities for marine biomass products, cluster support and business networks
Health and medicines	Accreditation, certification and standardisation activities, technology transfer and university enterprise cooperation, spin-off support	Advanced support services for enterprises, technology transfer and university enterprise cooperation
Green (nano)technologies	Investment in infrastructure; accreditation and standardisation activities for marine biomass products, spin-off support	Economic development incentives (e.g. tax credits and exemptions)
Smart energy systems	Technology transfer and university enterprise cooperation	Advanced support services for enterprises

Table 1 *Policy recommendations to accelerate the development of BBt in MED area*