

.....Blue Bioeconomy Roadmap for Portugal.....

BLUE BIOECONOMY ROADMAP FOR PORTUGAL

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Blue Bioeconomy Roadmap for Portugal

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ENDORSEMENT BY THE MINISTER OF THE SEA

The development of the Blue BioEconomy as a key engine for achieving a sustainable growth of the Ocean's GDP in Portugal has been one of the major priorities of the Ministry of the Sea.

It is, therefore, with great pleasure and motivation that we endorse the creation of this Blue BioEconomy Roadmap for Portugal. It represents an essential and valuable tool to guide all stakeholders towards a sustainable development and innovation roadmap that will permit the Portuguese Blue Economy to reach the 5% target of the total gross value added in 2020.

I congratulate all the entities and personalities involved in the creation of this roadmap for showing once again a consistent commitment and dedication for the promotion of a sustainable Blue Economy.

It is increasingly urgent that we are able to take the most out of the unique natural resources that our country provides in a sustainable way, in complete alignment with the 2030 Agenda for Sustainable Development.

Growth *per se* is not enough, it is not the sole ultimate goal. However, achieving it with innovation and sustainability is the main driver of our policy.



Ana Paula Vitorino
Minister of the Sea

ENDORSEMENT BY BLUEBIO ALLIANCE

The whole world is desperately trying to shift the path of current destruction we, the humankind, have imposed on planet Earth. Our past actions have led us to the major challenges we face today, such as climate change and global warming, famine, food/feed security and availability, scarcity of resources and their sustainable exploitation, new diseases to tackle, and an ever-growing longevity of human population.

Societies around the globe are seeking new opportunities for a more sustainable way of living and are starting to develop sustainable economic growth models. Bioeconomy models are based on the application of biotechnology into biomass of any kind to deliver new sustainable products and services. BLUE BIOECONOMY is an exciting field of innovation within this group, whereby aquatic bioresources can either be turned into, or help in the processes of, the production of novel foods, feed, cosmetics, pharmaceuticals, energy, alternative biomaterials and packaging, and much more. Portugal has always been a Blue Nation, and with the geopolitical importance of its waters, the country has realized the enormous opportunities it holds for a new paradigm of Blue Bioeconomic Development Model.

This Roadmap is the first stepping stone into this daring, innovative and sustainable blue path. It maps the current status and challenges in the BLUE BIOECONOMY in Portugal. More importantly, it points out actions needed to foster and boost such a relevant economic sector. It results from the collective intelligence of the major BLUE BIOECONOMY stakeholders in Portugal and it is for them that we, the BLUEBIO ALLIANCE, together with CIIMAR, have assembled this roadmap – a much desired and needed tool to act as a lighthouse pointing the way forward for the next decade!

May these new sailors surf the blue bioeconomy waves in safety to conquer new horizons!



Helena Vieira
Executive Director
BLUEBIO ALLIANCE

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Portugal will play a key role at the forefront of Blue Bioeconomy in Europe by 2030, contributing to the transition of the Portuguese economy towards a more competitive model focused on sustainable innovation.



EXECUTIVE SUMMARY

The relationship between Portugal and its surrounding blue environment is central to its historical, social and economic development. It has shaped the lives of Portuguese over centuries and has influenced the country development at cyclic timings. Portugal holds a great potential for an economic model based on blue bioresources that carries the solutions for current global economic, environmental and societal demands. Nevertheless, there are still numerous challenges hindering a prosperous Portuguese Blue Bioeconomy.

The BLUEandGREEN project funded by the European Union’s Horizon 2020 Research and Innovation programme prepared a Roadmap for Portuguese Blue Bioeconomy. Blue Bioeconomy is a new economic model focused on the knowledge-based production and use of blue bioresources to provide products, processes and services. The present document is divided in three main sections. The first section maps the Portuguese stakeholders involved in the Blue Bioeconomy value chain, their geographical distribution throughout Portugal, the resources they use, and their applications. The second section provides a qualitative and quantitative analysis of the main challenges currently faced by the Portuguese stakeholders actively engaged within Blue Bioeconomy. The third section provides a list of actions to address the previously identified challenges and suggests a roadmap for action implementation. This roadmap was based on the vision in which Portugal will play a key role at the forefront of Blue Bioeconomy in Europe by 2030, contributing to the transition of the Portuguese economy towards a more competitive model focused on sustainable innovation.

The overall results of the Blue Bioeconomy mapping in Portugal show that most of the stakeholders are focused either on producing and/or harvesting bioresources, or on providing Support services. In contrast, there are

a relatively low number of entities focused on Commercialisation and Market entry. The majority of stakeholders use fish as the main bioresource, despite a growing interest in microorganisms and algae. The predominant application of blue bioresources is the food sector, although various entities also target the feed, pharmaceutical, biomaterials, and cosmetic sectors.

The challenges identified in the present document are grouped as follows:

- Science, Technology & Logistics
- Cooperation
- Communication & Marketing
- Market & Consumer Demand
- Funding & Cost of Operations
- Legal & Regulatory

Despite the large span of challenges, most hurdles identified by stakeholders are associated with Cooperation, followed by Funding & Cost of Operation, and Legal & Regulatory factors. For instance, biomass producers recurrently face funding, regulatory, and scientific knowledge gaps that limit their productivity, but also the establishment of new aquaculture ventures. Stakeholders focused on Product Differentiation are often constrained by technological and logistics challenges, and also by cooperation actions that could facilitate knowledge transfer. At the opposite end of the value chain, stakeholders who are directly involved in Commercialisation and Market Entry often face communication and marketing constraints that affect the acceptance of new solutions by the final consumer. A list of the main challenges identified throughout the Portuguese Blue Bioeconomy value chain is summarised in Table 1. These challenges were identified by Portuguese Blue Bioeconomy stakeholders for each step of the value chain and grouped into the categories previously mentioned.

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Table 1. Main challenges identified for each group of major challenges throughout the Portuguese Blue Bioeconomy value chain.

	Harvesting, Biomass Production & Bioprospecting	Innovation Development & Product Differentiation	Commercialisation & Market Entry	Support Services
SCIENCE, TECHNOLOGY & LOGISTICS	Missing capacity to replicate bioresources in laboratory	Difficulty in hiring specialised human resources	Difficulty in penetrating existing value chains	Difficulty in accessing laboratory spaces
COOPERATION	Access to bioresources/ biobanks is complicated or not clear	Difficulty in accessing pilot scale units	Difficulty in accessing manufacturing facilities	Difficulty in finding national cooperation partners
COMMUNICATION & MARKETING			Difficulty in reaching out to clients	Difficulty to find the right events to showcase products and find new clients
MARKET & CONSUMER DEMAND		There is no market demand for innovative added-value products	Difficulty in determining real market need	Need help in defining and developing a business model
FUNDING & COST OF OPERATIONS	Complex mechanisms to receive funding	Difficulty in attracting reliable funding	Can not match desired price tag/ unit	Need help in attracting or securing funding
LEGAL & REGULATORY	Complex licensing and regulation	Complex licensing and regulation	Intellectual property issues	Lack of financial sector's knowledge on the Blue Bioeconomy aspects

Most hurdles identified by stakeholders are associated with Cooperation, followed by Funding & Cost of Operation, and Legal & Regulatory factors.

	Short-term (2019-2020)	Medium-term (2021-2025)	Long-term (2026-2030)
SCIENCE, TECHNOLOGY & LOGISTICS	Promote Tech Transfer Offices at Universities	Funding scheme for equipment networks and upgrading ship equipment for modern bioprospection	<p>Co-fund projects to install pilot units close to local industries, and improve commercial connections and logistical platforms surrounding blue bioresources production centres</p> <p>Public-private partnerships for sharing equipment and facilitate access to bioprospecting missions</p> <p>Create a quota system for marine algae</p>
COOPERATION	<p>Promote national and international matchmaking events, roadshows and collaborative actions between stakeholders</p> <p>Promote synergies through Blue Bioeconomy acceleration programmes</p> <p>Continue to support initiatives like the Blue Demo Network and Collaborative Laboratories (Co-LABs)</p>	<p>Create open innovation-based calls to address industry challenges and promote blue economy innovation vouchers</p> <p>Promote access to opportunities for public and private R&D institutions</p> <p>National blue pilot infrastructure to be used through the value chain</p>	Create a blue biobank national infrastructure with clear access rules
COMMUNICATION & MARKETING	<p>SMEs trainee vouchers for communicating industry reality to students</p> <p>Implement a Blue Hub National portal with information about stakeholders, bioresources, and available infrastructures</p>	<p>Funding for promotional actions, professional outreach and dissemination and branding campaigns of national blue bioproducts</p> <p>Revise training programmes for scientists, executives and public bodies to improve entrepreneurship, management and industrial skills</p>	Policy and position papers by national stakeholders
MARKET & CONSUMER DEMAND	<p>Communication materials to promote the sector and inform stakeholders and consumers</p> <p>Update the satellite account of the sea to include novel blue biobased activities</p>	National market study on blue bioproducts and their applications	
FUNDING & COST OF OPERATIONS	<p>Simplify national funding schemes, reduce time for evaluation, and implement fast track processes from decision to payment</p> <p>Blue acceleration programmes and funding for risky entrepreneurial exploratory projects</p> <p>Intellectual property and PhD vouchers for SMEs and startups</p>	<p>Broaden the scope of blue funding schemes to cover industrial processes, upscaling and de-risking technological development processes</p> <p>Incentives for foreign investors to invest in the national Blue Bioeconomy</p>	<p>Incentives for promoting circular economy processes in SMEs</p> <p>Create a public-private blue investment fund</p> <p>Specific bank support credit lines for the blue sector</p>
LEGAL & REGULATORY	Simple and efficient rules to access blue bioresources	<p>Simpler and faster regulatory approval paths for blue bioproducts</p> <p>Blue simplex to Blue Bioeconomy activities</p> <p>Faster regulatory process for blue intellectual property protection</p>	<p>Implement market importation barriers to non-EU suppliers</p> <p>Faster legislation approval mechanisms for aquaculture</p>

Most of the actions suggested are transversal to the value chain and will benefit stakeholders directly involved in multiple steps of the value chain, from biomass production to market entry. The overall analysis of all actions and implementation of the roadmap is summarised as follows:

1. Public support for implementing a Blue Bioeconomy hub portal with information about all stakeholders, their expertise, products and services. This web-based portal shall be the main entry point to the Portuguese Blue Bioeconomy.
2. Creation of an infrastructure that centralises requests for blue bioresources, prototyping and pilot scaling up facilities, including downstream processing for compound isolation and/or biorefinery. This action can be implemented through the continuous financial support of the Blue Demo Network (initiative promoted by the BLUEBIO ALLIANCE).
3. Revision of training programmes for young scientists enrolled in blue biobased courses to implement optional and compulsory training sessions in entrepreneurship, management and industrial skills to match current industry and economy needs.
4. Simplification of national funding schemes through the implementation of a two-stage submission process for projects: a simpler version for the first stage followed by the submission of a full project proposal only after approval in stage one. This will dramatically reduce the time needed to prepare such complex funding applications, as well as dramatically reduce the time and financial resources needed for evaluation. These implementation procedures could mimic those from EU instruments such as the SME Instrument. Fast track processes should also be implemented from decision to payment.
5. Development and implementation of acceleration and follow-up programmes focused on Blue Bioeconomy relevant sectors. Foster open innovation project calls where

the industry suggests challenges that can be addressed by stakeholders throughout the value chain through competitive calls and funding. Funding schemes for high-risk experimentation and exploratory projects should also be available.

This roadmap for Portuguese Blue Bioeconomy proposes a series of short-, medium- and long-term actions for each group of challenges identified together with Portuguese stakeholders (Table 2). The suggested actions address each of the previously identified groups of challenges.

This roadmap is based on the stakeholders' experience and their view on how to improve the sustainable use of blue bioresources for new products and processes.

Portugal has an enormous pool of well-trained and highly-skilled scientists, and substantial industrial knowledge, which in combination represent a powerful resource for fostering the development of Blue Bioeconomy. These assets combined with the strong expertise already developed in other sectors, such as agro-food, engineering, cork, energy, pulp and paper, and the food industry, can create fast track options for diverse market applications of blue-derived solutions. By applying such a combined strategy, together with the attraction of international investment, new technology-based industries and jobs that are locally operated with a global scope focus will be created. It is, however, important to note that international investment should be combined with Portuguese Bioeconomy funds, thereby facilitating the access of Portuguese stakeholders to international markets in order to grow and scale-up. Portugal has the prerequisites needed to become one of the main centres of the Blue Bioeconomy revolution, thereby contributing to a nature-based Blue Bioeconomy model that adds economic value while simultaneously respecting natural assets.

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Table 2. Summary of short- (2019/20), medium- (2021/25) and long-term (2026/30) actions for each group of challenges affecting the Portuguese Blue Bioeconomy.





The 2030 Blue Bioeconomy Vision



WHAT IS BIOECONOMY?

Bioeconomy is a new economic model adopted by an increasing number of countries and currently at the centre of the future EU economic model. According to the German Bioeconomy Council⁽¹⁾, it is “the knowledge-based production and use of biological resources to provide products, processes and services in all economic sectors within the frame of a sustainable economic system”. This economic model also comprises the full exploitation of waste streams that result from biobased industrial processes, including by- and co-products, thereby contributing for improved resource-efficient processes and for a circular economy.

Bioeconomy is not, however, a new concept. Agriculture, forestry, and agro-food systems are also bioeconomic activities that have been embedded in our culture for a long time and are part of our cultural heritage. In the past decade, numerous entities have renewed their interest in Bioeconomy and its potential to solve societal challenges, thus becoming a key focus of political and technological interest. This trend has been motivated by global challenges such as climate change, biodiversity loss and a growing human population, shifting our economy from fossil-based to a biobased and taking into consideration the ecological balance of natural ecosystems and social values.

This shift in production processes is supported by research and innovation, which are a cornerstone to Bioeconomy, as they provide the scientific knowledge needed to change and improve processes in a sustainable manner.

Bioeconomy spans over not only the agricultural or primary sectors, but also over other manufacturing activities associated with products and services that use or manage biore-sources, ranging from microorganisms to plants and animals. For example, Bioeconomy covers sectors such as forestry, fisheries, aquaculture, nutraceuticals, pharmaceuticals, textile, cosmetics, chemicals, energy, among others.

An exciting and uprising field within Bioeconomy is Blue Bioeconomy. Aquatic resources are widely recognised as raw materials for a large variety of applications that go far beyond food and feed production. As an example, novel pharmaceuticals, cosmetics, nutraceuticals, packaging materials, and chemicals coming from aquatic biodiversity and inspired in biological processes are emerging at an unprecedented rate. Innovative products and services driven by blue biobased research and development activities are opening new and diversified markets, while simultaneously improving the sustainable management of biological resources.

BLUE BIOECONOMY VALUE CHAIN

In order to fully understand the landscape of the Blue Bioeconomy in Portugal, it is important to have a global perspective of how blue bioresources are being used throughout the value chain. They can be used as the final product *per se*, without being transformed or processed, or they can serve as raw materials for a large variety of activities or applications. Indeed, blue bioresources are multi-disciplinary and transversally relevant throughout the entire value chain (Fig. 1). Consequently, the

Blue Bioeconomy value chain integrates all stakeholders ranging from those who harvest and/or produce biomass, to product developers and distributors who deliver the blue bioproducts or services to the final consumer.

The first steps of the Blue Bioeconomy value chain are associated with biomass production and/or harvesting. From researchers who explore biodiversity or are focused in bioprospecting aquatic organisms in the quest to

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⁽¹⁾ <http://biooekonomierat.de/en/>

find new chemical and structural diversity, to fishery stakeholders who are harvesting wild organisms and aquaculture companies producing blue bioresources in artificial settings, are all included in this essential part of the value chain. Several entities fit within these first two steps of the value chain, such as R&D units addressing blue biodiversity, pharmaceutical companies searching for new

lead compounds that will enter the drug discovery and development pipeline, as well as fishery and aquaculture enterprises. It is also important to note that this first step of the value chain encompasses all potential freshwater and marine bioresources, from microorganisms, such as bacteria and microalgae, to macroorganisms, such as invertebrates, fish, macroalgae and plants.

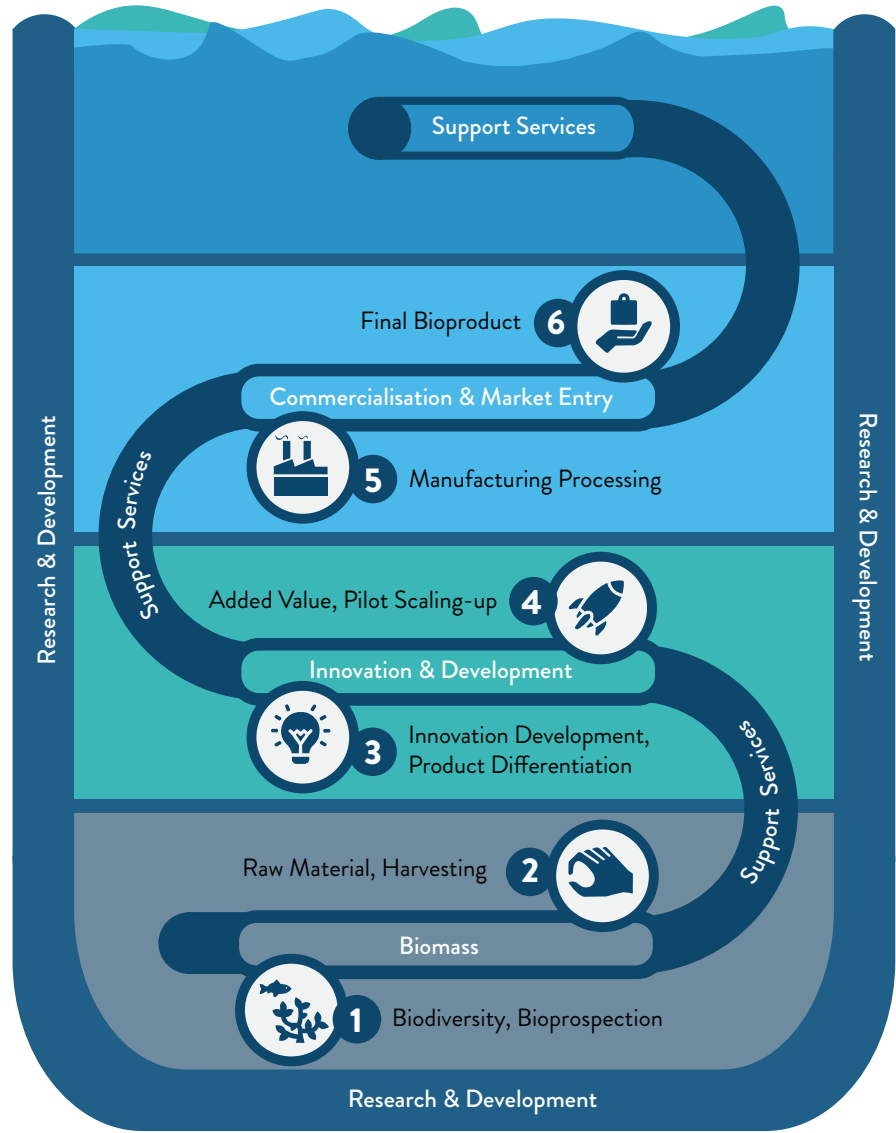
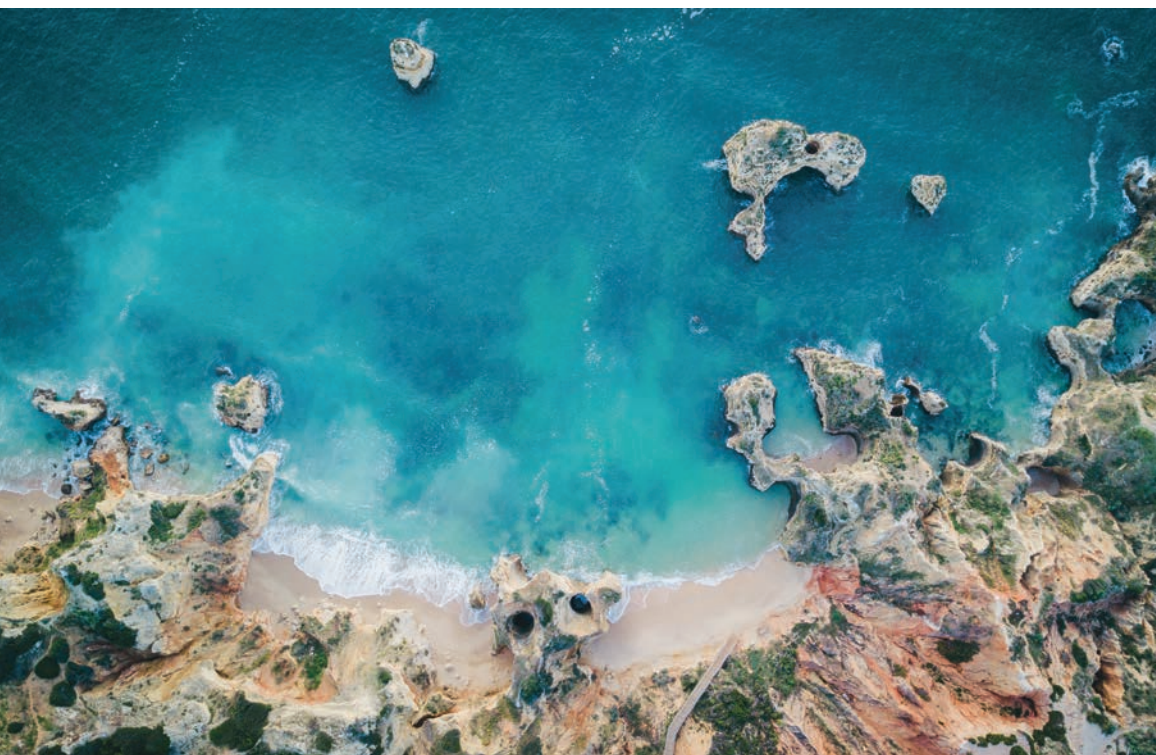


Fig. 1 Blue Bioeconomy value chain



The subsequent steps of the Blue Bioeconomy value chain include innovation and development activities, in particular the transformation of biomass into value-added products, the development of innovative applications for aquatic biomass, as well as the development and implementation of pilot scale technology and infrastructures. For instance, some products, such as enzymes, nutrients, and bioactive molecules are produced using blue biobased resources, such as whole organisms or genetic sequences originally retrieved from aquatic organisms. Refining and extraction processes also fit within the innovation and development steps of the Blue Bioeconomy value chain. Several industries produce waste streams that could be explored for multi-sectoral applications if these co-products are converted into useful and value-added compounds for other sectors. This process can rely on a variety of blue bioresources, such as chitin from crustaceans, and blue biobased chemicals or enzymes that display novel transformation mechanisms that contribute to improve the cost-efficiency of the transformation processes.

The last steps of the Blue Bioeconomy value chain are associated with commercialisation and market entry. These steps involve product manufacturing and processing, as well as the development and distribution of the final product. As an example, entities such as those that use specialised ingredients for the production of cosmetics, nutraceuticals, and pharmaceutical drugs are considered within these steps of the value chain. Moreover, entities distributing and commercialising blue bioproducts are also comprised in these last steps of the Blue Bioeconomy value chain.

Support services are transversal to all previously mentioned steps of the Blue Bioeconomy value chain. Entities ranging from public administration, to marketing, legal and intellectual property consultants, as well as funding entities and investors fit within this overarching group of entities. Another activity that is common throughout the entire value chain is research and development. This is, indeed, the foundation of the Blue Bioeconomy.


2030 VISION FOR BLUE BIOECONOMY IN PORTUGAL

In our vision, by 2030 Portugal's economy will be more competitive, with a focus on sustainable innovation and will be at the forefront of the Blue Bioeconomy in Europe. The ocean and its resources will be further perceived as valuable assets by our citizens, who will be enabled to take well-informed decisions to support a more sustainable lifestyle and contribute to our planet's sustainability. Some Portuguese industries will have started to shift towards circular biobased economic models and, thereby, supporting an economy that not only provides jobs but also enhances the well-being of society and the environment.

In this vision for the Blue Bioeconomy, the sustainable and innovative use of blue bioresources will continue to foster the activities of all stakeholders throughout the value chain. Their focus will be on sustaining the growing human population and concomitant needs, while simultaneously respecting the natural balance of the blue environment.

This vision relies on the continuous and lasting participation of the blue biobased community that is divided in three main pillars: scientific and technological research, entrepreneurship, and industrial and societal stakeholders. The interconnection between these three pillars and their mode of support and contribution to a dynamic value chain is crucial for sustaining the blue natural capital and promoting the long-term well-being of our planet– the Blue Planet. Funding and cooperation among entities focused on research and development is also essential. Only through the support of high-risk and high-reward activities will disruptive innovation be created, leading towards the fostering and improvement of new processes with the ultimate goal of a sustainable use of blue bioresources.

We envision a biobased economy oriented towards the sustainable use of the Portuguese blue natural capital that provides solutions for the current global societal demands of a fast growing, aging and more demanding and informed human population. An underlying assumption of this Bioeconomy model is that all actions must utterly respect and potentiate the carrying capacity of the natural blue ecosystems.



In our vision, by 2030 Portugal's economy will be more competitive, with a focus on sustainable innovation and will be at the forefront of the Blue Bioeconomy in Europe.





Blue Bioeconomy in Portugal

PORTUGUESE BLUE BIOECONOMY MAPPING

Blue Bioeconomy activities in Portugal have been traditionally focused on fisheries for human consumption and coastal tourism, particularly accommodation and recreational activities⁽¹⁾. Shipping, shipbuilding and repair, and deep-sea shipping have also been relevant activities within the Portuguese maritime sector. Overall, the economic growth of the Blue Economy sector in Portugal has been concomitant with Portugal's GDP progression. In fact, between 2013 and 2016, the Blue Economy sector grew by 13% whereas Portugal's GDP increased by 12%⁽²⁾.

The highest performing Blue Economy subsectors in the past decade were fisheries and aquaculture, ports and shipping, and shipbuilding, with an increased economic turnover between 2013 and 2016 of 5%, 13%, and 48%, respectively. It is also important to note that before 2013, fisheries, aquaculture, processing, wholesale and retail of its products also showed a notable gross value increase (1.2 billion Euros between 2010 and 2013⁽³⁾), which was mostly driven by the continuous increase in the value of export products⁽⁴⁾.

A new wave of Blue Bioeconomy subsectors has been recorded with a remarkable growth in volume of operations and projects, such as biotechnology and natural product research. Numerous scientific projects have been funded, with particular emphasis on European funding schemes. Since 2015, a total of 11 million Euros have been allocated to Portuguese

partners in competitive European H2020 calls focusing on the Blue Bioeconomy, marine biotechnology and marine bioresources⁽⁵⁾. However, only 7% of such contribution involved projects coordinated by a Portuguese partner.

Despite the clear potential for great economic growth, this newcomer group of new uses and resources only accounted for 7 million Euros in 2013, which corresponded to a minor fraction (0.2%) of the total satellite account for the sea⁽⁶⁾. It is also important to highlight that such assessment was made in 2013, and the present scenario is likely to be very different and remains to be evaluated by official entities. The recognition that the Blue Bioeconomy and the ocean are central to Portugal's future have led to a new wave of studies and strategies being thought and/or developed, such as the Thematic Agenda for Research and Innovation for the Sea 2030, produced by a group of Portuguese stakeholders under the coordination of Fundação para a Ciência e Tecnologia or the PorTECH Cluster strategy launched by the Ministry of the Sea. These, and other similar documents mentioned, are very relevant and important documents to which this Roadmap intends to build upon and add value to. Although the present strategic document is not aimed at providing an updated economic summary of the Blue Bioeconomical axis of Portugal, it aims at providing an overview of its organisation, identifying who are the main stakeholders, their activities, and their distribution across the Blue Bioeconomy value chain.

A large proportion of Portuguese entities acting in the Blue Bioeconomy are small and medium-sized enterprises (SMEs), suggesting that the private sector is an important driver of Portuguese Blue Bioeconomy.

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⁽¹⁾ Country Paper Portugal, March 2014 FWC MARE/2012/06-SCC1/2013/02

⁽²⁾ Ministério do Mar (2018)

⁽³⁾ Conta satélite do mar, Direção-Geral de Política do Mar (2014)

⁽⁴⁾ LEME – Barómetro PwC da Economia do Mar, Edição nº 9 (2019)

⁽⁵⁾ Cordis repository (Community Research and Development Information Service) (<https://cordis.europa.eu>)

⁽⁶⁾ Conta satélite do mar, Direção-Geral de Política do Mar (2014)

⁽⁷⁾ BLUEandGREEN Stakeholders' Database Platform (<http://blueandgreen.ciimar.up.pt/stakeholders/>) and BLUEBIO ALLIANCE Database

⁽⁸⁾ <https://www.fct.pt/apoios/CoLAB/index.phtml.pt>

The mapping of the Blue Bioeconomic stakeholders here assembled encompasses a total of 248 entities spread throughout Portugal⁽⁷⁾. Stakeholders were here defined as entities that have economic activities linked to the Blue Bioeconomy, regardless of being primary or secondary stakeholders. Primary stakeholders are those directly engaged in economic transactions, such as producers, wholesalers, researchers, among others. Secondary stakeholders are those that are affected by or that can affect the actions of primary stakeholders, such as governmental bodies, associations, support entities, among others.

Notably, a large proportion of Portuguese entities acting in the Blue Bioeconomy are small and medium-sized enterprises (SMEs), suggesting that the private sector is an important driver of the Portuguese Blue Bioeconomy (Fig. 2). Following SMEs, academic research entities and associations/incubators/non-governmental organisations (NGOs) are the most represented entities in the Portuguese Blue Bioeconomy sector. Academic research entities are mostly universities and polytechnic institutes, as well as research centres. There are also a large number of associations, incubators and NGOs that provide critical support services for SMEs and also for large companies, thus playing a critical role in the interaction with the public administration. It is also important to highlight the small number of startups, which only accounts for 8% of the number of entities in the assembled database.

However, this number is expected to increase considerably in the near future given the recent investment and entrepreneurial support to transfer scientific research into new economic activities and disruptive business models. The type of organisation that is least represented are science and technology parks/technological centres.

It is important to highlight a relatively recent type of organisation that is expected to play a vital role in Portuguese Blue Bioeconomy – collaborative laboratories (CoLabs)⁽⁸⁾. These are non-profit private entities with the main goal of implementing research and innovation agendas geared at creating economic and social value. Besides creating skilled and scientific jobs in Portugal, CoLabs foster the consolidation of collaborative practices between scientific, technological, higher education entities, and the social and economic sector. At present, a total of six CoLabs must be highlighted given their focus on Blue Bioeconomy:

- B2E – Collaborative Laboratory for Blue Bioeconomy
- GreenCoLAB – Green Ocean Technologies and Products Collaborative Laboratory
- BIOREF – Collaborative Laboratory for the Biorefineries
- Value4Health.CoLAB – Portuguese Value-Based Healthcare CoLab
- VectorB2B
- CoLab4Food – Collaborative Laboratory for Innovation in the Food Industry

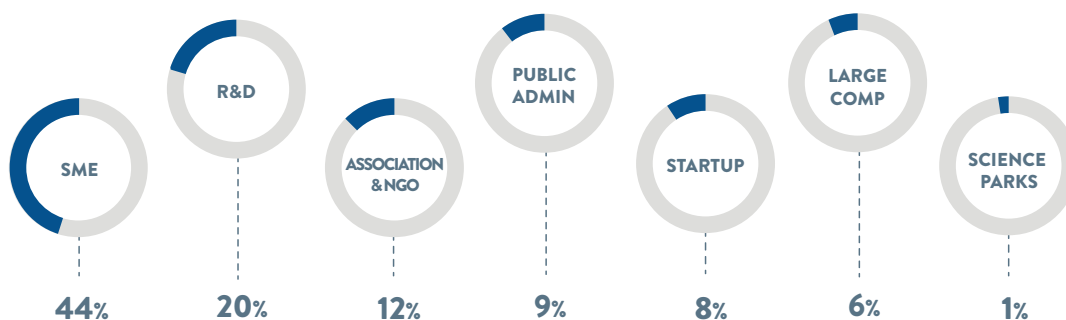


Fig. 2 Distribution of the entities involved in the Portuguese Blue Bioeconomy according to type of organisation.

From a geographic perspective, most of Portuguese Blue Bioeconomy stakeholders are located in the metropolitan area of Lisbon (41%) and in the Northern regions (28%) (Fig. 3). Nevertheless, the relative proportion of each type of organisation is relatively stable among geographical regions (Fig. 4). The only exception are public administration entities, as 86% of them are located in the Lisbon area.

The distribution of stakeholders throughout the Blue Bioeconomy value chain is not even. A large number of entities are focused on Innovation Development and Product Differentiation (Fig. 5); most of which are SMEs and academic research entities. The total number of entities associated with biomass production, such as fisheries and aquaculture, represent 41% of all stakeholders

in our map. Once more, academic research entities greatly contribute to the large number of biomass and harvesting related activities, such as bioprospecting and obtaining a better understanding of marine biodiversity. Support service entities, such as those providing services associated with communication and marketing, funding, legal and intellectual property, altogether represent 38% of the stakeholders mapped herein (Fig. 5).

The overall interpretation of these results denotes that Portuguese stakeholders are focused either in the first step of the value chain, which includes all biomass production-related activities, or in providing Support Services. In contrast, a relatively low number of stakeholders are associated with Commercialisation and Market Entry (Fig. 5).



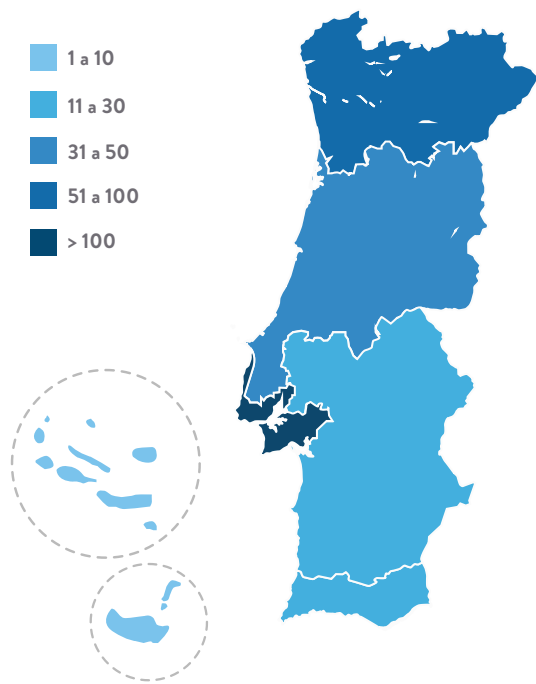


Fig. 3 Number of organisations involved in the Portuguese Blue Bioeconomy according to the Nomenclature of Territorial Units for Statistics (NUTS2).

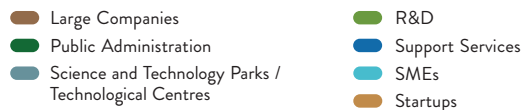


Fig. 4 Distribution of type of organisations for each geographical region. Relative proportions were calculated independently for each region.

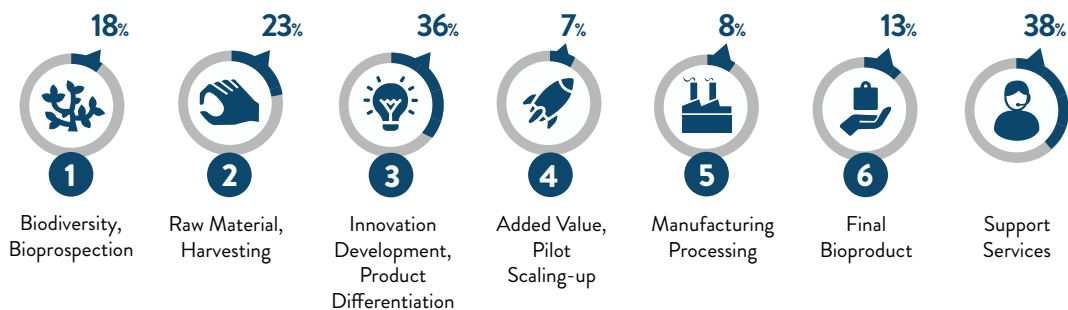
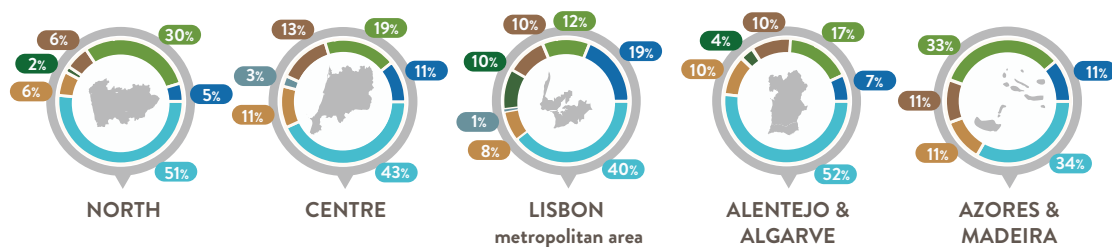


Fig. 5 Distribution of Portuguese entities throughout the Blue Bioeconomy value chain, from biodiversity and bioprospection (1) to the final bioproduct (6) and support services (e.g. incubators, funding entities, governmental organisations, marketing and communication agencies, legal offices, among others). Note that a single entity can be involved in more than one step of the value chain.

MAIN BLUE BIORESOURCES IN THE PORTUGUESE BIOECONOMY

The main bioresources identified in the Blue Bioeconomy sector are bacteria, fungi, other microorganisms, cyanobacteria, microalgae, macroalgae, sponges, molluscs, other invertebrates, fish, and fish industry co-products. It is, however, important to note that a single entity can use multiple bioresources. Although most of the stakeholders use a single bioresource type, there are entities using more than five types of bioresources. Such entities are mostly large companies and academic research entities tackling multiple innovation projects aiming at a large span of target applications.

Despite the growing interest in the “new” Blue Bioeconomy and the growing capacity to use innovative tools for developing biotechnology-based economic activities, it is interesting to observe that a considerably large fraction of Portuguese stakeholders is using fish as their main bioresource (Fig. 6). While 37% of the stakeholders have activities focusing on fish, only 8% use co-products from the fish industry. Also noteworthy are microorganisms (cyanobacteria, bacteria, fungi, and

others), which altogether are used by 36% of the stakeholders, and algae (micro- and macroalgae), which are used by 31% of the stakeholders. Both microorganisms and algae are used mostly by SMEs and academic research entities.

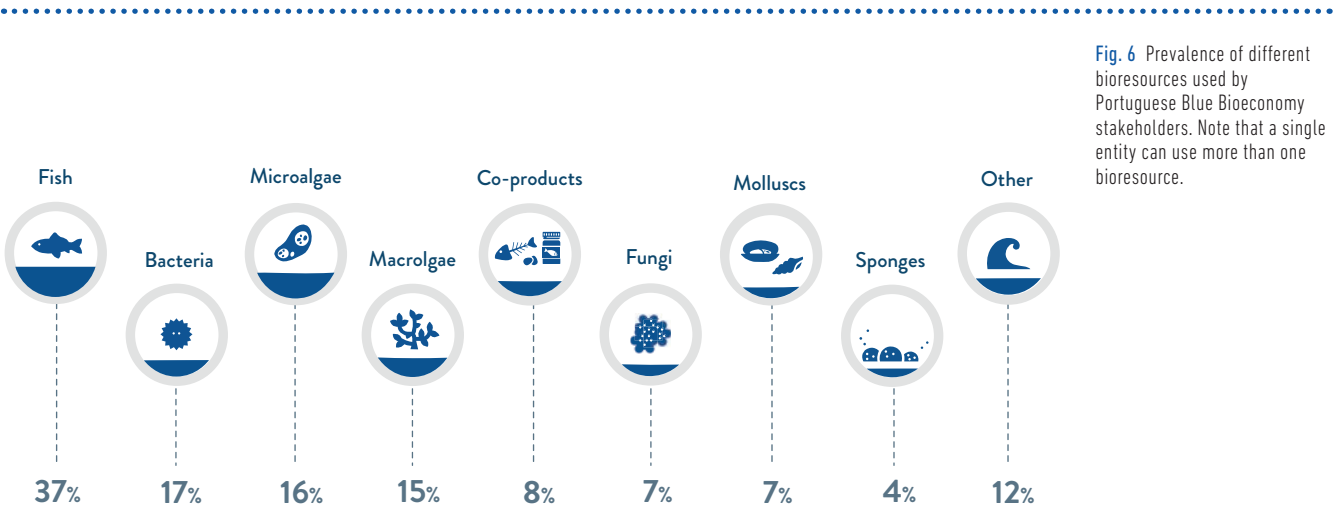
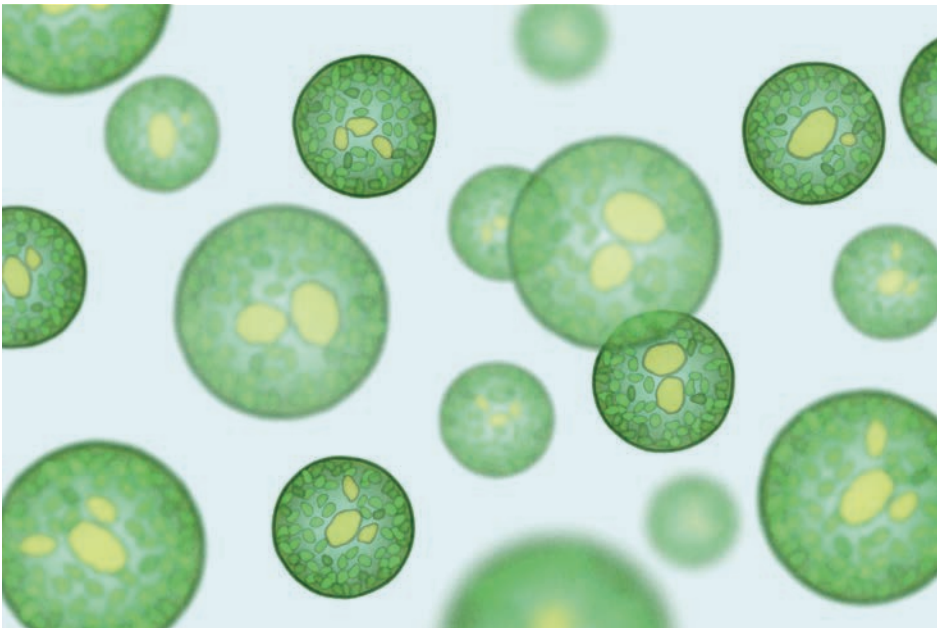


Fig. 6 Prevalence of different bioresources used by Portuguese Blue Bioeconomy stakeholders. Note that a single entity can use more than one bioresource.

MAJOR FIELDS OF APPLICATION OF BLUE BIORESOURCES

The stakeholders of the Portuguese Blue Bioeconomy sector are distributed among the following fields of applications: food, pharmaceutical, nutraceutical, cosmetics, feed, medical devices, biomaterials, antifouling, bioplastics, medical devices, and textiles. It is, however, important to note that the activities performed by a unique entity can cover multiple fields of applications. Indeed, each stakeholder covers an average of two fields of applications, and some others cover as many as five, or even more. However, such multi-disciplinary entities are mostly academic research entities with extensive and diverse teams.

Overall, a large fraction of the Blue Bioeconomy industry in Portugal is focused on applications for food, with almost 50% of stakeholders being focused on this area of application (Fig. 7). Pharmaceuticals, cosmetics, feed, and nutraceutical are each covered by approximately 18% of Portuguese Blue Bioeconomy stakeholders.

An interesting outcome from the interviews with stakeholders performed is the assessment made by each entity towards their expected prospects for development in the next ten years. When enquired about which field of applications their organisation will cover in ten years from now, most parties showed clear interest in expanding to other fields of application, which would result in a more even distribution of field of application in the future (Fig. 7). Food applications are still the main focus of most stakeholders, but an increasing interest to expand towards other fields, namely cosmetics, biomaterials and pharmaceuticals is noteworthy. This is especially relevant for applications associated with bioplastics and biomaterials, which are currently hot-topics at the forefront of blue biotechnology research and innovation, mostly driven by current environmental issues and a societal demand for more sustainable materials. It is also noted that most stakeholders that showed interest in moving their business into these two fields of application are mostly SMEs and academic research entities.

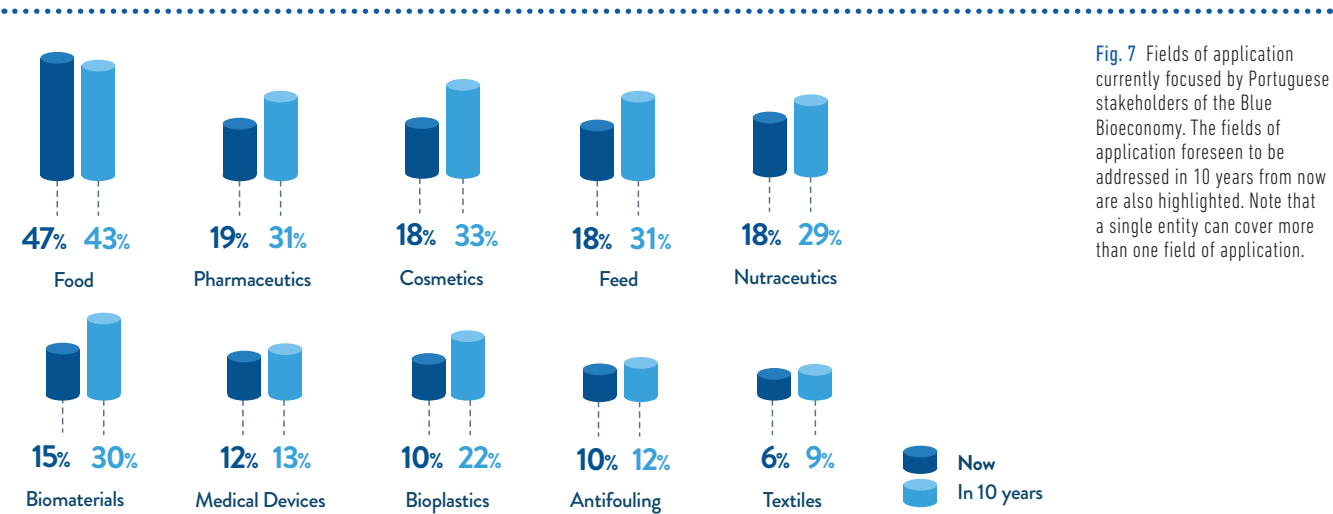


Fig. 7 Fields of application currently focused by Portuguese stakeholders of the Blue Bioeconomy. The fields of application foreseen to be addressed in 10 years from now are also highlighted. Note that a single entity can cover more than one field of application.





3

Challenges for the Portuguese Blue Bioeconomy

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GLOBAL OVERVIEW OF PORTUGUESE CHALLENGES

Over the past decades, the Portuguese Blue Bioeconomy sector has been advocated as one of the economy sectors with greatest growth potential. This has been recurrently covered by political agendas, as well as a priority for the allocation of public funding. Multiple funding schemes, such as MAR2020 and Fundo Azul, as well as multiple European funding mechanisms covering marine-related activities, have been created for this sector in Portugal in the past years. Despite the acknowledgment of this great potential, there are still numerous challenges that hinder the progress and the exponential development of the Portuguese Blue Bioeconomy. Mapping those challenges is, therefore, crucial for suggesting actions that can overcome those hurdles and foster the Blue Bioeconomy in Portugal.

Different approaches were used to assess the challenges affecting the Portuguese Blue Bioeconomy (see Annexes). Briefly, all stakeholders in the assembled database were interviewed to assess their opinion on the main bottlenecks that the Portuguese Blue Bioeconomy is facing in each step of the value chain and for their economic activity. Additionally, some of these stakeholders participated in a Strategic Think-Tank event focused on identifying the main hurdles faced by the Portuguese sector regarding major global Bioeconomy challenges, such as feeding a growing world population, climate change, pollution, and well-being and aging.

All the challenges interfering with the progress of the Portuguese Blue Bioeconomy identified by the stakeholders were grouped as follows:

- **Science, Technology & Logistics.** Refers to insufficient knowledge, training, scientific development or capacity to create, improve, scale-up, transport, accommodate or implement products, services or processes throughout the Blue Bioeconomy value chain.
- **Cooperation.** Refers to the limited knowledge-transfer and communication between stakeholders holding data, knowledge or infrastructures that could promote innovation or overcome barriers impeding the creation or development of a Blue Bioeconomy product or service.
- **Communication & Marketing.** Refers to challenges associated with communication throughout the value chain, but also marketing skills and expertise needed to engage clients, reach out to clients, and showcase products and services.
- **Market & Consumer Demand.** Refers to limited knowledge about the development and implementation of a product development plan and/or business plan that addresses market and consumer demands. This group also encompasses challenges associated with competitor products, understanding consumer behaviour, and improving consumer awareness.
- **Funding & Cost of Operations.** Refers to the understanding of available funding schemes, their access and appropriateness of funding schemes as well as the development of cost-efficient processes that do not jeopardize the operation due to excessive costs.
- **Legal & Regulatory.** Refers to licensing, regulatory and regulation frameworks needed to start new business, develop and commercialise new products or services, as well as difficulties with intellectual property issues. It also includes bottlenecks in dealing with public authorities or applicable regulatory authorities.

The largest number of identified challenges is associated with Cooperation.

An overall analysis of assembled data shows that the largest number of identified challenges (31%) is associated with Cooperation, followed by those associated with Funding & Cost of Operations (17%), Legal & Regulatory (20%), and Science, Technology & Logistics (14%). In contrast, the challenges least referred to by the stakeholders are associated with Communication & Marketing (12%), and Market & Consumer Demand (5%). These results, however, change throughout the Blue Bioeconomy value chain (Fig. 8). For instance, Funding & Cost of Operations and Legal & Regulatory challenges represent a large fraction of the challenges identified

by stakeholders focused on biomass production. Progressing further through the value chain to Innovation Development and Product Differentiation, the most common challenges are associated with Science, Technology & Logistics, as well as Cooperation challenges. Stakeholders focused on Commercialisation and Market Entry mostly highlight market and consumer-related challenges, as well as overall difficulty with communication and marketing.

The following sections provide detailed information about each group of challenges, and how they affect the different steps of the Blue Bioeconomy value chain.

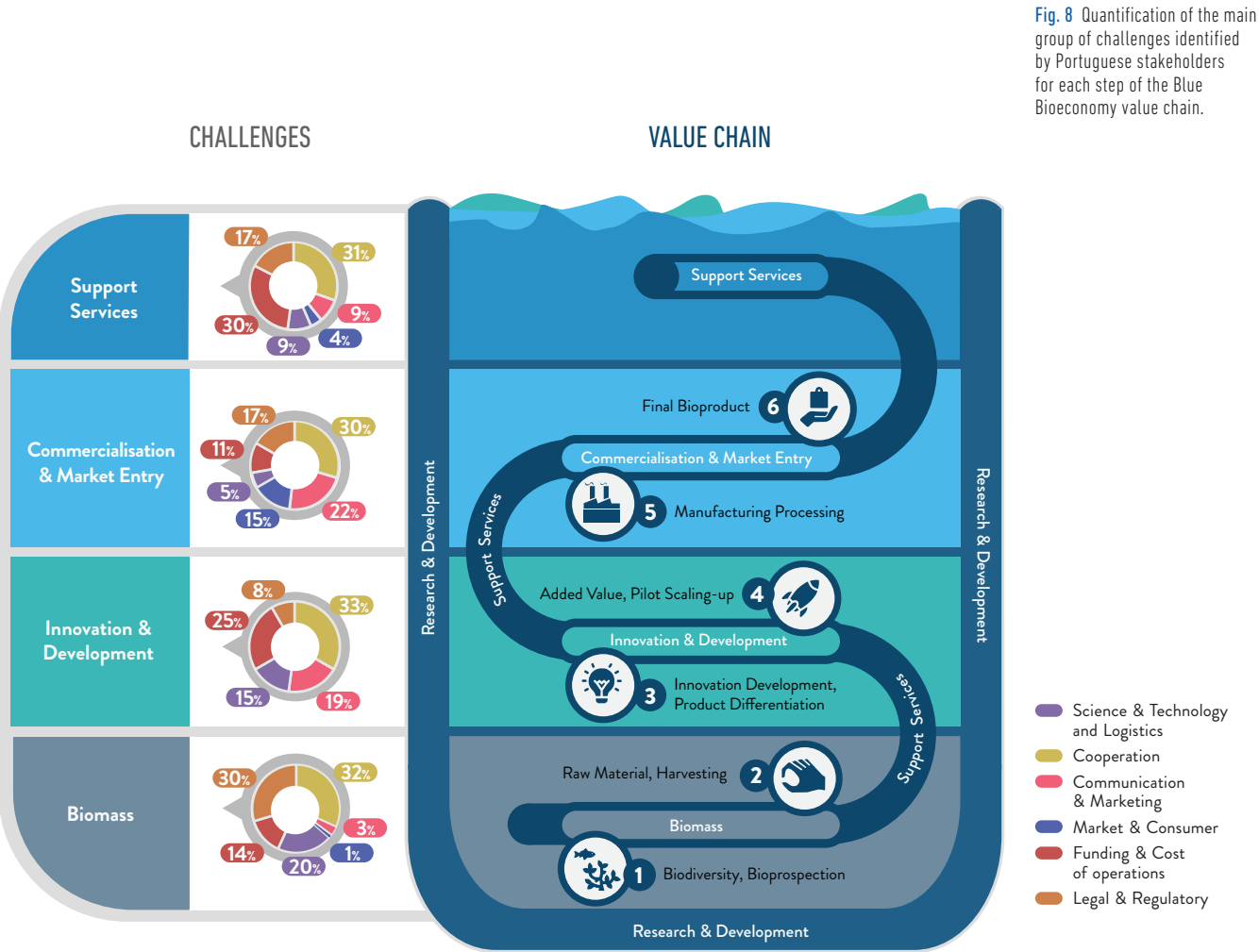


Fig. 8 Quantification of the main group of challenges identified by Portuguese stakeholders for each step of the Blue Bioeconomy value chain.

SCIENCE, TECHNOLOGY & LOGISTIC CHALLENGES

Challenges associated with scientific, technological and logistic processes often refer to insufficient knowledge, training, scientific development or capacity to create, improve, or scale-up products or processes. They cover a wide range of issues, from harvesting and biomass sampling approaches to logistic challenges associated with accommodation and transportation of highly perishable blue raw materials and products (Table 3).

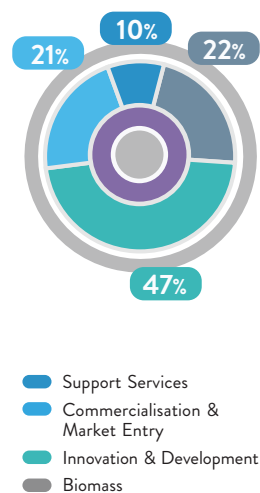
Science, Technology & Logistic challenges are transversal throughout the Blue Bioeconomy value chain. However, it is during the Innovation Development and Product Differentiation that this group of challenges is more frequently observed (Fig. 9). For instance, unawareness of scientific techniques or specialised services to help develop innovative and disruptive transformation technologies is a recurrent challenge. Another recurrent challenge faced during Innovation Development and Product Differentiation is access to a well-managed and controlled culture of sustainable biomass sources. Indeed, this particular challenge extends to various industries and multiple fields of application. For instance, the pharmaceutical sector not only has a higher technological demand for novel rapid screening tools for hit identification and to accelerate hit-to-lead processes, but it also requires a constant and reliable supply of replicable biomass to successfully isolate new compounds with therapeutic effects. This is the most severe bottleneck jeopardizing the development of marine-derived pharmaceuticals.

Stakeholders associated with harvesting, biomass, and bioprospecting also recurrently face Science, Technology & Logistic challenges (Fig. 9). For instance, these challenges can be associated with limited scientific knowledge about the bioresources available. Geographical mapping of bioresources, and qualitative and quantitative information about their distribution and availability within Portuguese

jurisdiction areas is often overlooked. However, such knowledge is a critical starting point for the Blue Bioeconomy pipeline and a must have in order to potentiate any endeavour in this sector. Information about the species that can be harvested from the wild and those that can be cultivated and mass-produced in controlled settings is also critical. Indeed, securing or developing a reliable, replicable, continuous, and sustainable biomass source based on biological resources is often considered a major challenge to supply biobased industries. Securing a sustainable and reliable biomass supply is among the most important requirements for the creation of innovative products and services and, ultimately, for the progress of the Blue Bioeconomy. For instance, in what concerns biobased products for intermediate value markets, such as nutraceuticals and cosmetics, securing the source of these biological resources in a controlled and cost-effective mode is essential for successfully launching new and improved products.

Human capital is also a predominant and recurrent challenge linked to science and technology. Skilled human resources are the backbone of disruptive thinking and technological development. Therefore, it is important to address the demand for highly-qualified multidisciplinary trained scientists, that are also managers and entrepreneurs with a focus on improving efficiency and productivity. The innovative capacity of Blue Bioeconomy stakeholders, and, ultimately, the quality and quantity of Portuguese human capital, relies on skilled human resources supported by academic entities at the forefront of scientific knowledge and that are actively engaged with the private sector. Currently, there is still a large mismatch between the training offered at universities and other training entities, and industry and market demands, which hinders the development of new blue businesses and products.

Fig. 9 Distribution of the Science, Technology & Logistics challenges identified throughout the Blue Bioeconomy value chain.



CHALLENGES IDENTIFIED BY STAKEHOLDERS

Harvesting, Biomass Production & Bioprospecting	Relevance
Missing capacity to replicate bioresources in the laboratory	1st
Difficulty in accessing water test facilities	2nd
Harvesting and sampling approaches are not adequate to biodiscovery	3rd
Innovation Development & Product Differentiation (transformation technologies)	Relevance
Difficulty in hiring specialised human resources	1st
Difficulty in getting sustainable and reproducible batch supply (adequate culture / harvest, adequate manufacturing technologies, adequate volumes yield)	2nd
Lack of innovation department / staff	3rd
Difficulty with separation and purification downstream protocols	4th
Difficulty in determining specific mode of action	6th
Difficulty in discovering novel marine natural products and bioactives	7rd
Difficulty with safety and efficacy testing protocols and timeframes	8th
Difficulty in innovating on screening technologies and platforms	9th
Difficulty in determining correct formulation for future desired / predicted route of administration	10th
Commercialisation & Market Entry (including branding & awareness)	Relevance
Difficulty in penetrating existing value chains	1st
Need to create new value chains	2nd
Logistics too complex or heavy	3rd
Lack of knowledge on the predicted / desired route of administration / type of formulation for final application	4th
Support Services (legal, financial and incubation/association)	Relevance
Difficulty in accessing lab spaces	1st
Difficulty in accessing water test spaces	2nd

Table 3. Main Science, Technology, & Logistics challenges identified by the Portuguese stakeholders for each step of the Blue Bioeconomy value chain. The challenges were quantified during stakeholder interviews and are ranked according to their relevance.

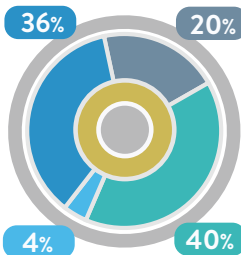
COOPERATION CHALLENGES

This group of challenges encompasses the limited knowledge-transfer and communication between stakeholders holding data, knowledge or infrastructures that could promote innovation or overcome barriers impeding the creation or development of a Blue Bioeconomy product or service. Practical examples of Cooperation challenges include the limited access to services and resources, as well as poor communication between stakeholders with access to key information that could benefit the successful progress of a particular innovation (Table 4). More broadly, Cooperation challenges also include difficulties in finding partners and building partnerships.

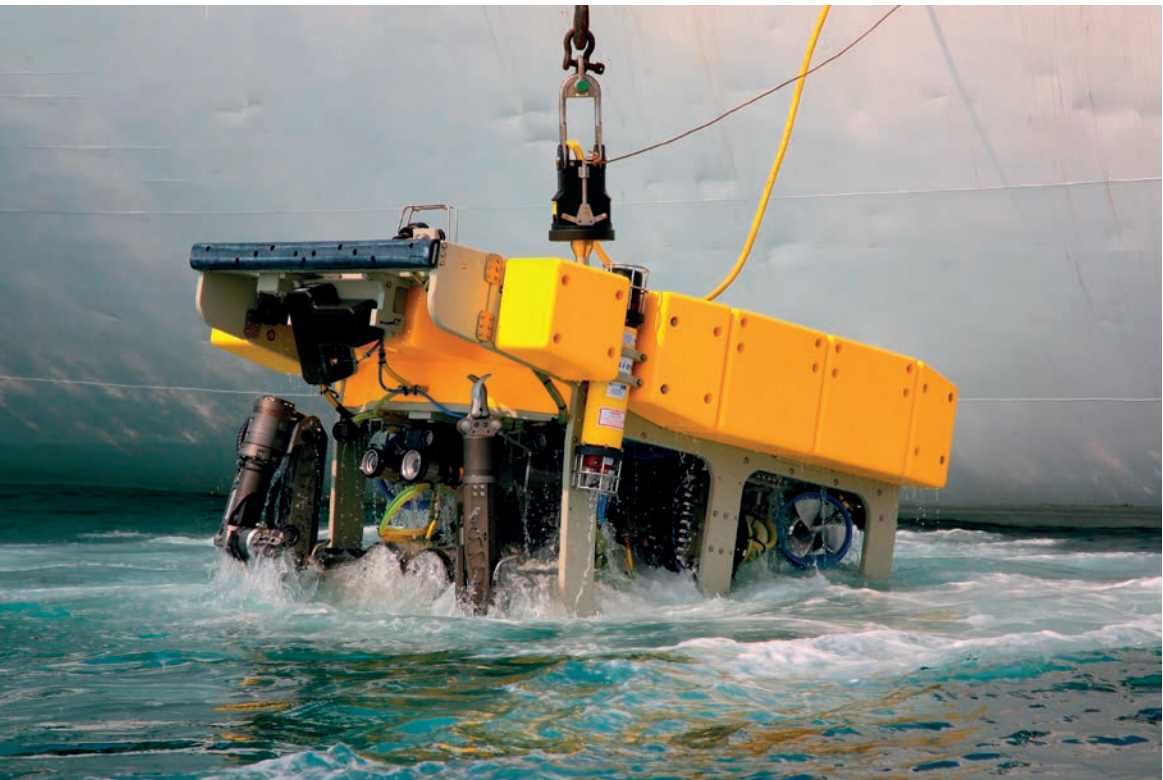
The majority of stakeholders (40%) who identify Cooperation challenges are those in the second step of the value chain – Innovation Development and Product Differentiation (Fig. 10).

Lack of Cooperation in the access to blue bioresources is indeed a major challenge that covers multiple bioresources and application fields. For instance, access to the deep ocean requires advanced and robust technology that is expensive and not accessible to all stakeholders focusing on marine bioprospecting, such as remotely operated underwater vehicles (ROVs). Difficult access to test facilities and pilot scale units is a challenge recurrently identified by stakeholders focused on Innovation Development and Product Differentiation (Table 2). More broadly across the value chain, a noteworthy number of stakeholders also identified difficulties in finding national and international cooperation partners.

Fig. 10 Distribution of the Cooperation challenges identified throughout the Blue Bioeconomy value chain.



- Support Services
- Commercialisation & Market Entry
- Innovation & Development
- Biomass



CHALLENGES IDENTIFIED BY STAKEHOLDERS

Harvesting, Biomass Production & Bioprospecting	Relevance
Access to bioresources/biobanks is complicated or not clear	1st
Unawareness of scientific techniques or specialised services	2nd
Difficulty in accessing robotics, ROVs and drones, as well as sensors materials and expertise	3rd
Innovation Development & Product Differentiation (transformation technologies)	Relevance
Difficulty in accessing pilot scale units	1st
Difficulty in finding national cooperation partners	2nd
Difficulty in accessing local laboratory facilities for product development and prototyping	3rd
Unawareness of scientific techniques or specialised services that could be helpful	4th
Difficulty in finding international cooperation partners	5th
Lack of necessary skills or specialised training	6th
Lack of knowledge on how to innovate	7th
Unawareness of international or regional regulation issues	8th
Difficulty in accessing water test facilities for prototyping	9th
Commercialisation & Market Entry (including branding & awareness)	Relevance
Difficulty in accessing local manufacturing facilities	1st
Support Services (legal, financial and incubation/association)	Relevance
Difficulty in finding national cooperation partners	1st
Lack of international business development support	2nd
Inappropriate political focus or strategy	3rd
Difficulty in accessing training and education tailored to individual needs	4th
Lack of national business development support	5th
Difficulty in accessing specialised legal, contractual services	6th
Difficulty in finding international cooperation partners	7th
Difficulty in accessing incubation/office services and spaces	8th
Need help in accounting and other business support services	9th

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Table 4. Main Cooperation challenges identified by Portuguese stakeholders for each step of the Blue Bioeconomy value chain. The challenges were quantified during the stakeholder interviews and are ranked according to their relevance.

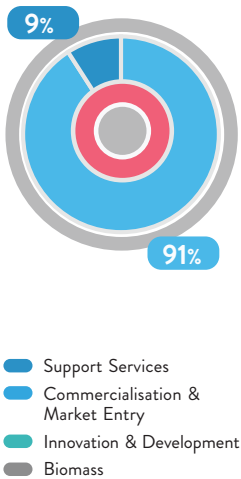
COMMUNICATION & MARKETING CHALLENGES

This group of challenges refers to hurdles in communication throughout the value chain, together with the need for marketing expertise to engage clients, reaching out to clients, and showcasing products and services. For instance, a typical challenge faced by biobased industries is the difficulty on how to communicate the added value of a product (Table 5). Consumers are increasingly informed and tend to ignore trends and focus on making their own decisions based on their set of personal values. Still, many are not willing to pay the current price for such innovative offers. The industry needs to not only continue focusing on more concrete and customised communication, but also to continuously invest in lowering technological costs on final consumer pricing.

Communication & Marketing is a major challenge mostly for stakeholders focused on the commercialisation and entry stage of the value chain (Fig. 11). Nevertheless, a minor fraction of challenges is also identified by support service stakeholders, such as finding and selecting the events to showcase their products and obtaining new clients.

Overall, communication is a lasting challenge that affects those who are not focused on business-to-business or business-to-client operations. For instance, the dissemination of scientific knowledge about blue bioresources, research capabilities, technical resources and facilities, has often been overlooked. This is a recurrent topic mentioned by a large variety of stakeholders. Most of the current market players in Portugal still feel difficulties in finding the desired information.

Fig. 11 Distribution of the Communication & Marketing challenges identified throughout the Blue Bioeconomy value chain.



CHALLENGES IDENTIFIED BY STAKEHOLDERS

Commercialisation & Market Entry (including branding & awareness)	Relevance
Difficulty in reaching out to clients	1st
Difficulty in communicating the added value of product to clients	2nd
Lacking marketing tools and development capacity	3rd
Need for new packaging	4th
Support Services (legal, financial and incubation/association)	Relevance
Difficulty in finding the right events to showcase products and finding new clients	1st

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Table 5. Main Communication & Marketing challenges identified by Portuguese stakeholders for each step of the Blue Bioeconomy value chain. The challenges were quantified during the stakeholder interviews and are ranked according to their relevance.

Communication & Marketing is a major challenge mostly for stakeholders focused on the commercialisation and entry stage

MARKET & CONSUMER DEMAND CHALLENGES

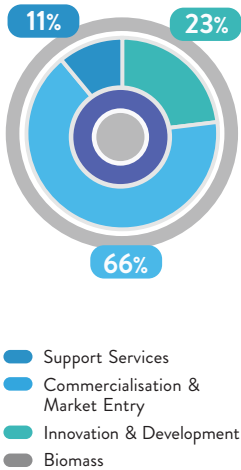
Market & Consumer Demand challenges encompass the limited knowledge about the development and implementation of a product development plan and/or business plan that addresses market and consumer demands. Additionally, this group of challenges includes hurdles associated with matching competitor prices, changing consumer behaviour towards sustainably manufactured products, and increasing consumer awareness (Table 6).

This group of challenges is mostly identified by stakeholders that are active in Commercialisation & Market entry (66%), followed by those performing innovation and development activities (23%) (Fig. 12). While most of the acknowledged challenges are associated with problems determining real market needs and building consumer awareness, we have also identified additional basic entrepreneurial hurdles associated with developing a business plan. For instance, it is still common practice, that new entrepreneurs spend a long time developing products without a thorough analysis of their target markets and customers, which often results in a delayed and expensive discovery of non-acceptance of the final product

and/or substantially different needs. Another challenge recurrently identified by Portuguese Blue Bioeconomy stakeholders is a poor market demand for innovative value-added products. For instance, adding value to a primary base product, such as seafood, is often suggested as the way forward for the fishery and aquaculture industry in Portugal, particularly through canning, transformation and diversification. However, relevant success factors for such strategy are international markets and customers that acknowledge (and are willing to pay for) such value-added products.

It is important to highlight a mismatch commonly observed between scientific innovation by academic research and market demand. For instance, marine biotechnology researchers have often failed to align their discovery and development activities with the needs of target markets and consumer trends. This issue is particularly meaningful when research programmes, supported by public tax money are not focused on generating leads that can be translated to the needs and benefits of the society and result in new products and services with market application.

Fig. 12 Distribution of the Market & Consumer Demand challenges identified throughout the Blue Bioeconomy value chain.



CHALLENGES IDENTIFIED BY STAKEHOLDERS

Innovation Development & Product Differentiation (transformation technologies)		Relevance
There is no market demand for innovative added-value products		1st
Do not know what to focus on or what the market needs		2nd
Commercialisation & Market Entry (including branding & awareness)		Relevance
Difficulty in determining real market needs		1st
Need to build consumer awareness		2nd
Lack of knowledge on how to develop a business plan		3rd
Consumer/market demands are not aligned with the limitations in production methods		4th
Competition (similar products)		5th
Support Services (legal, financial and incubation/association)		Relevance
Need help in defining and developing a business model		1st

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Table 6. Main Market & Consumer Demand challenges identified by Portuguese stakeholders for each step of the Blue Bioeconomy value chain. The challenges were quantified during the stakeholder interviews and are ranked according to their relevance.

A mismatch is commonly observed between scientific innovation by academic research and market demand.

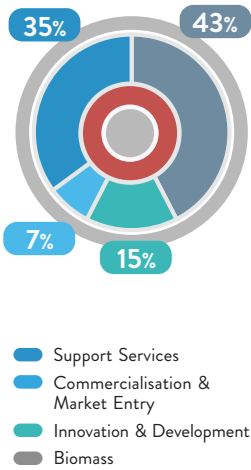
FUNDING & COST OF OPERATIONS CHALLENGES

This group of challenges includes issues associated with the understanding of available funding schemes, how to access them, and for which activities they are appropriate. It also encompasses challenges associated with cost-efficient processes (Table 7). For instance, the lack of funding available for high-risk ventures often affects the capacity to innovate and create disruptive technologies that could solve current societal issues.

Approximately 43% of the Funding & Cost of Operation challenges are associated with the first step of the Blue Bioeconomy value chain, whereas 35% are associated with Innovation Development and Product Differentiation (Fig. 13).

Financing is a common problem in Blue Bioeconomy ventures, as access to blue resources is often difficult or expensive and for which appropriate funding schemes are often unavailable. While the challenges of accessing funds might often be solved with specific public funding schemes, in general these are not suitable as a continuous source of reliable funding. Not only is public funding needed, but it is also important to improve the skills to attract private investors and to foster and cherish potential new investors in the field. Access to capital is often difficult, but the main challenge is to diversify capital sources to avoid entirely relying on the support from public administration. It is also important to note that, despite available funding schemes and mechanisms, most stakeholders characterise such opportunities as complex and often focusing on sectors and topics different from those where the current market demands are.

Fig. 13 Distribution of the Funding & Cost of Operations challenges identified throughout the Blue Bioeconomy value chain.



CHALLENGES IDENTIFIED BY STAKEHOLDERS

Harvesting, Biomass Production & Bioprospecting	Relevance
Complex mechanisms to receive funding	1st
Access to ocean is difficult or expensive	2nd
Reduced cost-efficiency of discovering novel marine natural products and bioactives	3rd
Innovation Development & Product Differentiation (transformation technologies)	Relevance
Difficulty in attracting reliable funding	1st
Commercialisation & Market Entry (including branding & awareness)	Relevance
Can not match desired price tag/unit	1st
Support Services (legal, financial and incubation/association)	Relevance
Need help in attracting or securing funding	1st
Lack of knowledge of available funding mechanisms	2nd
Difficulty in accessing public grants	3rd
Difficulty in accessing private investment	4th
Lack of dedicated or suitable crowdfunding platforms	5th

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Table 7. Main Funding & Cost of Operation challenges identified by Portuguese stakeholders for each step of the Blue Bioeconomy value chain. The challenges were quantified during the stakeholder interviews and are ranked according to their relevance.

Despite available funding schemes and mechanisms, most stakeholders characterise such opportunities as complex and often focusing on sectors and topics different from those where the current market demands are.

LEGAL & REGULATORY CHALLENGES

Legal & Regulatory challenges include issues with licensing, regulatory and regulation frameworks, together with difficulties with clarifying intellectual property. It also includes bottlenecks in dealing with public authorities and regulatory frameworks (Table 8). These challenges are evenly highlighted by stakeholders throughout the value chain, which suggests a common and broad barrier to the Blue Bioeconomy in Portugal (Fig. 14).

A large number of the challenges associated with the first step of the Blue Bioeconomy value chain (Biomass) are associated with complex licensing and regulation. This is often suggested as the decisive factor for failing to attract private investment due to the heavy regulations in Portugal.



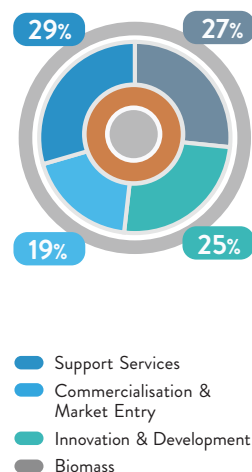
An example of this would be starting aquaculture ventures in coastal areas, which is associated with long and complex administrative tasks and multiple interactions with a multitude of regulatory bodies even before a particular venture kicks-off.

Public policies supporting a wider uptake of bioeconomy and circular economy actions are still absent, which creates challenges for those providing disruptive products and services that are at the forefront of Blue Bioeconomy ventures. Those stakeholders who focus on transforming waste materials into value-added products must also overcome hurdles based on the definition of waste products and legal frameworks that limit their uses.

Complex licensing and regulation together with complex certification schemes and a multitude of regulatory bodies often delays product commercialisation and market entry. A large number of interviewed stakeholders acknowledged difficulties in understanding regulatory requirements. This is also highlighted by support service entities that suggested a general lack of knowledge by the financial sector on Blue Bioeconomy aspects.

It is also important to acknowledge intellectual property-related challenges. These are often suggested as critical factors that might delay the scale-up and commercialisation of recent biobased products due to the relatively long time frame needed to protect intellectual property (IP). However, only a relatively low number of stakeholders (Table 6) acknowledged IP related-issues. This result could be associated with the availability of highly-qualified support services entities that provide IP services or unawareness of stakeholders on the importance of IP.

Fig. 14 Distribution of the Legal & Regulatory challenges identified throughout the Blue Bioeconomy value chain.



CHALLENGES IDENTIFIED BY STAKEHOLDERS

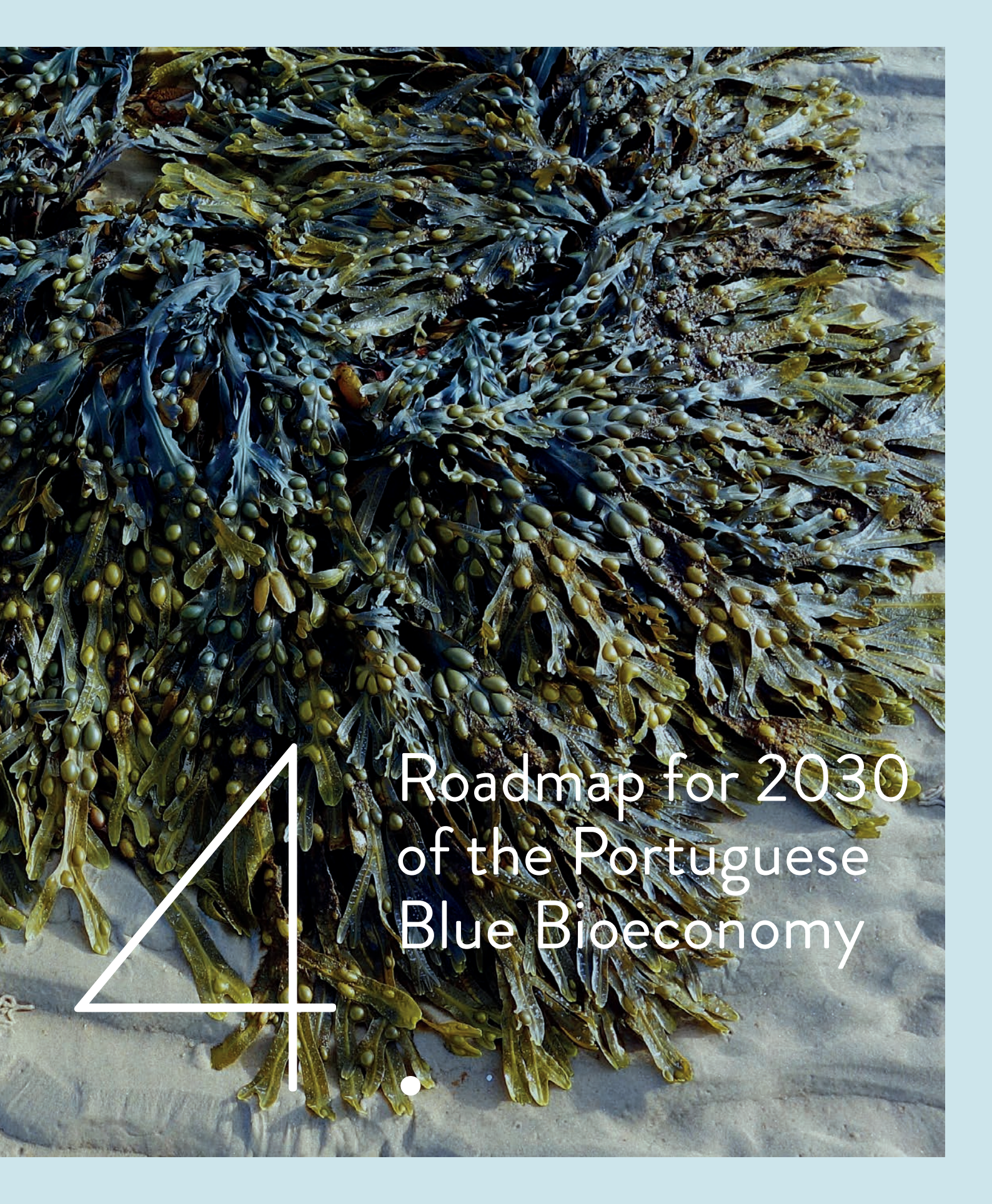
Harvesting, Biomass production & Bioprospecting	Relevance
Complex licensing and regulation	1st
Innovation Development & Product Differentiation (transformation technologies)	Relevance
Complex licensing and regulation	1st
Find several Legal/IP constraints to innovate and develop new products	2nd
Commercialisation & Market Entry (including branding & awareness)	Relevance
Intellectual property issues	1st
Difficulty in understanding or in complying with heavy regulatory requirements	2nd
Complex design of certification schemes	3rd
Support Services (legal, financial and incubation/association)	Relevance
Lack of financial sector's knowledge on the Blue Bioeconomy aspects	1st
Difficulty in dealing with IP issues	2nd
Complex international or regional regulatory issues	3rd

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Table 8. Main Legal & Regulatory challenges identified by Portuguese stakeholders for each step of the Blue Bioeconomy value chain. The challenges were quantified during the stakeholder interviews and are ranked according to their relevance.

Stakeholders who focus on transforming waste materials into value-added products must also overcome hurdles based on the definition of waste products and legal frameworks that limit their uses.





4

Roadmap for 2030
of the Portuguese
Blue Bioeconomy

GLOBAL OVERVIEW OF 2030 BLUE BIOECONOMY ROADMAP ACTIONS

Defining and paving the way forward to promote the development of the Portuguese Blue Bioeconomy is a task that can only be achieved by an extensive interaction with and among stakeholders. Rather than trying to predict the future of the Portuguese Blue Bioeconomy sector and being biased towards a certain perspective, this roadmap takes advantage of the stakeholders' expertise on how the blue biobased sector will be able to improve the sustainable use of bioresources for new products, services and processes.

A roadmap is, by nature, a plan that aims to lead somewhere better. It focuses on actions and predicted timelines to promote a certain sector during a predefined timeframe. Therefore, more than just evaluating the specific challenges that the Portuguese Blue Bioeconomy sector is facing today, this document is the result of a multi-stakeholder consultation endeavour and followed by a thorough data analysis. The goal of this roadmap is to develop and propose a set of carefully designed actions that can truly foster the Blue Bioeconomy if implemented by the relevant stakeholders in the Portuguese economy.

Multiple and highly diverse actions are suggested here to foster blue innovation and increase the contribution of this sector to the Portuguese domestic economic production.

It is critical to promote innovative and diversified economic ventures that take advantage of our impressive scientific and technological innovation capacity, extensive national jurisdiction areas, and transportation products and services overseas. A better organised value chain will boost growth, whereas a swift legislation and strengthened branding of Portuguese blue biobased products can exponentiate its international acceptability. However, it is important to avoid neglecting our national market despite its relatively reduced dimension. Making the Portuguese society proud of its Blue Bioeconomy is essential to improve the acceptance of blue value-added products and reduce international imports of goods and services that are readily available in our own territory.

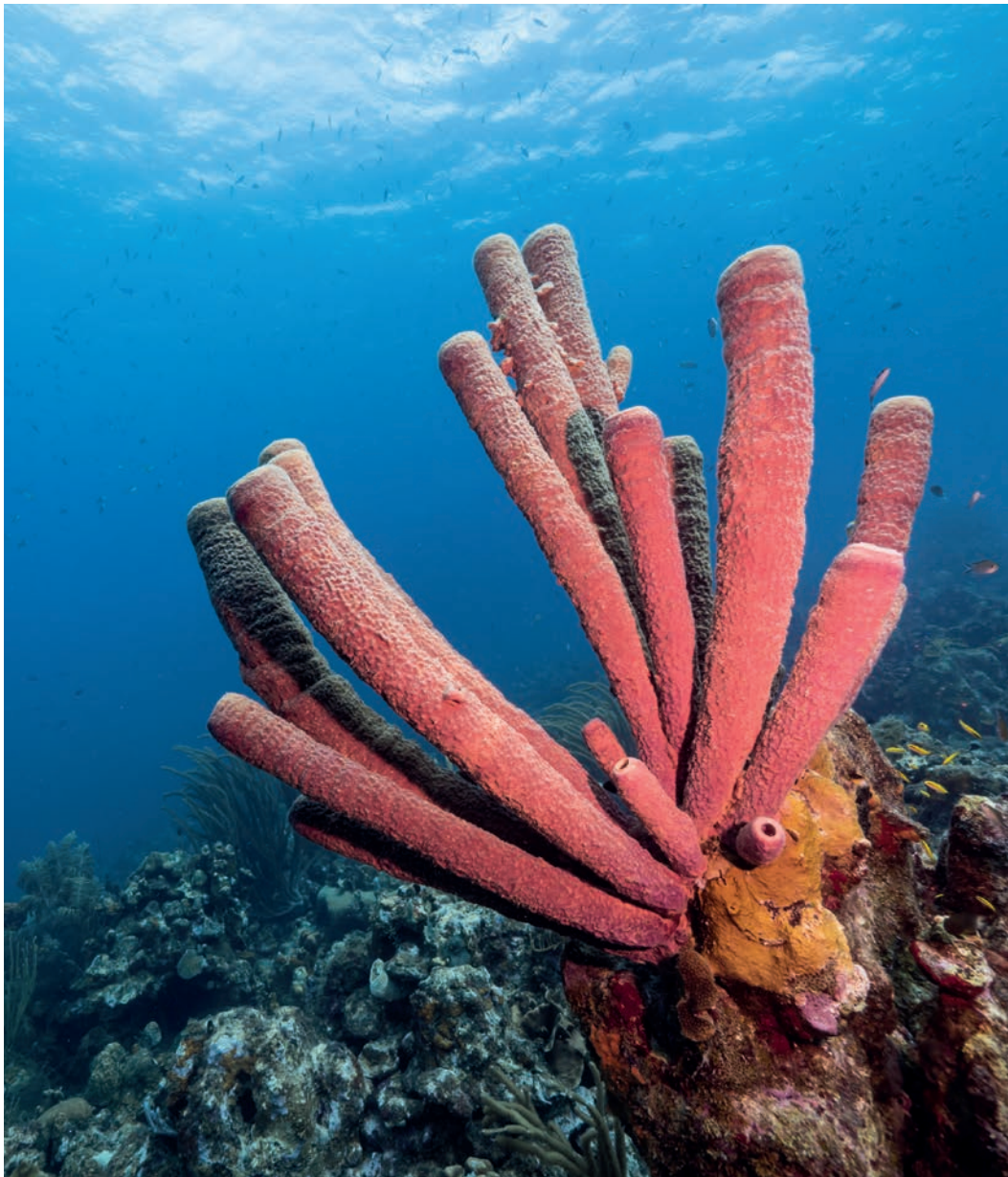
The stakeholders in the assembled database were asked for specific actions to address the hurdles previously identified for each step of the Blue Bioeconomy value chain. All suggested actions were analysed, grouped and organised according to the groups of challenges previously identified:

- Science, Technology & Logistics
- Cooperation
- Communication & Marketing
- Market & Consumer Demand
- Funding & Cost of Operations
- Legal & Regulatory

It is critical to promote innovative and diversified economic ventures that take advantage of our impressive scientific and technological innovation capacity, extensive national jurisdiction areas, and transportation products and services overseas.

Most of the actions suggested by the stakeholders (34%) address Cooperation challenges, followed by Funding & Cost of Operations (20%), and Legal & Regulatory factors (19%). As the suggestions recorded match the relative importance of each group of challenges identified in the previous section, it is fair to say that the collective knowledge displayed by Portuguese stakeholders acting in the Blue Bioeconomy value chain is reliable and coherent. For instance, Cooperation actions often focus on improving networking and communication among parties, whereas Funding & Cost of Operations actions often focus on simplification of public funding schemes and

increased support for new entrepreneurial ventures. While these actions are relevant, regardless of the step of the Blue Bioeconomy value chain, it is also important to consider specific actions relevant for each step of the value chain. For instance, Cooperation actions that facilitate the access to pilot and upscale units are specific for the Innovation and Development step of the value chain. Legal & Regulatory actions associated with improved market access rules for Portuguese and foreign produced products are specific for the Commercialisation & Market entry step of the value chain.



The overall analysis of the suggestions made by all interviewed stakeholders can be summarised in the following five most cited actions (Fig. 15):

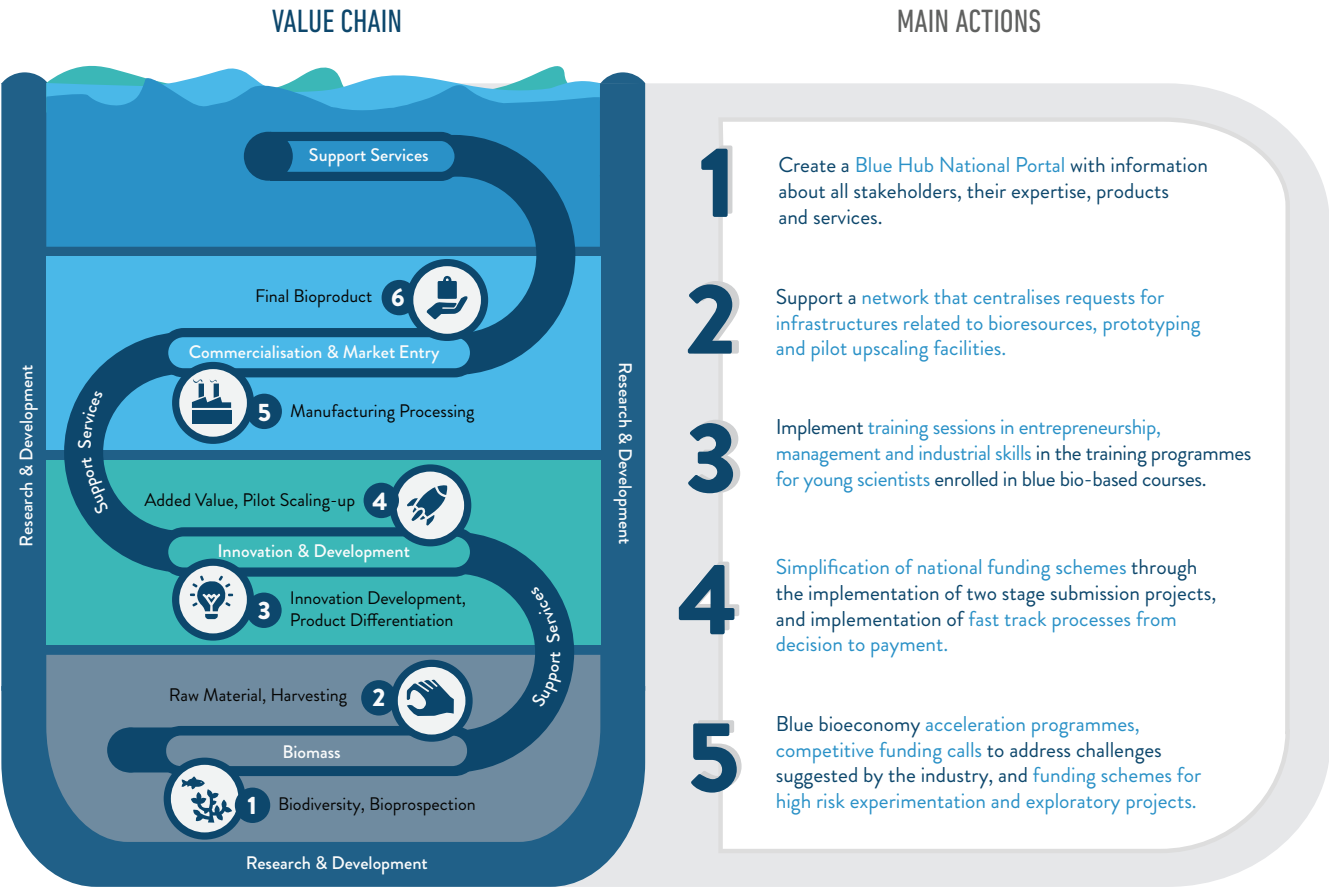
1. Public support and implementation of a Blue Hub Portal with information about all stakeholders, their expertise, products and services. This web-based portal shall be the main entry point to the Portuguese Blue Bioeconomy.
2. Creation of an infrastructure that centralises requests for blue bioresources, biobanks, prototyping and pilot upscaling facilities, including downstream processing for compound isolation and/or biorefinery. This action can be implemented through the continuous support of the Blue Demo Network with public funds and active collaboration with the Collaborative Laboratory for the Blue Bioeconomy (B2E).
3. Reformulation of training programmes for young scientists enrolled in blue biobased courses to implement optional and compulsory training sessions in entrepreneurship, management and industrial skills to match current industry and economy needs.
4. Simplification of funding schemes in Portugal through the implementation of two stage submission projects: a simpler project proposal version for the first stage followed by submission of full project proposals only after approval of stage one. This will dramatically reduce the time needed to prepare such complex funding applications, as well as shortening the time needed for evaluation. These implementation procedures could be learned from EU funding instruments, such as the SME Instrument. Fast track processes should also be implemented from decision to payment, and the budget of national agencies for participating in transnational cooperation initiatives should be reinforced.
5. Development and implementation of more acceleration programmes in the most relevant Blue Bioeconomy sectors. Foster open innovation project calls, where the industry suggests challenges that can be addressed by stakeholders throughout the value chain through competitive calls and funding. Funding schemes for high-risk experimentation and exploratory projects should also be available.



The 2030 Roadmap for the Portuguese Blue Bioeconomy relies on a well-defined action plan to be implemented at different time scales. The actions suggested in the following sections are proposed according to an implementation time plan divided as short- (2019/20), medium- (2021/25) and long-term (2026/30) scales depending on their urgency and complexity.

This roadmap takes advantage of the stakeholders' expertise on how the blue biobased sector will be able to improve the sustainable use of bioresources for new products, services and processes.

Fig. 15 Five main actions to address the challenges currently faced by Portuguese Blue Bioeconomy stakeholders.



SCIENCE, TECHNOLOGY & LOGISTICS ACTIONS

Overall, the actions proposed to address Science, Technology & Logistic challenges focus on accessing and improving the technological capacity, adequate training of highly-qualified human resources and targeted scientific and technologic transfer of relevant information to all stakeholders. The main actions proposed in this group of challenges are shown in [Table 9](#).

It is relevant to highlight that some of the actions suggested by stakeholders are being addressed by a recent programme launched by BBA – the Blue Demo Network. The main goal of this network is to promote and enable access to a set of Portuguese infrastructures and services for startups and SMEs focused on the Blue Bioeconomy. Other countries such as Norway or Finland have established similar infrastructures in other fields, such as health or telecommunication, which boosted those sectors dramatically in these nations.

Most of the highlighted actions could be implemented by stakeholders focusing on support services, such as public authorities, clusters or associations. Besides funding, that is mandatory to implement those actions, also a wide but closely interacting network of partners is extremely relevant to ensure that Blue Bioeconomy stakeholders remain informed.

The information here available can also serve as a guide for funding entities to better define how sector-specific calls can help improving the Portuguese Blue Bioeconomy. It is important to continue funding academic research entities to develop basic research but, if the goal is to boost the Blue Bioeconomy, it is important to develop funding schemes better aligned with current market reality and more attractive to the private sector. The private sector is key, as it is the main driver of innovative goods and services contributing to the development of the Portuguese Blue Bioeconomy. The number of private sector entities needs to increase as well as their volume of transactions. This will drive Blue Bioeconomy leading to creation of new jobs and thus, guarantee that the Blue Bioeconomy becomes a productive and economically relevant sector for the Portuguese gross domestic product.

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Table 9. Main actions proposed by the stakeholders addressing Science, Technologic & Logistic challenges, and suggested concomitant implementation plan. Actions are classified according to timing of their implementation (short-term 2019/20, medium-term 2021/25, long-term 2026/30)

It is important to develop funding schemes better aligned with current market reality and more attractive to the private sector.

ACTIONS PROPOSED BY STAKEHOLDERS

Web-based catalogue of all national bioresources, stakeholders and available infrastructures.

Create a unique **marine biobank facility**, with **prototyping** and **pilot scaling-up infrastructure** for micro, macroalgae and other microbial marine bioresources, including downstream processing and biorefinery for every stakeholder to use as services.

Increase **technology transfer** from academic research institutions to the industry.

Reinforce equipment in national institutions to encompass marine natural products deconvolution. Reinforce and update equipment available on bioprospection ships.

Better **dissemination and communication** between **R&D ship owners and national scientific community**, as well as, opening more calls for bioprospecting national waters, and to support longer and more often missions.

Improve **logistics** surrounding marine bioresources centres for product distribution and more **efficient transportation**.

Adequate **student training** with a set of industry and real market skills.

Support ocean-based **algae harvesting**.

ROADMAP ACTION TO IMPLEMENT

Support and implement a **Blue Hub National portal** with all information for any stakeholder to consult.

Blue bioresources central infrastructure with biobank, prototyping and pilot upscaling facilities, including downstream processing for compound isolation and/or biorefinery.

Support and incentivise **Tech Transfer Offices** at universities with highly **experienced staff with real industry experience** and paid accordingly. Revise salary values and implement **science management career path**.

Set up a call with appropriate budget (FCT) for **equipment reinforcement** of current national equipment networks. Support IPMA and similar state bodies in **upgrading ships' equipment** for modern bioprospection.

Promote **partnerships between public institutions** which have the technical equipment for bioprospecting **with the private sector** to facilitate missions and promote collaborative efforts to apply for funding schemes.

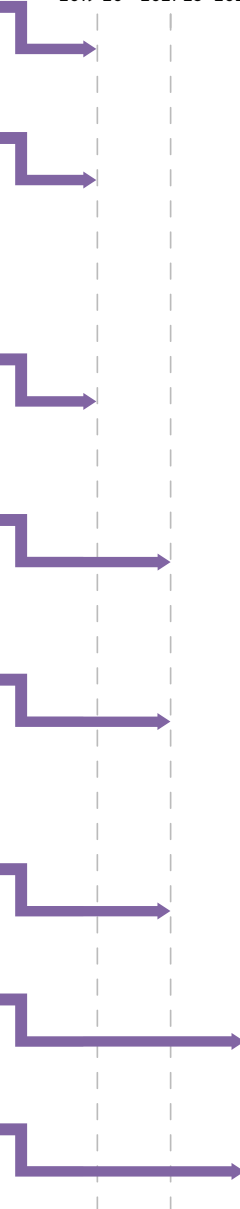
Improve **commercial connections and/or logistical platforms** surrounding major blue bioresource production centres.

Reformulate **training programmes** with the implementation of optional and compulsory training in **entrepreneurship, management and industrial skills**.

Create **quota systems for marine algae harvesting** and promote supporting benefits for new enterprises.

TIME TO IMPLEMENT

2019-20 2021-25 2026-30



COOPERATION ACTIONS

As the main focus of the challenges identified by the Portuguese Blue Bioeconomy stakeholders, actions to improve Cooperation among stakeholders are presumably the key ingredient for the success of this sector. Thus, some of the actions suggested here (Table 10) focus on facilitating the exchange of information among stakeholders; this ranges from simply mapping different types of stakeholders and their respective focus, to creating a list of infrastructures, products and services, and promoting matchmaking events. Such simple tasks, that could be promoted by associations, would greatly contribute to the exchange and flow of critical information to promote cooperation among stakeholders.

Cooperation is vital for generation and establishment of viable and functional partnerships. This will intensify and promote the development of this highly promising sector in Portugal.

In order to promote Cooperation, it is critical to improve communication among stakeholders. Indeed, cooperation and communication should be coupled. This would facilitate knowledge-transfer between academic research entities and the private sector. However, in order to succeed, improved market-oriented training for students and scientists should be available. This is, however, a two-way road, as the private sector should also be focused on lively and continuous communication with academic research to recruit new talents and increase awareness among researchers about their real market needs. As an example, Galp created an academic partnership with several Portuguese universities in order to develop projects directly applicable for the energy industry. Such partnerships substantially improve cooperation and communication, while simultaneously addressing science and technology challenges often faced by SMEs and large companies.

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Table 10. Main actions proposed by the stakeholders addressing Cooperation challenges, and suggested concomitant implementation plan. Actions are classified according to timing of their implementation (short-term 2019/20, medium-term 2021/25, long-term 2026/30).



ACTIONS PROPOSED BY STAKEHOLDERS

Facilitate **matchmaking events** for searching adequate partners to each stakeholder.

Connect different **incubators** and different **companies** in different regions.

Direct **cooperation** between **industry** players / sector representatives and **regulatory** bodies.

More **acceleration/innovation** programmes to promote startups and their networks.

Attract early stage international investors for the sector via building case studies.

Implement a **common infrastructure network for the blue sector**, with common pilot & upscale units available for all stakeholders, and clear access and management structures.

Promote **integration between R&D and industry** demand through joint projects that address concrete market challenges.

Better and more **market-oriented training for scientists, students, and professionals** that need updated sector knowledge.

Better **promotion of bioprospecting and sampling campaigns**

Inform industry players about the need of **innovation and science-based product** development.

Inventory of national bioresources and publicly and continuously managed biobanks with deposit and clear access rules.

Develop systems to effectively collect co-products from a variety of industries in an appropriate format for further use in a circular economy concept.

ROADMAP ACTION TO IMPLEMENT

Database (mapping) of stakeholders with description of who, what and where; matchmaking events to promote partnerships.

Promote matchmaking events and more collaborative actions between incubators/infrastructures through regional open days.

Promote associations that **lobby at regulatory bodies**. Provide information relevant to regulatory bodies with position papers from associations. Create databases available for consultation.

Develop and implement more **acceleration programmes in the Blue Bioeconomy** and promote synergies.

Showcase portfolio, international roadshows, and promotion of investor days.

Consolidate the Blue Demo Network to help streamline and foster current existing infrastructures. Co-Fund building/setting-of a national blue pilot infrastructure with appropriate lab and upscale conditions. Engage with the **Collaborative Laboratories for the Blue BioEconomy (B2E)**.

Open innovation-based calls for projects, where industry posts challenges to be addressed by stakeholders at different stages of the value chain.

Design management and entrepreneurial courses for undergraduate and executive training.

Improve **communication** via stakeholder databases of publicly funded expeditions and facilitate **access opportunities for public and private R&D institutions**.

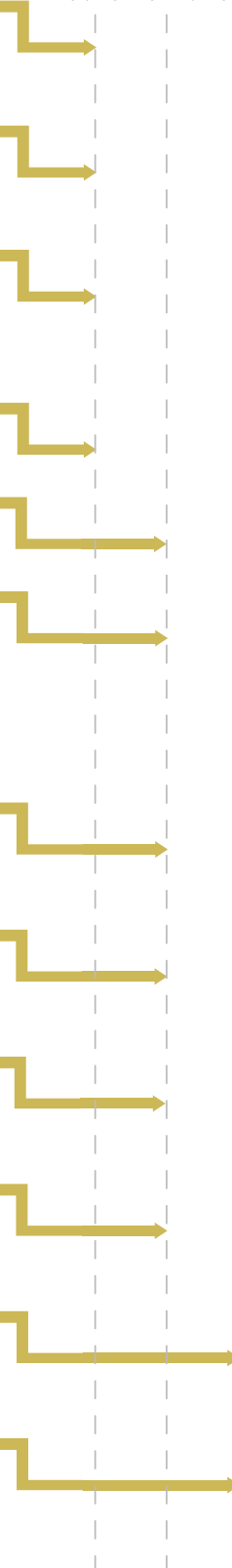
Promote **publicly funded blue economy innovation vouchers** adjusted to the sector's reality – time and cost for innovation development.

Co-Fund **blue biobank national infrastructure** with clear access rules – learn from EU case studies (Norway). Promote a blue bioresource mapping transnational project.

Co-fund projects to set up **biorefineries near industries** with co-products. Co-fund projects with R&D institutions and industry to help install such pilot units close to local industries.

TIME TO IMPLEMENT

2019-20 2021-25 2026-30



COMMUNICATION & MARKETING ACTIONS

Challenges associated with Communication & Marketing were often identified, as expected, by stakeholders focused on Commercialisation & Market entry. Nevertheless, most of the actions here suggested are transversal to the whole value chain (Table 11).

Marketing-specific actions are mostly limited to the need to develop alternative packaging using sustainable bioresources, as well as improved capacity to reach out to clients to improve their perception, awareness and understanding of the added value of particular transformation and innovation products and processes. Ultimately, improved capacitation of stakeholders, entrepreneurs, and the wider public is needed for facilitating well-informed decisions made at all levels of the value chain and of our society.

Large awareness-raising campaigns, as that performed to advocate the quality of Portuguese fish, can be replicated for a broader variety of marine bioresources, such as algae or sea-based products. Canada has launched similar initiatives for algae-based products with huge success and lessons can be learned to foster similar Portuguese programmes.

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Table 11. Main actions proposed by the stakeholders addressing Communication & Marketing challenges, and suggested concomitant implementation plan. Actions are classified according to timing of their implementation (short-term 2019/20, medium-term 2021/25, long-term 2026/30).



ACTIONS PROPOSED BY STAKEHOLDERS

Train science students in real market / industry context.

Create **database** of bioresources, stakeholders and biobased pipelines.

Dissemination actions towards different groups of stakeholders (investors, funding agents, marketing chains, consumers and citizens).

Research and study more alternatives of biobased products and packaging, and **improve communication to industry players**.

Capacitation of entrepreneurs.

Better **communication** between major **industry** players, SMEs and startups with the **local authorities and regulatory bodies**.

ROADMAP ACTION TO IMPLEMENT

Communicate industry reality to students. Support training actions inside industry – **SMEs Trainee vouchers**. Promote adequate and market oriented graduate and postgraduate/executive training.

Build **national databases** and catalogues with appropriate public support and funds.

Guided and professional outreach and dissemination campaigns. More **funding schemes for promotional actions**. Joint industry participation in major international events. Support and incentives for public information campaigns.

Industry showcase of national solutions. Open innovation calls directed to the industry. Foster industry participation in open days, roadshows and demonstration activities.

More marketing of blue sector entrepreneurship to promote acceleration of the sector through **training** activities for **science-based entrepreneurs**.

More active **participation of national stakeholders into associative work**. Produce policy and position papers regarding relevant subjects to disseminate with governmental and regulatory bodies.

TIME TO IMPLEMENT

2019-20 2021-25 2026-30

A priority area is the improvement of dissemination of actions among stakeholders, improved communication between the industry and students, and facilitated communication pathways between the private sector and public administration entities.

MARKET & CONSUMER DEMAND ACTIONS

Market & Consumer Demand challenges were mostly identified by stakeholders focusing on Commercialisation & Market Entry, as well as those focused on Innovation and Development. However, market demand information is of utmost importance for almost the entire Blue Bioeconomy value chain. As for any entrepreneur developing a new idea or business model, the golden rule is to evaluate potential markets and customer demand for the product or service being developed. Similarly, some of the actions suggested by stakeholders indicate the need for market studies that allow identification of niche markets and of those markets already saturated with multiple competitors (Table 12).

Consumer-oriented communication is also a critical action to facilitate the acceptance of a particular product or service by the end-consumer. This particular action is helpful for stakeholders throughout the value chain, but most often it is only economically sustainable for large companies. Funding schemes for consumer-oriented dissemination and promotion campaigns could be supported by public funds and examples such as those previously mentioned for locally captured fish are excellent case studies.

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Table 12. Main actions proposed by the stakeholders addressing Market & Consumer Demand challenges, and suggested concomitant implementation plan. Actions are classified according to timing of their implementation (short-term 2019/20, medium-term 2021/25, long-term 2026/30).



ACTIONS PROPOSED BY STAKEHOLDERS

Produce a **catalogue of national business cases** for market value dissemination and investors.

More **market economic data** to help identify niche markets.

National **market studies** on bioresources supply and demand chains.

Consumer oriented dissemination and promotion campaigns.

Matchmaking for national and international partners for increasing product exports.

ROADMAP ACTION TO IMPLEMENT

Produce **catalogue of national business cases** for market value dissemination and investors.

Update satellite account of the sea with novel blue biobased activities, refine search and extend applications of blue economy to other sectors of the economy to evaluate real national dimension.

National **market studies on blue biobased products** and their applications.

Design joint **public-private consumer branding campaigns for blue biobased products**, its advantages and benefits. Co-fund promotional projects for increasing consumer awareness.

Support national presence at **international matchmaking events**. Support for exploratory market trips/roadshows.

TIME TO IMPLEMENT

2019-20 2021-25 2026-30

Consumer-oriented communication is also a critical action to facilitate the acceptance of a particular product or service by the end-consumer.

FUNDING & COST OF OPERATIONS ACTIONS

Together with Cooperation, Funding & Cost of Operations is among the most widespread group of challenges across the Blue Bioeconomy value chain. The suggested actions to meet these challenges, however, are mostly directed towards funding entities and private investors (Table 13).

Not only should funding schemes be simplified, but also the stakeholders and investors should also be better informed about the Blue Bioeconomy sector. This is especially important with regards to investments for highly specific high-tech fields, since a deep understanding of the business and the underlying technologies is needed for promoting successful investments. Developing, and supporting with fiscal benefits and other incentives, specialised blue private investment funds will speed up the development of the Blue Bioeconomy sector. The same rationale has been

applied to health/life science funds in the EU with tremendous success in countries, such as Finland and Sweden. Financial support should also be available for participation in international show cases, as well as increased efforts to reduce the time-consuming and complex process associated with the approval of new products, which notably affects the cost of operations for any stakeholder and deters investors from this sector. Creating the conditions for the Blue Bioeconomy sector to thrive and flourish in its entrepreneurial activity to levels currently deployed in national sectors, such as mobile and web-based business or Fintech, will help to foster the creation of new businesses, jobs and blue biobased products, as well as contribute to building the vision within this roadmap.

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Table 13. Main actions proposed by the stakeholders addressing Funding & Cost of Operations challenges, and suggested concomitant implementation plan. Actions are classified according to timing of their implementation (short-term 2019/20, medium-term 2021/25, long-term 2026/30).



ACTIONS PROPOSED BY STAKEHOLDERS

Simplification of public funding schemes, more focused and with less side information request, that result in a **faster evaluation process** and **simpler reporting systems**.

Increase and foster financial support to **blue entrepreneurship**.

Promote **knowledge dissemination** and information on the sector for investors and funding stakeholders.

Co-funds to promote **intellectual property protection**, **internationalisation** as well as hiring highly **skilled human resources**.

Promote **international investment** into the blue sector with business cases.

Funding required for **industrialisation to mature production technology status**, as well as to **modernise and digitalise SMEs** in order to decrease production costs and produce more competitive consumer priced products.

Blue private funding and venture capitals with constant operations.

De-risk bank support to SMEs with approved public funding projects.

Promote SMEs that incorporate **sustainable and circular economy** processes and solutions into their pipelines.

Reduce approval costs of new products.

ROADMAP ACTION TO IMPLEMENT

Simplification of national funding schemes - Implement two stage submission projects, with a first simpler version and only submission of the full project at a later stage. **Dramatically reduce time of evaluation** - learn from EU instruments like SME instrument. **Implementation of fast track processes** from decision to payment.

Promote and fund **acceleration programmes** within the sector. Launch specific and with appropriate value funding calls for **risky entrepreneurial exploratory projects**. Promote failure in scientific experimentation via funding pilot testing project calls.

Produce **databases** on the sector, infographics and **marketing and communication** materials targeted to **funding stakeholders**. Create events for dissemination and informing stakeholders.

Re-launch **intellectual property vouchers and PhD vouchers for SMEs and startups** at national level. Modify P2020 calls to biobased business taking into account business cycles dimensions and time frames. Fiscal incentives for stakeholders that promote **intellectual property protection** and have **high percentages of PhDs in their staff**.

Fiscal incentives for foreign investors into the blue economy. Produce a **portfolio of Blue Bioeconomy business cases** as showcase material.

Broaden the scope of blue funding schemes - more funding schemes for industrial processes, for upscaling and de-risking technological process development for production technologies and processes. Expand the focus of the call to blue bioresources and not only marine resources.

Set up a **public-private blue fund for early stage to series A investment** in national blue startups and SMEs.

Create specific **bank support credit lines for blue sector**, without the need for extra guarantees than the project approval.

Fiscal benefits and/or incentives for **SMEs that incorporate sustainable and circular economy processes and solutions** into their pipelines.

Lobby with EU regulators for **faster approval** and also co-funding for regulatory approval of **national blue products**.

TIME TO IMPLEMENT

2019-20 2021-25 2026-30



LEGAL & REGULATORY ACTIONS

For generating competitiveness on a global scale, fostering a sector based on scientific excellence, paving the way to the forefront of Blue Bioeconomy innovation, is crucial. Once creative ideas are successfully tested and shown to succeed, they can eventually be ready for commercialisation and market entry. However, the development of innovative products and services also requires a concomitant continuous improvement of legal frameworks. Unfortunately, nowadays, often long and continuously delayed regulatory processes recurrently affect market entry of innovative biobased products. This can be interpreted from numerous actions suggested by stakeholders (Table 14), who often see their businesses failing because their product never went through the last gate for market entry – the legal and regulatory gate.

In general, all the suggested actions focus on support service entities, particularly the public administration, but also on entities, which promote the training and improved capacity building of human resources. For example, many new products and solutions being developed from novel microalgae or

macroalgae face immense hurdles from the EU list of approved food components and production norms. Algae have been the basis of food in Asian countries for centuries, where they are safely consumed and incorporated, but in the EU, they simply cannot be deployed due to a very restrictive regulation. Furthermore, the process of approval for new foods to enter those lists is cumbersome and prevents the success of many blue biobased enterprises. In addition, EU blue biobased products often face a long list of safety compliance rules, which are not imposed on non-EU-produced products, such as bivalves or algae-based products from aquaculture, that unfairly compete with those made in the EU. Overall, it is important to emphasise the importance of legal and regulatory entities to keep up with the blue biobased innovation and development processes. It is, however, important to note that this is a herculean task. Not only scientific information is being generated at increasingly higher rates, but public administration offices are recurrently facing budget cuts severely impacting the efficiency and productivity of manpower.

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Table 14. Main actions proposed by the stakeholders addressing Legal & Regulatory challenges, and suggested concomitant implementation plan. Actions are classified according to timing of their implementation (short-term 2019/20, medium-term 2021/25, long-term 2026/30).



ACTIONS PROPOSED BY STAKEHOLDERS

Clarify, describe and implement **access policies to national bioresources**. Widespread, digital, easy access and support for requesting licenses and access to bioresources in compliance with Nagoya Protocol and biodiversity conventions.

Lobby to facilitate, simplify and reduce time and cost for **European approval of new products** (food, feed, cosmetics and pharmaceutical). European norms shall be implemented in all EU countries in equal standards.

Simplify legislation for new packaging, particularly for food & feed, to promote new bio-based packaging solutions.

Simplify and **speed up licensing procedures**, including expansion licenses.

Facilitate and **simplify intellectual property** issues.

Training and reinforcement of public administration staff in recent blue sector technological activities and regulatory aspects.

Market access rules for national versus non-national produced **blue bioresources** needs to be reviewed, specifically with barriers to market entry of non-EU products that pose unfair competition to local and highly regulated production units.

Revise current **legislation** on aquaculture, namely O DL 565/99.

ROADMAP ACTION TO IMPLEMENT

Elaborate and approve **simple and efficient rules for accessing national bioresources** that should be disseminated among stakeholders. Promote awareness and implement national bioresources biobank access infrastructure. Implement national template for licensing and bioresource access with a centralised channel for requests and submissions.

Production of **position and policy papers** to foster simpler regulatory approval paths by representative associations of the sector.

Fast track approval for novel bio-based packaging solutions. National approval scheme for faster market entry of bio-based packaging solutions.

Promote **blue simplex to more blue bioeconomy activities**, such as aquaculture, aquaponics, and access to bioresources. Facilitate expansion licensing. Zero license area for R&D activities and pilot testing. Implement a caution for disaster support, allowing **de-risking licensing** in touristic or protected areas and accelerate granting of licenses to promote development and innovation.

Fast track to blue **intellectual property** protection, with support services to request patents.

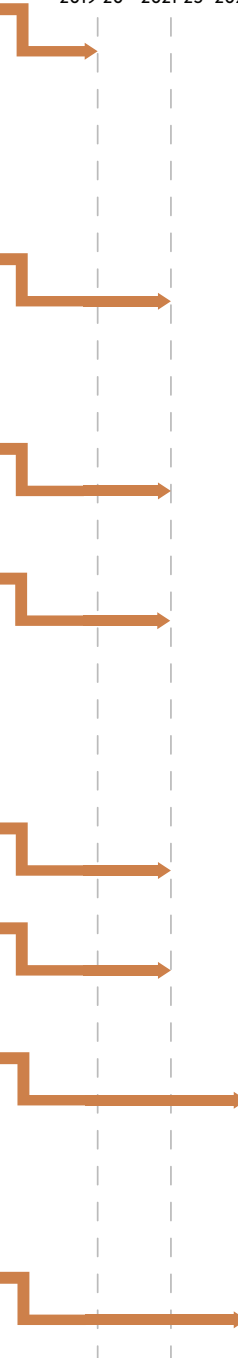
Promote **qualification programmes for public bodies staff**. Cooperate with national scientific system to ensure qualifications.

Implement **market importation barriers** to non-EU suppliers whose production is unfair and not complaint to current national production rules.

Promote **faster legislation approval mechanisms** within the central government.

TIME TO IMPLEMENT

2019-20 2021-25 2026-30







ANNEXES

BLUEANDGREEN PROJECT

The H2020 Twinning project BLUEandGREEN aimed to increase the performance of CIIMAR, in the area of Marine Biotechnology. This was achieved by a consortium joining CIIMAR with four internationally-leading counterparts at EU level: University of Helsinki - Finland, the University of Bergen - Norway, GEOMAR-Helmholtz Centre for Ocean Research Kiel - Germany, and Fundación MEDINA - Spain. BLUEandGREEN was a complementary transdisciplinary effort of the four partners that contributed to raise CIIMAR's scientific excellence and innovation capacity in biorefineries based on marine resources.

BLUEandGREEN enforced cluster dynamics and was performed in close interaction with industrial partners to contribute to regional, national and EU Blue Growth strategies, especially to the economic growth of the marine biotechnology industry. The objectives were attained by the implementation of short-term staff exchanges and expert visits; short-term training and workshops; a summer school and an international conference. The contribution to the economic growth is being implemented by mapping of relevant actors of the Blue Bioeconomy value chain (at regional and national levels) and the preparation of collaborative market-oriented projects. Moreover, an important contribution of the project is the strengthening of the interactions between research and innovation makers and the industry, with the development of the Blue Bioeconomy roadmap for Portugal. The roadmap clarifies the Portuguese landscape of marine biotechnology and provides important recommendations for the future Blue Bioeconomy strategy in Portugal. This has helped to increase the dialogue and interactions between different actors and to promote knowledge enhancements and its conversion into business. Being implemented in Portugal, and especially Northern Portugal, a peripheral region, this project is significantly contributing to change its economic landscape towards marine bioresource valorisation, giving new opportunities for development and job creation.

METHODOLOGY FOR THE BUILDING OF THIS ROADMAP

This roadmap results from multiple and joint tasks taken by the consortium of the BLUEandGREEN project and by the BLUEBIO ALLIANCE (BBA; a Portuguese network of the blue biotechnology and marine bioresource sectors in Portugal). Such tasks provided the data and insights needed to draw a detailed picture of the Portuguese Blue Bioeconomy sector and to propose a roadmap for the future development of this sector (Fig. 15).

Stakeholders' database/mapping

A database was constructed with a large set of data from the Portuguese Blue Bioeconomy stakeholders serving as the basis of the entire mapping and consultation processes. This task was divided into two phases. The first phase comprised the previous collaboration contacts of the investigators from the BLUEandGREEN team. The second phase consisted in the integration of additional contacts from the BBA, and assemblage of additional contacts from brokerage events with national and international stakeholders, and from participation in business conventions and other international events. Each contact was classified according to its geographical location, type of organisation, position in the value chain, type of bioresource they use and field(s) of application(s). Although the final database does not include information from all Portuguese entities directly or indirectly involved in the Portuguese Blue Bioeconomy sector, it includes a total of 248 entities, which certainly provides a representative overview of this sector.

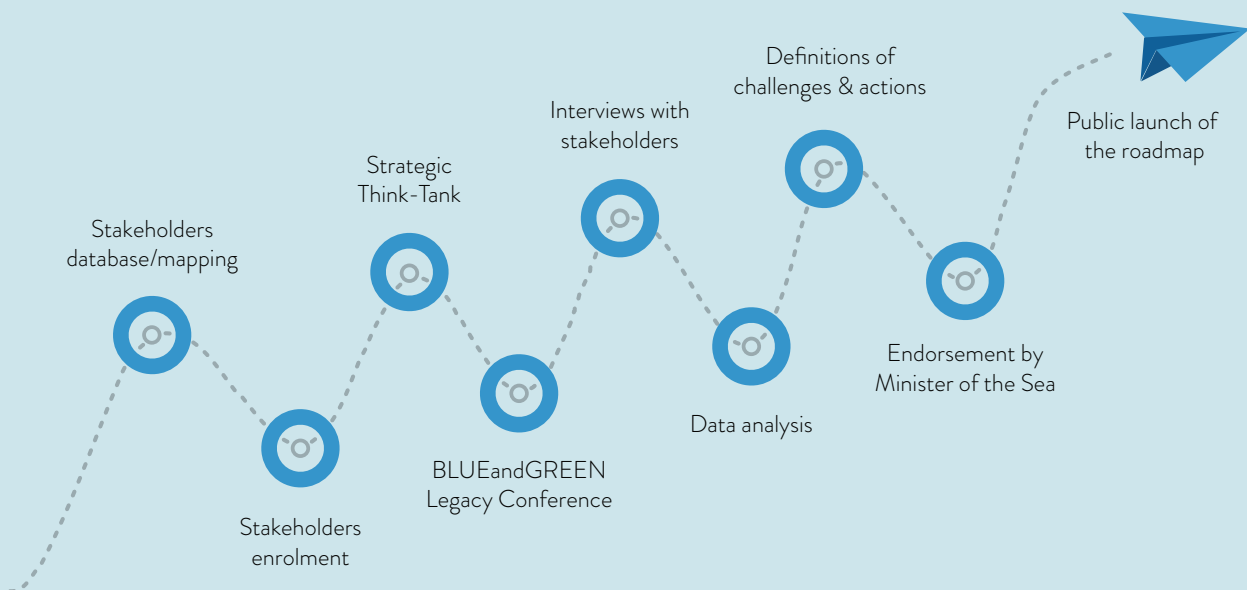
Enrolment of stakeholders

Important Portuguese stakeholders, such as BBA and Oceano Azul Foundation, were involved in the preparation of the roadmap. BBA has the mission to collectively organise the Blue Bioeconomy value chain to foster its relations and dynamics, leveraging SMEs' growth and accelerating their internationalisation by increasing their outreach and exportation. Oceano Azul Foundation aims to promote an integrated ocean management, based on scientific knowledge, thereby supporting an innovative and sustainable Blue Bioeconomy. Other key stakeholders of Portuguese Blue Bioeconomy were also enrolled during the preparation of this roadmap, such as Fórum Oceano, among others.

Strategic Think-Tank

A strategic think-tank which focused on “The Portuguese Blue Bioeconomy’s Role – National solutions for global challenges” was organised. Rapporteurs from CIIMAR collected information developed in four parallel sessions of this workshop moderated by the BBA. Each session covered one of the following topics: 1) Sustainably feeding the growing population, 2) Climate change and CO₂ control, 3) Aging population and well-being, and 4) Management of bioresources and plastic reduction. The information collected in each thematic session was used in the preparation of the identification of current bottlenecks of Blue Bioeconomy in Portugal throughout the value chain, as well to identify relevant actions for some of the identified hurdles.

Fig. 16 Methodological steps taken for developing the current roadmap for the Portuguese Blue Bioeconomy.



BLUEandGREEN legacy conference: Adding value to marine bioresources

A conference was organised with key international speakers in the field of marine biotechnology, bioeconomy, and circular economy. The main goal of this conference was to better understand the Portuguese landscape of Blue Bioeconomy and collect expert opinions that were relevant for the preparation of the current roadmap. A round table was organised during the session “National BLUEandGREEN Biotechnology Landscape”. The moderator was Miguel Marques (PricewaterhouseCoopers), and the following key Portuguese players participated in the round table: Vitor Vasconcelos (CIIMAR), Helena Vieira (BLUEBIO ALLIANCE), Helena Reis (Across Science), Miguel Herédia (Oceano Azul Foundation), Carla Domingues (Fórum Oceano), and Alexandre Almeida (National Smart Specialiation Strategy Coordination). The information collected during this session was also an important asset for the preparation of this roadmap⁽¹⁾.

Interviews with stakeholders

A standardised interview included in the database was prepared and sent to all the stakeholders in a questionnaire format. The interviews focused on providing information about the entity and its role in the Blue Bioeconomy value chain, but also identifying their main field of application and how it is foreseen to develop/change within the next five years. Also, importantly, these interviews assembled the stakeholders’ opinion on the main bottlenecks of the Blue Bioeconomy in Portugal for each of the four main steps of the value chain (biomass, Innovation and Development, Commercialisation and Market Entry) and support services, as well as suggestions of relevant actions on the immediate and medium-term solutions to address the identified hurdles.

Data analysis

Data analysis was performed for three different groups of information:

- Stakeholders’ map
- Identification and quantification of challenges
- Identification and prioritisation of actions

The data for these three different groups was retrieved from the stakeholder’s database and from the interviews. Additional data was retrieved from official sources like CORDIS database, National Institute of Statistics (sea account), reports from the Ministry of the Sea, and LEME – a yearly report from PwC on the Sea Economy of Portugal.

The stakeholders’ mapping was performed by grouping all entities according to type of organisation, their geographical distribution, position in the value chain, bioresource usage, and fields of application for bioresources nowadays and prospectively, five years from today.

As for the challenges, the identified hurdles were classified according to the following groups:

- Science, Technology & Logistics
- Cooperation
- Communication & Marketing
- Market & Consumer Demand
- Funding & Cost of Operations
- Legal & Regulatory

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⁽¹⁾ BLUEandGREEN Legacy International Conference and Workshop – Adding value to Marine Bioresources 2018. V. Vasconcelos, J. Moreira-Silva, S. Amaral, S. Moreira & A. Cavadas (EDS.), Publisher: CIIMAR, MATOSINHOS, PORTUGAL. ISBN: 978-989-54077-4-3

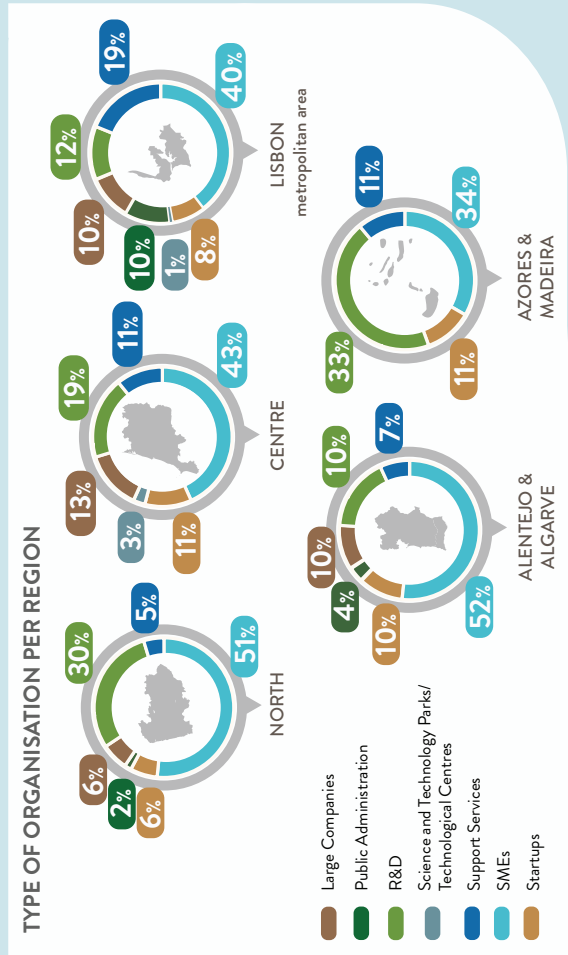
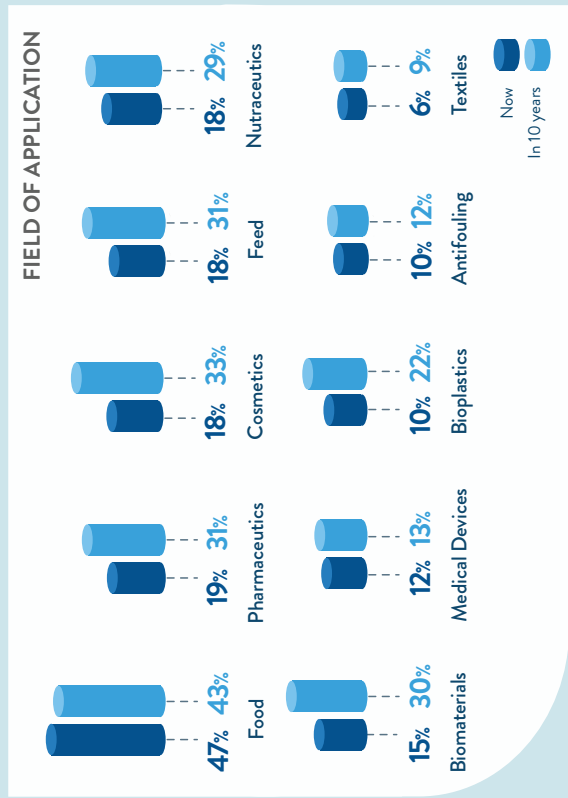
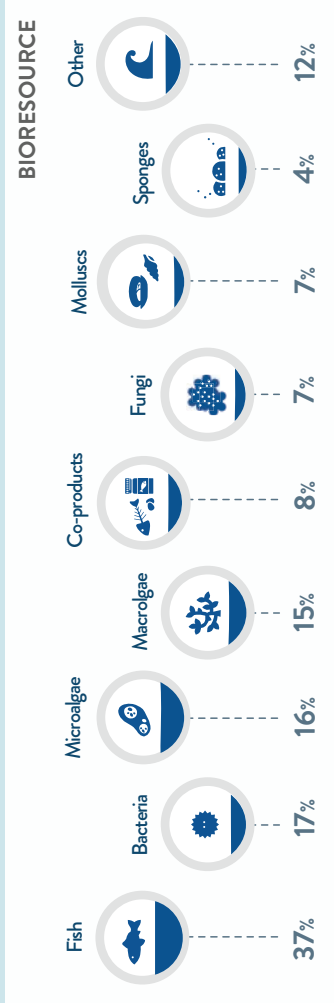
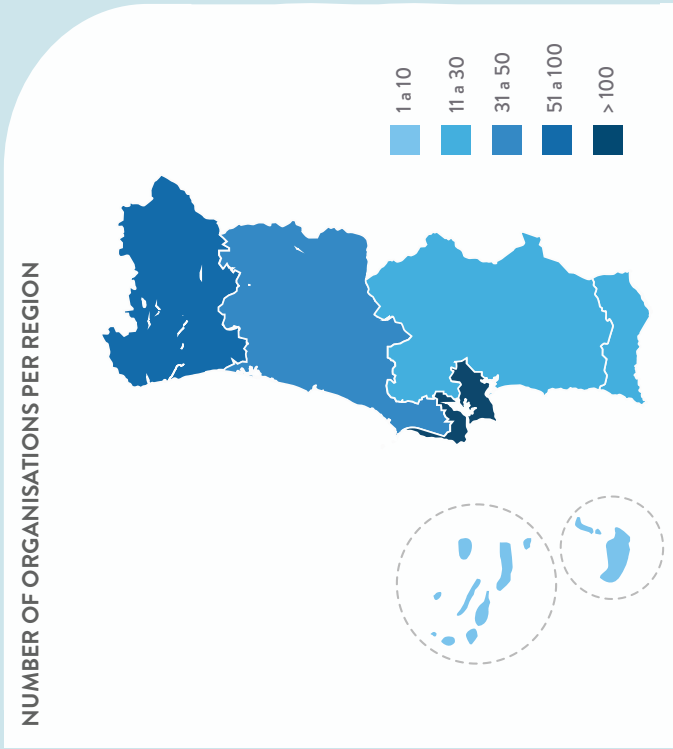
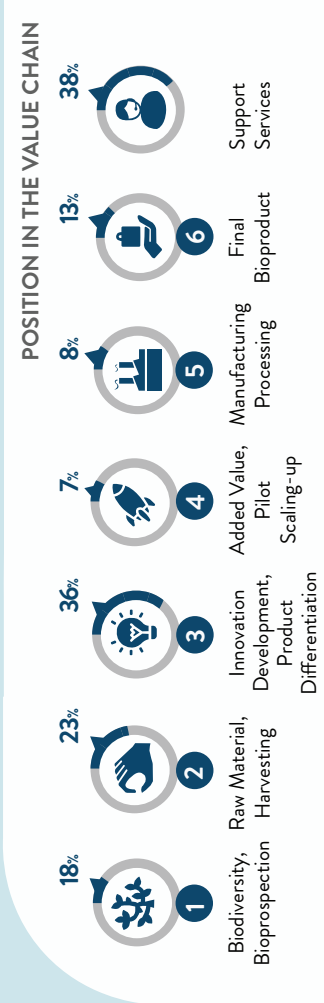
The first group (Science, Technology & Logistics) includes challenges associated with the lack of scientific knowledge of technical infrastructures, as well as complex logistics for testing, scaling-up or the implementation of production processes. The second group (Cooperation) encompasses challenges where access to resources, technical expertise, specialised services or products, and innovative processes can be facilitated through cooperation. The third group (Market & Consumer Demand) includes challenges associated with better understanding market demands, consumer awareness and behaviour, and competitors. The fourth group (Communication & Marketing) comprises challenges that are directly related with reaching out to clients, product positioning, branding, and packaging. The fifth group (Funding & Cost of Operations) includes challenges associated with access to funding, cost-efficiency of innovation and production processes. The last group (Legal & Regulatory) comprises all the challenges associated with licensing and regulation, intellectual property, and certification. After categorising each challenge, they were quantified for each step of the value chain.

The actions identified by the stakeholders were first grouped by similarity, and then grouped according to the same challenge's groups previously described. They were then quantified in order to prioritise the actions needed to improve each step of the value chain and build a roadmap for the 2030 Portuguese Blue Bioeconomy.

Definition of challenges and actions

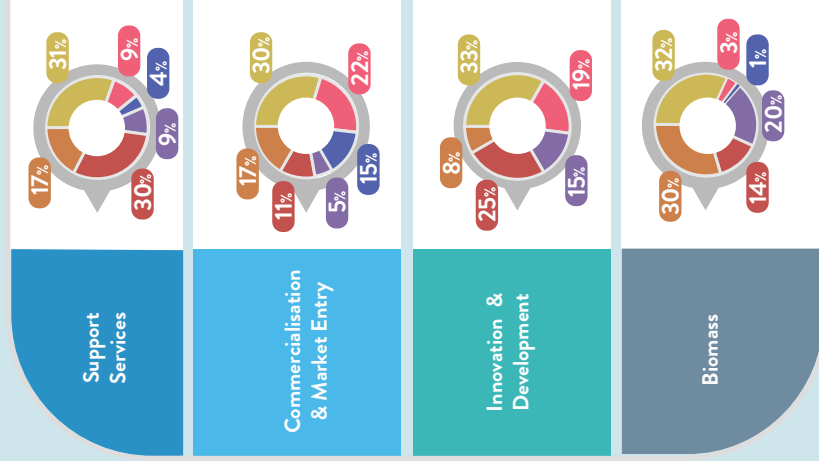
After analysing the data, the results were summarised and combined with information retrieved from the previous steps, including the opinions of the enrolled key stakeholders and key Portuguese players in Blue Bioeconomy. All information was assembled and critically reviewed in order to pinpoint the most relevant challenges and the corresponding actions needed to address those challenges. Ultimately, this assemblage and discussions of ideas and opinions, combined with the multi-disciplinary view of the CIIMAR and BBA groups, led to the 2030 Roadmap for Portuguese Bioeconomy.

MAPPING OF THE BLUE BIOECONOMY IN PORTUGAL

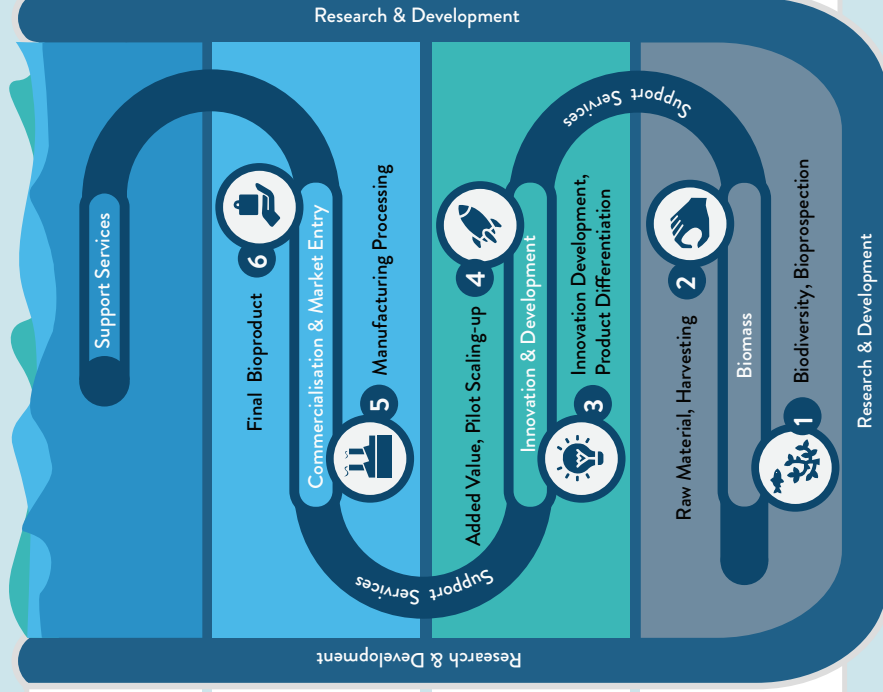


CHALLENGES AND ACTIONS FOR THE PORTUGUESE BLUE BIOECONOMY SECTOR

CHALLENGES

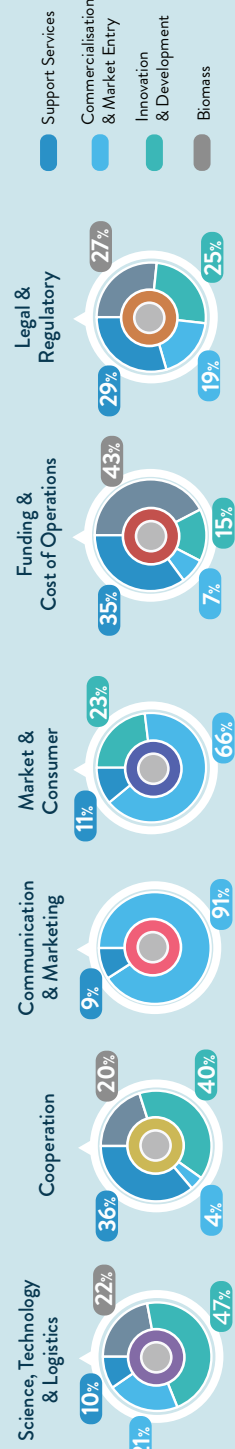
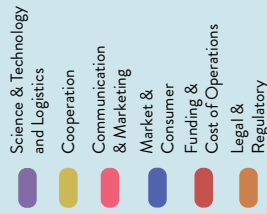


VALUE CHAIN



MAIN ACTIONS

- 1** Create a Blue Hub National Portal with information about all stakeholders, their expertise, products and services.
- 2** Support a network that centralises requests for infrastructures related to bioresources, prototyping and pilot upscaling facilities.
- 3** Implement training sessions in entrepreneurship, management and industrial skills in the training programmes for young scientists enrolled in blue bio-based courses.
- 4** Simplification of national funding schemes through the implementation of two stage submission projects, and implementation of fast track processes from decision to payment.
- 5** Blue bioeconomy acceleration programmes, competitive funding calls to address challenges suggested by the industry, and funding schemes for high-risk experimentation and exploratory projects.





BLUE_{and} GREEN

PROJECT
CONSORTIUM:



UNIVERSITY OF HELSINKI



ciimar



GEOMAR

Helmholtz Centre for Ocean Research Kiel



MEDINA

UNIVERSITY OF BERGEN



A roadmap is, by nature, a plan that aims to lead somewhere better. It focuses on actions and predicted timelines to promote a certain sector during a predefined timeframe. Therefore, more than just evaluating the specific challenges that the Portuguese Blue Bioeconomy sector is facing today, this roadmap is the result of a multi-stakeholder consultation endeavour and followed by a thorough data analysis. It takes advantage of the stakeholders' expertise on how the blue bio-based sector will be able to improve the sustainable use of bioresources for new products, services and processes.



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