IAI PAPERS 22 | 22 - SEPTEMBER 2022

ISSN 2610-9603 | ISBN 978-88-9368-261-9

Istituto Affari Internazionali

The Blue Economy in the Mediterranean Region and Opportunities for the Algae Industry

by Raffaele Mancini

ABSTRACT

The blue economy is a complex multi-theme and multi-layer conceptual paradigm according to which marine spaces are considered as spaces with great potential for sustainable development and socio-economic prosperity. This is particularly true for the Mediterranean where, since ancient times, marine and maritime activities have played a key role in the well-being of coastal countries and communities. Today, there are emerging economic sectors that provide opportunities for business development and job creation. Algal biomass production is one of the most promising.

keywords

Mediterranean | European Union | Sustainable development | Renewable energy | Aquaculture | Algae industry | Biofuel production

ISSN 2610-9603 | ISBN 978-88-9368-261-9

IAI PAPERS 22 | 22 - SEPTEMBER 2022

The Blue Economy in the Mediterranean Region and Opportunities for the Algae Industry

by Raffaele Mancini*

Introduction

In the Rio+20 United Nations Conference on Sustainable Development (June 2012), the concept and implementation of a green economy was at the core of the debate. Throughout the preparatory process, many coastal countries questioned the applicability of the green economy to themselves and presented strong positions for a "blue" economy approach on the assumption that seas and oceans are crucial to move towards sustainable, low-carbon, resource efficient, and inclusive development patterns able to decouple economic growth from resource use and environmental impacts.[1]

Since ancient times, the economic activities occurring along the coastline of the Mediterranean Sea have been crucial for the development of the entire region and the well-being of the local communities. Today, the Mediterranean blue economy generates an annual value of 450 billion US dollars.[2] If it was a nation, this would make the Mediterranean Sea the fifth largest economy in the region: fisheries and aquaculture have an economic value of 4.1 billion euro and create 353,000 direct jobs. They are the third most important blue economy sector in socio-economic terms in the Mediterranean after tourism and maritime transport. In 2030, aquaculture production in the EU Mediterranean countries is expected to increase 112 per cent with respect to the production level in 2010. Tourism represents 4.5

[1] United Nations, *Blue Economy Concept Paper*, January 2014, https://www.unep.org/node/1018.

[2] Mauro Randone et al., *Reviving the Economy of the Mediterranean Sea. Actions for a Sustainable Future*, Rome, WWF Mediterranean Marine Initiative, September 2017, p. 16, https://wwfeu.awsassets.panda.org/downloads/reviving_mediterranean_sea_economy_full_rep_lowres.pdf.

* Raffaele Mancini has 25 years of professional experience in nature conservation and sustainable development at the EU and Mediterranean level. He has coordinated marine and maritime projects and initiatives serving as Blue Economy Expert for the European Commission, the Union for the Mediterranean and the Mediterranean Action Plan of the United Nations. He is currently Head of European Projects and Initiatives at Assoittica Italia.

Paper prepared in the framework of the IAI-Eni Strategic Partnership

per cent of the GDP of the Mediterranean countries, accounting for 11.5 per cent of the total employment in their economies. Moreover, the number of tourists is set to reach 500 million in 2030, of whom 250 million will likely concentrate in coastal areas. The Mediterranean cruise industry is the world's second largest market after the Caribbean, while the recreational boating value chain sector counts approximately 32,000 companies. There is an upward trend for maritime traffic routes in the Mediterranean, which is expected to become the largest load and discharge centre for the transport of oil products. The Mediterranean has about 600 ports, some of them among the most important in the world, while its fleet hovers around 8,000 vessels whose carrying capacity has increased 30 per cent over the past two decades, delivering about 20 per cent of world seaborne trade and 6 per cent of worldwide container throughput.[3]

This paper will address the concept of blue economy, dwelling on policies and regulations relevant to promote this concept in the Mediterranean region and reflecting on financial tools that can support the process. Existing regional and sub-regional blue-economy initiatives will be also presented. Finally, the production of algal biomass will be analysed as one of the most promising emerging sectors.

1. The conceptual framework

There are multiple definitions of the blue economy. All of them underline that the blue economy is a powerful tool to promote sustainable development, reduce the exploitation of marine ecosystems and resources, support the sustainable growth of coastal communities and contribute to environmental resilience. In 2017, a definition adapted to the specificities of the Mediterranean region was proposed: "a low polluting, resource-efficient and circular economy based on sustainable consumption and production patterns, enhancing human well-being and social equity, generating economic value and employment, and significantly reducing environmental risks and ecological scarcities".[4]

1.1 Policy and regulatory frameworks

The European Green Deal (EGD) – a very ambitious energy transition pathway on which the EU has embarked – aims to limit the increase in global warming and achieve zero net polluting emissions by 2050.[5] The "blue" component of the EGD is

[3] Plan Bleu website: *Blue Economy: A New Frontier for Growth and a Healthy Mediterranean*, https://planbleu.org/en/?p=6762; Kristian Petrick et al., *Blue Economy in the Mediterranean*, Union for the Mediterranean, 2017, p. 40, https://ufmsecretariat.org/wp-content/uploads/2017/12/UfMS_Blue-Economy_Report.pdf.

[4] Plan Bleu et al., *A Blue Economy for a Sustainable Development of the Mediterranean Region. Measuring, Monitoring and Promoting. Concept Note*, Marseilles, 30-31 May 2017, p. 6, https://planbleu.org/wp-content/uploads/2017/04/BE_ConceptNote_Draft.pdf.

[5] European Commission, *The European Green Deal* (COM/2019/640), 11 December 2019, https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52019DC0640.

ISSN 2610-9603 | ISBN 978-88-9368-261-9

of paramount importance since such an objective is impossible to achieve without healthy oceans and seas.[6] This is why the blue economy sectors, currently a major source of greenhouse gas emissions, must undergo a profound transformation abandoning the current "linear" economic model (take-make-dispose) and move towards a new "circular" model. A sustainable blue economy can only be based on circular economy principles and practices. In this view, over the last years, the European Commission has adopted a set of circular economy plans, strategies and measures with the aim to eliminate waste (mainly plastics and micro-plastics) and reintroduce used products and materials into the market at their highest value.[7] In the Mediterranean region there are already plenty of examples of how "circularity" may turn into a business opportunity. Such examples range from companies reusing nets to produce iPhone cases, watches and glasses to companies producing furniture and installations or even high-tech filament for 3D printing.[8] These business initiatives are somehow comforting in a region where approximately 730 tonnes of plastic waste are estimated to end up in the sea every day.[9] At the heart of the EGD, furthermore, the "Farm to Fork Strategy" deals with the transition to a sustainable food system.[10] Among other aims, this strategy advocates for circular business models in fishery and aquaculture. As to the latter, the so-called integrated multi-trophic approach (IMTA) allows for farming two or more aquatic organisms at the same time so that species farmed at the lower trophic level – usually plants or invertebrates – use waste products (e.g., faeces, uneaten feed, etc.) of the higher trophic species – typically finfish – as nutrients.

[6] Oceans absorb approximately 23 per cent of the annual emissions of anthropogenic CO_2 into the atmosphere and more than 90 per cent of the excess heat from human activities. See World Meteorological Organization (WMO), *State of the Global Climate 2021*, Geneva, WMO, 2022, p. 7 and 11, https://library.wmo.int/index.php?lvl=notice_display&id=22080.

[7] European Commission, *A New Circular Economy Action Plan. For a Cleaner and More Competitive Europe* (COM/2020/98), 11 March 2020, https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52020DC0098; European Commission, *A European Strategy for Plastics in a Circular Economy* (COM/2018/28), 16 January 2018, https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52018DC0028; European Parliament and Council of the European Union, *Directive (EU) 2019/904 of 5 June 2019 on the Reduction of the Impact of Certain Plastic Products on the Environment*, http://data.europa.eu/eli/dir/2019/904/oj; European Commission website: *Circular Plastics Alliance*, https://europa.eu/!BVXmTH.

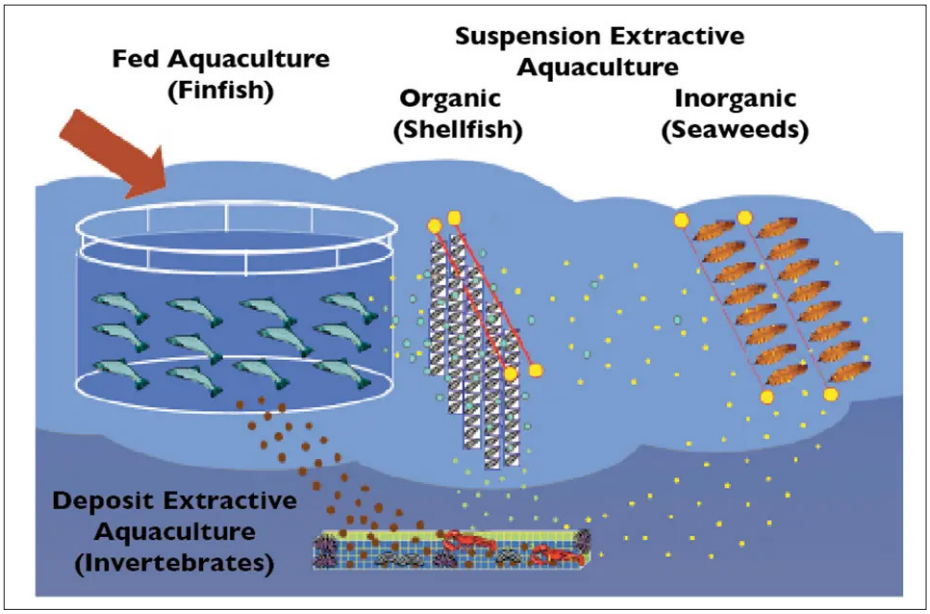
[8] Martina Bocci and Raffaele Mancini, *A Circular Blue Economy for the Mediterranean. Current Practices and Opportunities*, CPMR Intermediterranean Commission and MedWaves, June 2022, https://www.euneighbours.eu/en/node/44701.

[9] Different sources report that plastic waste accounts for 95 to 100 per cent of total floating litter in the Mediterranean Sea, and more than 50 per cent of seabed litter, while single-use plastics represent more than 60 per cent of the total recorded marine litter on Mediterranean beaches. See United Nations Environment Programme/Mediterranean Action Plan (UNEP/MAP) website: *Pollution in the Mediterranean*, https://www.unep.org/unepmap/node/21808.

[10] European Commission, *A Farm to Fork Strategy for a Fair, Healthy and Environmentally-Friendly Food System* (COM/2020/381), 20 May 2020, https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52020DC0381.

ISSN 2610-9603 | ISBN 978-88-9368-261-9

Figure 1 | Integrated multi-trophic aquaculture



Source: Thierry Chopin et al., "Integrated Multi-Trophic Aquaculture. Part I: Responsible Practice Provides Diversified Products, Biomitigation", in *Global Aquaculture Advocate*, September/October 2010, p. 38-39, https://www.globalseafood.org/?p=37491.

Beyond the evident environmental advantages, the lower trophic species harvested in addition to the higher trophic species ensure additional revenues to the farmer. In this perspective, the huge amount of waste produced by the aquaculture sector in the Mediterranean can be seen not only as a problem to tackle but also as a business opportunity.[11]

In May 2021, the European Commission published the Communication on "A New Approach for a Sustainable Blue Economy in the EU",[12] which takes a systemic view that integrates ocean policy into Europe's new economic policy to make the blue economy instrumental to achieve the transformation set out in the EGD. To this end, a transformation in the EU for the industries and sectors related to oceans, seas and coasts is needed also in view to ensuring a green and inclusive recovery from the pandemic. The Communication sets out a detailed agenda for the blue economy to: i) achieve the objectives of climate neutrality and zero pollution; ii) switch to a circular economy and reduce pollution; iii) preserve biodiversity and invest in nature; iv) support climate adaptation and coastal resilience; v) ensure sustainable food production; vi) improve management of space at sea.

[11] Martina Bocci and Raffaele Mancini, *A Circular Blue Economy for the Mediterranean*, cit.

[12] European Commission, *A New Approach for a Sustainable Blue Economy in the EU: Transforming the EU's Blue Economy for a Sustainable Future* (COM/2021/240), 17 May 2021, https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52021DC0240.

IAI PAPERS 22 | 22 - SEPTEMBER 2022 ISSN 2610-9603 | ISBN 978-88-9368-261-9

Applied to the Mediterranean region, this new approach urges the inclusion of stringent sustainability considerations when it comes to the development of a regional offshore wind energy industry. There are 23 offshore wind projects in the pipeline in the Mediterranean region, although most of them are still in the planning and permitting development stages. The first marine wind farm in the Mediterranean was inaugurated in April 2022 in Taranto (Italy). The plant, called Beleolico, includes ten blades for a total capacity of 30 megawatt (MW) and will ensure a production of over 58 thousand MWh, equal to the annual needs of 60 thousand people saving 730,000 tons of carbon dioxide in 25 years. It is noteworthy that there exists good potential for other forms of ocean energy in the Mediterranean – wave energy and localised potential for tidal energy.

1.2 Financing the blue economy

The global business community are increasingly aware that their investment choices are decisive for the health of oceans and seas. The "Sustainable Blue Economy Finance Principles" reflect this new sensitivity by providing banks, insurers and investors with a guide to use when investing in marine and maritime projects.[13] The principles were developed by the European Commission, the World Wildlife Fund, the World Resources Institute and the European Investment Bank, and are hosted by the United Nations Environment Programme Finance Initiative as part of the Sustainable Blue Economy Finance Initiative, a UN-convened global community focused on the intersection between private finance and ocean health.[14]

Over the years several financial tools have been considered to help finance the blue economy (e.g., contingent recoverable grants, climate funds, levy and insurance, impact bonds, debt swaps, crowdsourcing and diaspora finance, etc.). Two of these tools are presented in more detail below.

In 2018, the Republic of Seychelles launched the "Seychelles Sovereign Blue Bond", the world's first blue bond issuance programme. It is a mix of public grants and private investments that help the country go through the sustainability transition of its marine and maritime activities.[15] The blue bonds are ten-year sovereign bonds issued by the Seychelles government with the commitment of protecting marine areas hosting important biodiversity habitats. They are backed by a guarantee from the World Bank and the Global Environment Facility, and the private investors are guaranteed a 6.5 per cent annual interest rate. This is also beneficial for the issuing

[13] UNEP website: *The Sustainable Blue Economy Finance Principles*, https://www.unepfi.org/?p=31826.

[14] UNEP website: *United Nations' Sustainable Blue Finance Initiative*, https://www.unepfi.org/?p=31719.

[15] World Bank, *Seychelles Launches World's First Sovereign Blue Bond*, 29 October 2018, https://www.worldbank.org/en/news/press-release/2018/10/29/seychelles-launches-worlds-first-sovereign-blue-bond.

ISSN 2610-9603 | ISBN 978-88-9368-261-9

country, which is allowed to restructure its sovereign debt with lower interest rates and longer payment periods, as long as the money saved goes to a trust fund that pays for marine protection, fishery management and other projects to safeguard the ocean economy and provide positive environmental, economic and climate impacts. This scheme is replicable and scalable. Indeed, the Nordic Investment Bank has issued the Nordic-Baltic Blue Bonds to finance environmental projects,[16] and also Belize has adopted a similar approach to lower its debt.[17] Whether or not blue bonds are applicable to the Mediterranean region is still a subject of debate among the major regional players, even as blue bonds have already broken into the Mediterranean scenario through Chinese institutions. Indeed, in 2020, the Bank of China issued over 900 million US dollars blue bonds to fund ocean-related projects, such as wastewater treatment plants to treat effluents before they are discharged into the sea, and offshore wind power. France is one of the countries targeted by this initiative.

1.3 Regional and sub-regional cooperation for a sustainable blue economy in the Mediterranean

Sustainability cannot stop at borders. This is particularly true in the Mediterranean region where countries, each with its peculiarities, share the same history and culture and are inextricably linked by common interests. Effective regional cooperation is crucial to tackle common marine and maritime challenges applying common sustainability standards. This requires, however, effective mechanisms concerning the pooling together of cutting-edge technologies, knowledge and skills as well as the sharing not only of lessons learned and successful practices but also of financial resources. Over the last 20 years, cooperation among Mediterranean countries around the conservation and sustainable use of marine resources has increased exponentially, giving raise to unprecedented opportunities for North-South and South-South dialogue on operationalising the principles enshrined in many strategic documents.

The so-called Barcelona Convention is the most consolidated, and the only legally binding, multilateral environmental agreement dealing with the protection and sustainable use of the marine and coastal resources of the Mediterranean Sea.[18] To this end, the Contracting Parties adopted the Mediterranean Strategy for Sustainable Development 2016–2025 with the aim to adapt international commitments to the regional conditions and influence national strategies.[19] Its objective 5 (Transition

[16] Nordic Investment Bank (NIB), *NIB Issues First Nordic–Baltic Blue Bond*, 24 January 2019, https://www.nib.int/releases/nib-issues-first-nordic-baltic-blue-bond.

[17] Belize Government, *Belize Announces Commencement of Cash Tender Offer and Consent Solicitation*, 31 September 2021, https://www.centralbank.org.bz/news/details?newsid=358.

[18] UNEP website: *Barcelona Convention and Protocols*, https://www.unep.org/unepmap/node/7612.

[19] UNEP/MAP, *Mediterranean Strategy for Sustainable Development 2016-2025*, Valbonne, Plan Bleu Regional Activity Centre, 2016, https://wedocs.unep.org/bitstream/handle/20.500.11822/7097/mssd_2016_2025_eng.pdf.

ISSN 2610-9603 | ISBN 978-88-9368-261-9

towards a green and blue economy) rests on the belief that only a sustainable green and blue economy is capable of generating sustainable development and employment, preventing the loss of biodiversity and ecosystem services. To this end, the strategy urges for major public and private expenditure, innovative policy and regulatory changes that facilitate the uptake of new technologies and processes, tax and job reforms, and the implementation of circular economy principles and practices.[20]

Created on the initiative of France, which was eager to affirm its leading role in the Mediterranean area, the Union for the Mediterranean (UfM) is an intergovernmental institution bringing together the EU countries and 15 countries from the southern and eastern shores of the Mediterranean Sea. It is the only regional intergovernmental institution that counts Israel and Palestine among its members. Unlike the Barcelona Convention, UfM decisions are not binding but have political relevance since its highest decision-making body (the Senior Officials Meetings) represents the Ministries of Foreign Affairs of its member countries. In 2021, the Ministers of the UfM adopted a Ministerial Declaration indicating the blue economy as an opportunity to recover from the economic crisis caused by the COVID-19 pandemic and calling on international financial institutions, development partners, and public and private actors to prioritise investments in blue circular activities.[21] Recently, a Roadmap for the implementation of the Ministerial Declaration on blue economy has been adopted identifying specific actions to undertake within regional projects, including innovation of small ports and marinas, ports as "hubs" of clean and renewable energy and circular practices, scaling-up good practices on sustainable food value-chains, alliances of "blue" clusters, coastal tourism diversification/digitalisation, and a maritime spatial planning approach for proper planning (e.g., marine renewables energy zones, fisheries areas or allocated zone for aquaculture) also in Southern Mediterranean countries, etc.[22]

The UfM is also one of the main architects of the initiative for the sustainable development of the blue economy in the western Mediterranean region, a macro-regional strategy that was finally adopted by the European Commission in 2017. The following year, WestMED was established gathering five EU member states (France, Italy, Portugal, Spain and Malta), and five Southern partner countries (Algeria, Libya, Mauritania, Morocco and Tunisia) with the aim of developing a smart and resilient blue economy on both sides of the western Mediterranean through the implementation of local and regional projects. The relevance of the initiative rests on the socio-economic potential of the maritime economy in the

[20] Ibid.

[21] Union for the Mediterranean (UfM), *Ministerial Declaration on Sustainable Blue Economy*, 2 February 2021, https://ufmsecretariat.org/wp-content/uploads/2021/02/Declaration-UfM-Blue-Economy-EN-1.pdf.

[22] UfM Blue Economy Working Group, *Roadmap to Set the Path towards the Implementation of the 2021 UfM Ministerial Declaration on Sustainable Blue Economy. Advanced Draft Roadmap*, 23 March 2022, https://medblueconomyplatform.org/wp-content/uploads/2022/03/1.A-roadmap_bocci_fernandez.pdf.

IAI PAPERS 22 | 22 - SEPTEMBER 2022

western Mediterranean region: it hosts 200 ports and terminals, attracts the largest number of tourists in the region and is a rich fishing ground that accounts for over 30 per cent of the total value of landings in the Mediterranean providing over 36,000 direct jobs on fishing vessels.[23]

Focus box | Example of cooperation in Africa – the case of the Tunisian Maritime Cluster

The Tunisian Maritime Cluster (or Cluster Maritime Tunisien – CTM) is the only independent maritime cluster in Africa and in the Arab world. Since 2019 it has brought together all the actors of the maritime ecosystem (industry services and maritime activities of all kinds), playing the role of facilitator for the development of their business and innovative projects, and creating synergies between maritime players, so that the entire economy can benefit from the innovation capacities and business opportunities offered by the activities at sea. It advocates for an economic model at the national level that considers the potential of the sectors of the blue economy. The CMT operates to get the blue economy sectors recognised as crucial along with the potential of Tunisia at the crossroads between the eastern and western Mediterranean and strategic axis between the north of the Mediterranean and the African continent. To this end, the CTM has developed its Mediterranean diplomacy with the countries of the northern and southern shores by partnering up with the French Maritime Cluster, the Mediterranean pole, and the Blue Italian Growth Technology Cluster (BIG TC),* and by supporting the creation of the Maghreb Maritime Cluster as well as the Arab and African Maritime Cluster. The CTM pushes forward for a Blue Economy African Summit so as to become the driving force for the clustering of the maritime sector.

Note: BIG TC is an open structure gathering all national actors interested in blue growth issues. The aim is to create a national community that serve as a reference at international level and a platform for discussion at national level.

The focus box is a contribution from Mr. Ezzeddine Kacem, President and Founder of the Tunisian Maritime Cluster, and Prof. Lobna Boudaya from the University of Sfax.

At the bilateral level, it is worth recalling the agreement between Italy and France of November 2021 in which the two countries recognised the close interconnection they have through the Mediterranean. The agreement formalises their commitment to developing synergies and strengthening coordination not only for the implementation of the UN 2030 Agenda for Sustainable Development and EGD, but also to making the Mediterranean a clean and ecologically sustainable sea by developing a sustainable blue economy.[24]

[23] European Commission, *Towards an Initiative for the Sustainable Development of the Blue Economy in the Western Mediterranean. Goals and Priorities*, September 2017, https://op.europa.eu/s/wV6J.

[24] See Article 6.7 of the Treaty between the Italian Republic and the French Republic for Enhanced

ISSN 2610-9603 | ISBN 978-88-9368-261-9

2. A promising blue economy sector: Algal biomass production

This section looks at one of the most promising blue economy industries in the Mediterranean region: algal biomass production. The rationale behind this choice is that algae not only have an economic potential in terms of business opportunities and job creation but play a crucial ecological energy role, as the base of the food web for all aquatic organisms.[25]

There exist tens of thousands of species of algae worldwide but only a small fraction is used in industry. A general classification divides macro and micro algae. These are both aquatic photosynthetic plant-like organisms but whereas the first are large and multicellular, the second are small and unicellular.

The global market for microalgae is estimated to reach over 18 billion US dollars by 2028,[26] especially for two specific genera: Spirulina and Chlorella,[27] with strong antioxidant, anticancer and antiviral properties capable also of combatting obesity, diabetes and inflammatory allergic reactions.[28] In particular, Chlorella is an important protein source and a feedstock for biofuels, and it also absorbs a great amount of CO_2 and removes nutrients such as phosphorus and nitrogen, making it a better candidate for greenhouse gas biomodulation and wastewater bioremediation.[29] On the other hand, the global market for macroalgae (seaweeds) is expected to reach 12.85 billion US dollars by 2027, and increasing production of macroalgae is occurring in China, Indonesia, Korea, the Philippines and Japan, as well as other Asian countries.[30]

Algae have many commercial applications, including cosmetics (anti-aging moisturisers, toothpaste), crop nutrition/bio-fertilisers, bio-packaging (packaging,

Bilateral Cooperation. The treaty's Italian and French versions are available here: Italian Government, *Italy-France Treaty Signed at the Quirinale Palace*, 26 November 2021, https://www.governo.it/en/node/18662.

[25] Algae produce oxygen for many aquatic organisms and serve as habitat for thousands of species. Algae absorb great quantity of CO_2 and, in many cases, also organic contaminants from seawater.

[26] Facts & Factors, "Demand for Global Microalgae Market Size & Share Worth USD 18.3 Billion by 2028, Exhibit a CAGR of 8.2% Growth", in *GlobeNewsWire*, 12 May 2022, https://www.globenewswire.com/en/news-release/2022/05/12/2442303/0/en/Demand-for-Global-Microalgae-Market-Size-Share-Worth-USD-18-3-Billion-by-2028-Exhibit-a-CAGR-of-8-2-Growth-Microalgae-Industry-Trends-Value-Analysis-Forecast-Exclusive-Insight-Repo.html.

[27] AquaFarm and NovelFarm, *Microalgae Cultivation: Market, Production and Research Updates Presented at the AlgaeFarm*, 31 March 2021, https://www.aquafarm.show/wp-content/uploads/2021/10/CS_AlgaeFarm-digital-preview_ENG.pdf.

[28] João Reboleira et al., "Spirulina", in Seyed Mohammad Nabavi and Ana Sanches Silva (eds), *Nonvitamin and Nonmineral Nutritional Supplements*, London, Academic Press, 2019, p. 409-413.

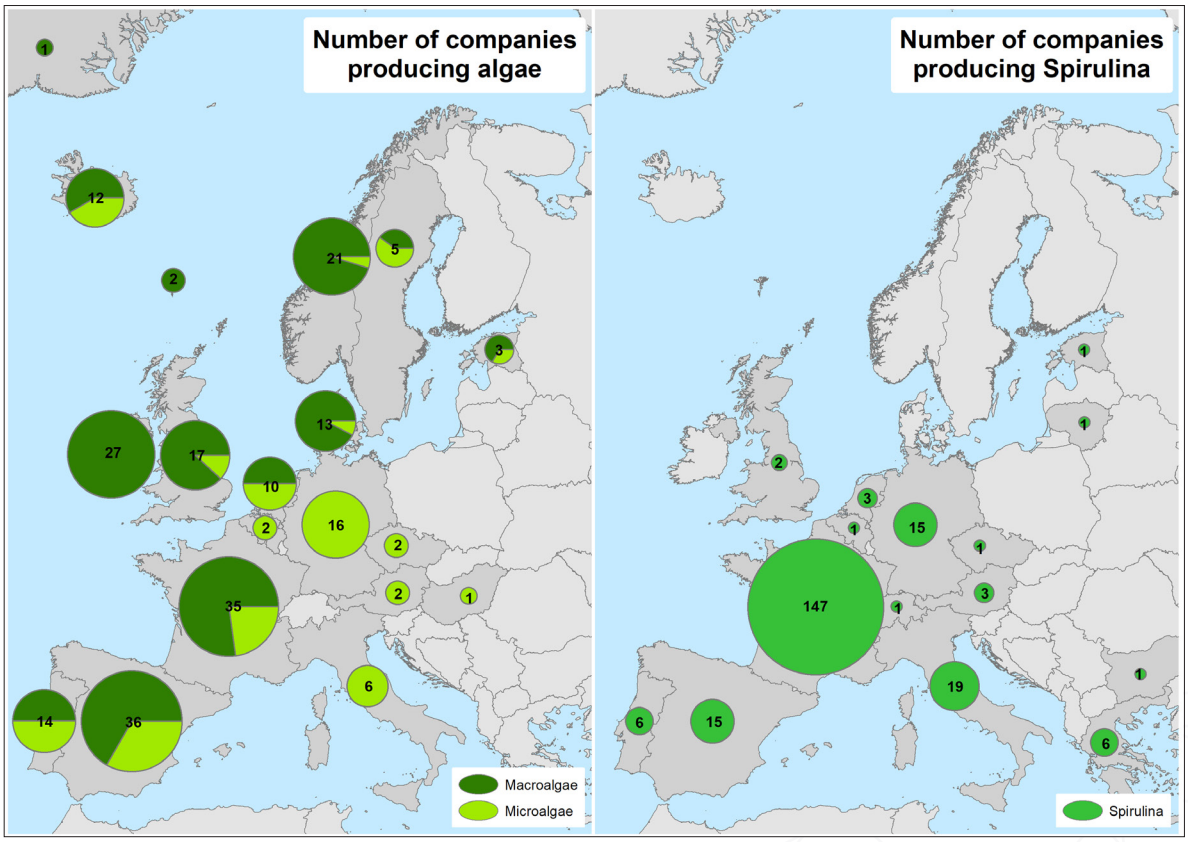
[29] Ibrahim A. Ibrahim and Zizy I. Elbaily, "A Review: Importance of Chlorella and Different Applications", in *Alexandria Journal of Veterinary Sciences*, Vol. 65, No. 1 (2020), p. 16-34, https://doi.org/10.5455/ajvs.94847.

[30] IMARC, *Seaweed Market: Global Industry Trends, Share, Size, Growth, Opportunity and Forecast 2022-2027*, 2022, https://www.imarcgroup.com/seaweed-market.

IAI PAPERS 22 | 22 - SEPTEMBER 2022 ISSN 2610-9603 | ISBN 978-88-9368-261-9

coatings, and plastic films for food containers), energy (biofuel), etc.[31] Microalgae are particularly used in human and animal diets (e.g., fish farming or feed supplements for cattle) whereas macroalgae (Phaeophyta, Rhodophyta and Chlorophyta) are collected for pharmaceutical, biomedical or biotechnological purposes or are used as a fertiliser, plant bio-stimulant or bioactive product for cosmetics and nutraceuticals.[32]

Figure 2 | Algae manufacturing companies



Source: Knowledge Centre for Bioeconomy website: *Algae Production Industry in Europe*, cit.

Figure 2 shows that, at the Mediterranean level, France and Spain are among the top macroalgae (seaweed) producing countries, Spain and Italy stand as the top countries for microalgae, while over 60 per cent of the companies producing Spirulina in the Mediterranean region are in France.[33] It is noteworthy that

[31] European Commission website: *Blue Bioeconomy and Blue Biotechnology*, https://europa.eu/!w74nfP.

[32] Rita Araújo et al., "Current Status of the Algae Production Industry in Europe: An Emerging Sector of the Blue Bioeconomy", in *Frontiers in Marine Science*, Vol. 7 (2021), Article 626389, https://doi.org/10.3389/fmars.2020.626389.

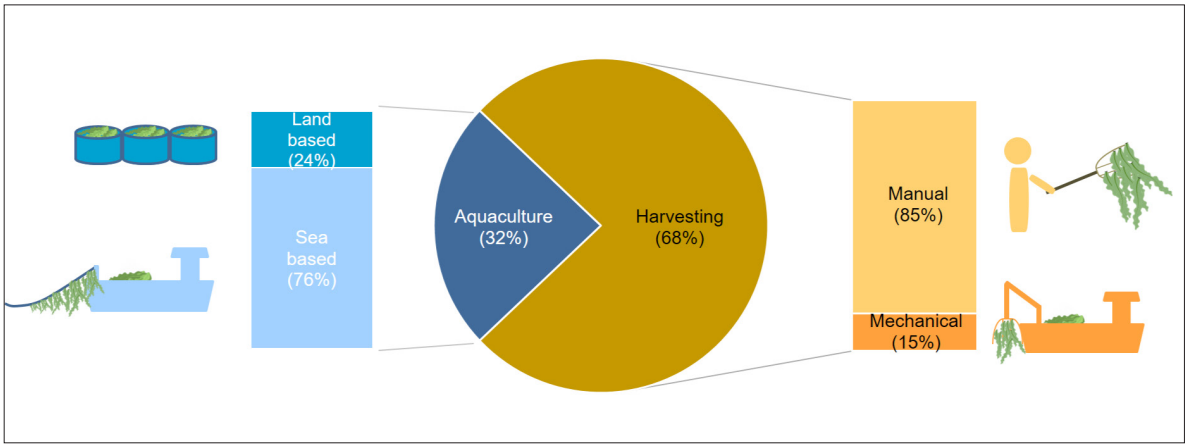
[33] Knowledge Centre for Bioeconomy website: *Algae Production Industry in Europe*, https://europa.eu/!tCkvDR; Alison G. Smith et al., "What Are Algae?", in *EABA Position Papers*, No. 1 (April 2021),

IAI PAPERS 22 | 22 - SEPTEMBER 2022 ISSN 2610-9603 | ISBN 978-88-9368-261-9

Mediterranean native algae species (e.g., Ulva sp., Gracilaria sp.) correspond to a minority of the overall European production.[34]

Figure 3 shows that macroalgae production in 2021 is still dependant on manual harvesting from wild stocks (68 per cent of the macroalgae production units) whereas macroalgae aquaculture (land-based and at sea) represents 32 per cent of the macroalgae production units.[35]

Figure 3 | Macroalgae production methods



Source: Knowledge Centre for Bioeconomy website: *Algae Production Industry in Europe*, cit.

Researchers are now trying to identify the factors limiting the expansion of this activity in the Mediterranean and discussing measures that could increase the cultivation of seaweeds in the region.[36]

2.1 Relevance of the algae sector for aquaculture, food security and biofuel production

The diversification of aquaculture, as an alternative to monoculture, is key to promote environmental sustainability. The aquaculture of algae has an almost zero ecological footprint and contributes to the regeneration of marine ecosystems by reducing nutrient pollution, providing clean habitats for fish stocks and limiting feed producers' reliance on fish meal and fish oil from wild stocks.[37] Moreover, among the nutrients used by algae to grow are nitrogen and phosphorus, which are

https://www.what-are-algae.com.

[34] Rita Araújo et al., "Current Status of the Algae Production Industry in Europe", cit.

[35] Ibid.

[36] Ibid.

[37] European Commission, *Strategic Guidelines for a More Sustainable and Competitive EU Aquaculture for the Period 2021 to 2030* (COM/2021/236), 12 May 2021, p. 11, https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52021DC0236.

ISSN 2610-9603 | ISBN 978-88-9368-261-9

highly polluting substances often present in excessive quantities in aquaculture wastewater. The aquaculture of algae can be considered a "restorative" aquaculture that may bring exceptional benefits which are still untapped. Indeed, there are promising examples of business initiatives in the Mediterranean: macroalgae are cultivated in a lagoon near Bizerte (Tunisia) to produce food thickeners, a type of product that could replace gelatine of animal origin. To this end, red algae are cultivated on an industrial scale, increasing tenfold the initial biomass harvested from the sea.[38] Actually, Tunisia has been developing a remarkable know-how in transforming algae into different products, such as biodegradable bottles, noodles or vegetarian nuggets.

Algae could play a significant role in feeding the growing population of the Mediterranean, mostly dependent on the cultivation of crops vulnerable to global warming and prolonged drought. Indeed, the algae industry claims that when used in conjunction with bioreactors, algae can be efficient in removing carbon dioxide from the atmosphere since they cover more surface area and grow much faster.[39] Actually, a study published a few years ago asserted that microalgae can biofix carbon dioxide 50 times more than plants[40] though such capacity may vary according to the environment where they are cultured (e.g., open waters or bioreactors). Also, macroalgae are carbon dioxide sinks capable of sequestering great amounts each year, transporting it to the ocean seafloor where it remains trapped for centuries.[41] In 2019, research proved for the first time the important role that the connectivity between macroalgae and the seabed plays in permanently removing carbon dioxide from the atmosphere. This has crucial implications for efforts to reduce emissions.[42] It comes as no surprise that five countries included the protection or restoration of coastal and marine ecosystems, including algae, as mitigation measure in their Nationally Determined Contribution under the Paris Agreement: Argentina, Chile, Costa Rica, Fiji and the Republic of Korea.[43]

Algae could also contribute to food security in the Mediterranean since they grow rapidly, do not need fertilisers and do not compete with traditional food-crops for space or resources. Indeed, they provide more proteins (up to 60 per cent of dry matter) than many terrestrial crops. For the time being, however, algae and algae-

[38] Selt Marine Group website: https://seltmarinegroup.com.

[39] HyperGiant Industries' statement with respect to the harvesting technology of chlorella vulgaris by the Eos Bioreactors.

[40] Virthie Bhola et al., "Overview of the Potential of Microalgae for CO_2 Sequestration", in *International Journal of Environmental Science and Technology*, Vol. 11, No. 7 (October 2014), p. 2103-2118.

[41] Jiajun Wu, David P. Keller and Andreas Oschlies, "Carbon Dioxide Removal via Macroalgae Open-ocean Mariculture and Sinking: An Earth System Modeling Study", in *Earth System Dynamics*, 14 January 2022 (preprint), https://doi.org/10.5194/esd-2021-104.

[42] Ana Moura Queirós et al., "Connected Macroalgal-Sediment Systems: Blue Carbon and Food Webs in the Deep Coastal Ocean", in *Ecological Monographs*, Vol. 89, No. 3 (August 2019), Article e01366, https://doi.org/10.1002/ecm.1366.

[43] Marine Lecerf et al., *Coastal and Marine Ecosystems as Nature-Based Solutions in New or Updated Nationally Determined Contributions*, Ocean & Climate Platform et al., June 2021, p. 18, https://ocean-climate.org/?p=12436.

ISSN 2610-9603 | ISBN 978-88-9368-261-9

derived products are mostly directed to high-value and low-volume markets and are still unable to compete with cheap plant-based proteins. The main barriers to increasing the cultivation of algae in the region are the lack of national "blue" bioeconomy strategies and poor incentives to support private investments, both of which limit the entrance of innovative SMEs that could help bridge the current gap between research on algae and commercial application.

The world energy crisis is one of the most pressing problems of our society exacerbated by population growth, fast industrialisation and increased use of fossil fuels. In this context, renewable energy is playing, and will increasingly play, a key role in the decarbonisation of the Mediterranean energy system. The energy mix is expected to become far more diversified with a corresponding increase in the role of renewable energy as the Mediterranean countries continue down the path of electrification. The scale of this shift varies significantly according to the foreseen scenarios, with the share of hydrocarbons in primary energy declining from 76 per cent in 2018 to between 37–73 per cent by 2050 and the share of renewable energy increasing to between 19–57 per cent.[44]

Table 1 | Microalgae as a source of renewable energy

Advantages of using microalgae as a source of renewable energy
• High growth rate;
• Short life cycle;
• Able to live under different environmental conditions;
• Production of high added value molecules;
• Can grow in wastewater and on land that cannot be used for agriculture;
• High efficiency of conversion of solar energy into biomass.

Disadvantages of using microalgae as a source of renewable energy
• Energy production from microalgae is not widespread at an industrial scale;
• The most promising technologies for algae growth (e.g., photobioreactors) are not economically competitive;
• Problems related to the sustainability of the process and the consumption of water resources;
• It is difficult to choose the microalgae species to balance the production of biofuels and co-products;
• The energy cost of the whole extraction process is high.

Source: Summarised by the author from different sources.

[44] Observatoire Méditerranéen de l'Energie (OME), *Mediterranean Energy Perspectives to 2050. Executive Summary*, 2021 Edition, https://www.ome.org/wp-content/uploads/2021/09/MEPto2050-2021-ed-Executive-Summary.pdf.

ISSN 2610-9603 | ISBN 978-88-9368-261-9

Although there are advantages and disadvantages in using microalgae as a source of renewable energy (Table 1), there is wide agreement that they represent a promising option as an alternative biofuel for the most energy-intensive sectors (e.g., iron and steel, cement and lime, chemicals and refineries). They still have high associated costs when compared to fossil fuels (production cost estimated for microalgae biomass is 2.01 euro/kg^{-1} and for biodiesel is 0.33 euro/L^{-1})[45] but there are initiatives to reduce such costs and build efficient microalgae-based bio-refinery systems.[46] Biofuels from algae are considered economically viable when associated to other co-products (e.g., pharmaceuticals and nutraceuticals, additives for animal feed, bioplastics, etc.) and integrated into larger operations (e.g., waste gas recovery and/or wastewater treatment).

In the Mediterranean, attention is being paid to the potential for producing biofuel from microalgae, especially in the form of liquid fuel (diesel, ethanol). Among other initiatives to foster the development of microalgae as an alternative fuel, the MED-ALGAE project promoted the establishment of a new value chain for the production of renewable energy based on microalgae to secure sufficient quantity and quality of biodiesel while identifying also other microalgae by-products and related business opportunities.[47] Another interesting project is the Israeli SeamBiotic whereby carbon dioxide from flue gas and other waste from coal-fired power stations feeds algae biomass that is subsequently converted into biofuels and other useful co-products.[48]

For microalgae-based biofuels to tackle the challenges posed by petroleum-based fuels and traditional biofuel sources, it is necessary to design and set up an effective supply chain. Indeed, a solid algae biofuel supply chain would not only allow for meeting the increasing demand, due to the many commercial applications, by ensuring enough algal biomass for the manufacturing processes even under an uncertain and volatile market. It would also guarantee its distribution to the final customers, maximising economic commercialisation and minimising costs of production, operation and transportation over a long-term planning horizon. Applied to the Mediterranean region, a solid algae biofuel supply chain would contribute to pursuing those sustainability objectives enshrined in many regional strategic documents. Figure 4 shows the core activities required to convert algae, as raw material, into finished biofuel for end users.

[45] Monique Branco-Vieira et al., "Economic Analysis of Microalgae Biodiesel Production in a Small-Scale Facility", in *Energy Reports*, Vol. 6, Suppl. 8 (December 2020), p. 325-332, https://doi.org/10.1016/j.egyr.2020.11.156.

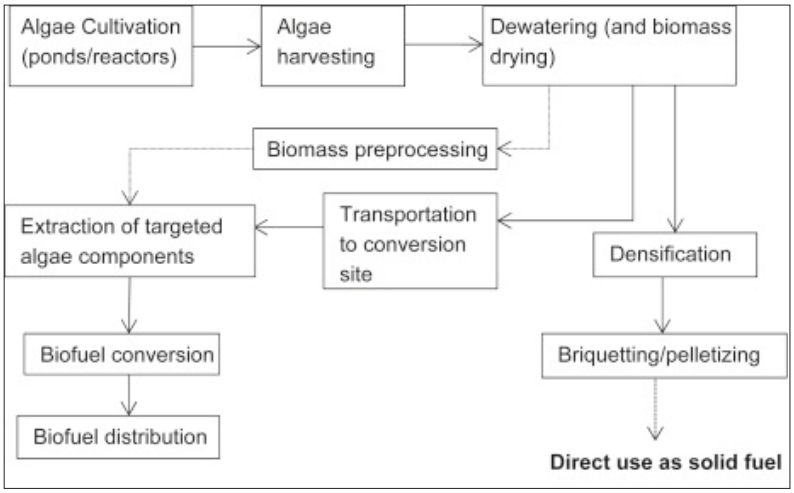
[46] Valuable Products from Algae Using new Magnetic Cultivation and Extraction Techniques (VALUEMAG) project website: https://www.valuemag.eu.

[47] ENPI CBC Med website: MED-ALGAE project description, http://www.enpicbcmed.eu/node/8469.

[48] Seambiotic Ltd.'s pilot facility at the Israel Electric Corporation's (IEC) Rutenberg coal-fired power station in Ashkelon (Israel). See Electric Power Research Institute (EPRI), *Program on Technology Innovation: A Case Study of Seambiotic's Research on Utility-Connected Algae Systems*, June 2010, https://www.epri.com/research/products/1020807.

ISSN 2610-9603 | ISBN 978-88-9368-261-9

Figure 4 | Algae supply chain for biofuel



Source: Ehiaze Augustine Ehimen, "Algae Biomass Supply Chains", in Jens Bo Holm-Nielsen and Ehiaze Augustine Ehimen (eds), *Biomass Supply Chains for Bioenergy and Biorefining*, Amsterdam, Woodhead Publishing, 2016, p. 326.

There is an extensive literature on this topic and various models for an optimum algae biofuel supply chain. Each model owns a different level of complexity even if all of them aim to address the same challenges, in particular: i) the right amount of algal biomass to harvest to meet the demand downstream; ii) the number, size and optimal location of biorefineries so as to reduce production, transportation and investment costs; iii) the way to tackle variables such as the geographical fragmentation and temporal availability of algal biomass; iv) the selection of appropriate algae species with the highest lipid content for cultivation, etc.[49]

3. Recommendations

Some recommendations are hereby proposed as food for thought to promote a sustainable blue economy in the Mediterranean region:

• Put the general concept of "transition" at the heart of the new Euro-Mediterranean partnership and include it in the negotiations with South Mediterranean partner countries by putting on the table, for instance, the preparation of a Euro-Med Renewable Energy Road Map;

• Strengthen the decisional power of regional organisations dealing with the blue economy in the Mediterranean region especially when it comes to selecting which

[49] Soumia Yadala et al., "Optimization of the Algal Biomass to Biodiesel Supply Chain: Case Studies of the State of Oklahoma and the United States", in *Processes*, Vol. 8, No. 4 (2020), Article 476, https://doi.org/10.3390/pr8040476.

ISSN 2610-9603 | ISBN 978-88-9368-261-9

projects or initiatives should be financially supported and included in the regional political agenda;

• Support the implementation of the EU Bioeconomy Strategy as a tool to promote the sustainable growth and development of the EU bio-based sectors;

• Support energy-intensive industries in the transition by the means of policies and financial instruments at the regional and national level, as well as through the private sector;
• Support "blue" small and medium-sized enterprises by strengthening the link between incubators/accelerators and maritime clusters as powerful tools to support the sustainable and inclusive growth of the blue economic sectors;

• Support the networking of maritime clusters as a tool to multiply technical capacity, research and innovation while playing the role of broker between the EU and the Mediterranean neighbouring countries;

• Build demand-driven and market-oriented "blue" skills targeting CEOs, middle managers and operators as main actors of a sustainable blue economy in the Mediterranean;

• Channel steady financial resources for the development of blue economy sectors through structural investments, special taxation schemes, new grants and loans, etc.;

• Design tools and mechanisms to incentivise venture capitalists to invest in emerging blue economy sectors such as algal biomass;

• Communicate circular economy as an opportunity for "blue" entrepreneurs, especially from the southern countries of the Mediterranean, who often do not yet perceive the full range of benefits that circularity can bring to their business;

• Frame circular principles and practices within simple regional and national policies and regulations and align the concept of "waste" as a secondary raw material;

• Create circular supply chains sharing the multiple use of the same initial resource and unlocking enough value to attract an increasing number of agents;

• Some sectors are currently better placed to serve as driving force for the whole Mediterranean blue economy, such as off-shore wind power. Other sectors, including the algae industry, have very high potential although still lacking clear policies, regulations and incentives as well as methods to fully assess environmental impact.

Updated 9 September 2022

ISSN 2610-9603 | ISBN 978-88-9368-261-9

References

AquaFarm and NovelFarm, *Microalgae Cultivation: Market, Production and Research Updates Presented at the AlgaeFarm*, 31 March 2021, https://www.aquafarm.show/wp-content/uploads/2021/10/CS_AlgaeFarm-digital-preview_ENG.pdf

Rita Araújo et al., "Current Status of the Algae Production Industry in Europe: An Emerging Sector of the Blue Bioeconomy", in *Frontiers in Marine Science*, Vol. 7 (2021), Article 626389, https://doi.org/10.3389/fmars.2020.626389

Belize Government, *Belize Announces Commencement of Cash Tender Offer and Consent Solicitation*, 31 September 2021, https://www.centralbank.org.bz/news/details?newsid=358

Virthie Bhola et al., "Overview of the Potential of Microalgae for CO_2 Sequestration", in *International Journal of Environmental Science and Technology*, Vol. 11, No. 7 (October 2014), p. 2103-2118

Martina Bocci and Raffaele Mancini, *A Circular Blue Economy for the Mediterranean. Current Practices and Opportunities*, CPMR Intermediterranean Commission and MedWaves, June 2022, https://www.euneighbours.eu/en/node/44701

Monique Branco-Vieira et al., "Economic Analysis of Microalgae Biodiesel Production in a Small-Scale Facility", in *Energy Reports*, Vol. 6, Suppl. 8 (December 2020), p. 325-332, https://doi.org/10.1016/j.egyr.2020.11.156

Thierry Chopin et al., "Integrated Multi-Trophic Aquaculture. Part I: Responsible Practice Provides Diversified Products, Biomitigation", in *Global Aquaculture Advocate*, September/October 2010, p. 38-39, https://www.globalseafood.org/?p=37491

Ehiaze Augustine Ehimen, "Algae Biomass Supply Chains", in Jens Bo Holm-Nielsen and Ehiaze Augustine Ehimen (eds), *Biomass Supply Chains for Bioenergy and Biorefining*, Amsterdam, Woodhead Publishing, 2016, p. 319-332

Electric Power Research Institute (EPRI), *Program on Technology Innovation: A Case Study of Seambiotic's Research on Utility-Connected Algae Systems*, June 2010, https://www.epri.com/research/products/1020807

European Commission, *A Farm to Fork Strategy for a Fair, Healthy and Environmentally-Friendly Food System* (COM/2020/381), 20 May 2020, https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52020DC0381

European Commission, *The European Green Deal* (COM/2019/640), 11 December 2019, https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52019DC0640

ISSN 2610-9603 | ISBN 978-88-9368-261-9

European Commission, *A European Strategy for Plastics in a Circular Economy* (COM/2018/28), 16 January 2018, https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52018DC0028

European Commission, *A New Approach for a Sustainable Blue Economy in the EU: Transforming the EU's Blue Economy for a Sustainable Future* (COM/2021/240), 17 May 2021, https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52021DC0240

European Commission, *A New Circular Economy Action Plan. For a Cleaner and More Competitive Europe* (COM/2020/98), 11 March 2020, https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52020DC0098

European Commission, *Strategic Guidelines for a More Sustainable and Competitive EU Aquaculture for the Period 2021 to 2030* (COM/2021/236), 12 May 2021, https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52021DC0236

European Commission, *Towards an Initiative for the Sustainable Development of the Blue Economy in the Western Mediterranean. Goals and Priorities*, September 2017, https://op.europa.eu/s/wV6J

European Parliament and Council of the European Union, *Directive (EU) 2019/904 of 5 June 2019 on the Reduction of the Impact of Certain Plastic Products on the Environment*, http://data.europa.eu/eli/dir/2019/904/oj

Facts & Factors, "Demand for Global Microalgae Market Size & Share Worth USD 18.3 Billion by 2028, Exhibit a CAGR of 8.2% Growth", in *GlobeNewsWire*, 12 May 2022, https://www.globenewswire.com/en/news-release/2022/05/12/2442303/0/en/Demand-for-Global-Microalgae-Market-Size-Share-Worth-USD-18-3-Billion-by-2028-Exhibit-a-CAGR-of-8-2-Growth-Microalgae-Industry-Trends-Value-Analysis-Forecast-Exclusive-Insight-Repo.html

Ibrahim A. Ibrahim and Zizy I. Elbaily, "A Review: Importance of Chlorella and Different Applications", in *Alexandria Journal of Veterinary Sciences*, Vol. 65, No. 1 (2020), p. 16-34, https://doi.org/10.5455/ajvs.94847

IMARC, *Seaweed Market: Global Industry Trends, Share, Size, Growth, Opportunity and Forecast 2022-2027*, 2022, https://www.imarcgroup.com/seaweed-market

Italian Government, *Italy-France Treaty Signed at the Quirinale Palace*, 26 November 2021, https://www.governo.it/en/node/18662

Marine Lecerf et al., *Coastal and Marine Ecosystems as Nature-Based Solutions in New or Updated Nationally Determined Contributions*, Ocean & Climate Platform et al., June 2021, https://ocean-climate.org/?p=12436

ISSN 2610-9603 | ISBN 978-88-9368-261-9

Nordic Investment Bank (NIB), *NIB Issues First Nordic–Baltic Blue Bond*, 24 January 2019, https://www.nib.int/releases/nib-issues-first-nordic-baltic-blue-bond

Observatoire Méditerranéen de l'Energie (OME), *Mediterranean Energy Perspectives to 2050. Executive Summary*, 2021 Edition, https://www.ome.org/wp-content/uploads/2021/09/MEPto2050-2021-ed-Executive-Summary.pdf

Kristian Petrick et al., *Blue Economy in the Mediterranean, Union for the Mediterranean, 2017*, https://ufmsecretariat.org/wp-content/uploads/2017/12/UfMS_Blue-Economy_Report.pdf

Plan Bleu et al., *A Blue Economy for a Sustainable Development of the Mediterranean Region. Measuring, Monitoring and Promoting. Concept Note*, Marseilles, 30-31 May 2017, https://planbleu.org/wp-content/uploads/2017/04/BE_ConceptNote_Draft.pdf

Ana Moura Queirós et al., "Connected Macroalgal-Sediment Systems: Blue Carbon and Food Webs in the Deep Coastal Ocean", in *Ecological Monographs*, Vol. 89, No. 3 (August 2019), Article e01366, https://doi.org/10.1002/ecm.1366

Mauro Randone et al., *Reviving the Economy of the Mediterranean Sea. Actions for a Sustainable Future*, Rome, WWF Mediterranean Marine Initiative, September 2017, https://wwfeu.awsassets.panda.org/downloads/reviving_mediterranean_sea_economy_full_rep_lowres.pdf

João Reboleira et al., "Spirulina", in Seyed Mohammad Nabavi and Ana Sanches Silva (eds), *Nonvitamin and Nonmineral Nutritional Supplements*, London, Academic Press, 2019, p. 409-413

Alison G. Smith et al., "What Are Algae?", in *EABA Position Papers*, No. 1 (April 2021), https://www.what-are-algae.com

United Nations, *Blue Economy Concept Paper*, January 2014, https://www.unep.org/node/1018

United Nations Environment Programme/Mediterranean Action Plan (UNEP/MAP), *Mediterranean Strategy for Sustainable Development 2016-2025*, Valbonne, Plan Bleu Regional Activity Centre, 2016, https://wedocs.unep.org/bitstream/handle/20.500.11822/7097/mssd_2016_2025_eng.pdf

Union for the Mediterranean (UfM), *Ministerial Declaration on Sustainable Blue Economy*, 2 February 2021, https://ufmsecretariat.org/wp-content/uploads/2021/02/Declaration-UfM-Blue-Economy-EN-1.pdf

UfM Blue Economy Working Group, *Roadmap to Set the Path towards the Implementation of the 2021 UfM Ministerial Declaration on Sustainable Blue Economy. Advanced Draft Roadmap*, 23 March 2022, https://

ISSN 2610-9603 | ISBN 978-88-9368-261-9

medblueconomyplatform.org/wp-content/uploads/2022/03/1.A-roadmap_bocci_fernandez.pdf

World Bank, *Seychelles Launches World's First Sovereign Blue Bond*, 29 October 2018, https://www.worldbank.org/en/news/press-release/2018/10/29/seychelles-launches-worlds-first-sovereign-blue-bond

World Meteorological Organization (WMO), *State of the Global Climate 2021*, Geneva, WMO, 2022, https://library.wmo.int/index.php?lvl=notice_display&id=22080

Jiajun Wu, David P. Keller and Andreas Oschlies, "Carbon Dioxide Removal via Macroalgae Open-ocean Mariculture and Sinking: An Earth System Modeling Study", in *Earth System Dynamics*, 14 January 2022 (preprint), https://doi.org/10.5194/esd-2021-104

Soumia Yadala et al., "Optimization of the Algal Biomass to Biodiesel Supply Chain: Case Studies of the State of Oklahoma and the United States", in *Processes*, Vol. 8, No. 4 (2020), Article 476, https://doi.org/10.3390/pr8040476

ISSN 2610-9603 | ISBN 978-88-9368-261-9

Istituto Affari Internazionali (IAI)
The Istituto Affari Internazionali (IAI) is a private, independent non-profit think tank, founded in 1965 on the initiative of Altiero Spinelli. IAI seeks to promote awareness of international politics and to contribute to the advancement of European integration and multilateral cooperation. Its focus embraces topics of strategic relevance such as European integration, security and defence, international economics and global governance, energy, climate and Italian foreign policy; as well as the dynamics of cooperation and conflict in key geographical regions such as the Mediterranean and Middle East, Asia, Eurasia, Africa and the Americas. IAI publishes an English-language quarterly (*The International Spectator*), an online webzine (*AffarInternazionali*), three book series (*Global Politics and Security*, *Quaderni IAI* and *IAI Research Studies*) and some papers' series related to IAI research projects (*Documenti IAI*, *IAI Papers*, etc.).

Via dei Montecatini, 17 - I-00186 Rome, Italy
T +39 06 6976831
iai@iai.it
www.iai.it

Latest IAI PAPERS

22 | 22 Raffaele Mancini, *The Blue Economy in the Mediterranean Region and Opportunities for the Algae Industry*

22 | 21 Kamila Godzinska and Maria Pastukhova, *Russia's Climate Action and Geopolitics of Energy Transition: The Uncertain and Unsettling Outlook following Russia's Invasion of Ukraine*

22 | 20 Oleg Buklemishev, *The Russian Economy Is Muddling Through the Sanctions War*

22 | 19 Marina Pisklakova-Parker, *Gender Issues in Russia*

22 | 18 Isak Runarsson, *Can the West Afford to Let the World Go Hungry? Overcoming Challenges to Establishing a Humanitarian Corridor in the Black Sea*

22 | 17 Marco Giuli, *The Geopolitics of Clean Hydrogen – Opportunities and Challenges for Italy*

22 | 16 Olga Romanova, *Legislation as a Tool for Expanding the Power of the State and Limiting Political and Civil Rights in Modern Russia*

22 | 15 Nathalie Tocci, *Why Ukraine (and Moldova) Must Become EU Candidates*

22 | 14 Denis Volkov, *Russian Youth: Their Attitude to the Ruling Elite and Political Processes*

22 | 13 Dario Cristiani, *An Overview of the Current State of US-Italian Political-Security Relations*

ISSN 2610-9603 | ISBN 978-88-9368-261-9