UNIVERSITY OF PIRAEUS

DEPARTMENT OF ECONOMICS

NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS

DEPARTMENT OF BIOLOGY

A thesis submitted for the degree of

M.Sc. in Bioeconomics

ANALYSIS OF BIOECONOMY STRATEGIES

Advisory Committee

Prof. Constantinos E. Vorgias (Supervisor)

Ass. Prof. Constantina Kottaridi

Ass. Prof. Dimitris Hatzinikolaou

By

Anneza Kollarou

SID: 1705

Piraeus, Greece, October 2020

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΩΣ

ΤΜΗΜΑ ΟΙΚΟΝΟΜΙΚΗΣ ΕΠΙΣΤΗΜΗΣ

ΕΘΝΙΚΟ ΚΑΙ ΚΑΠΟΔΙΣΤΡΙΑΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ

ΤΜΗΜΑ ΒΙΟΛΟΓΙΑΣ

ΔΜΠΣ ΣΤΗ ΒΙΟΟΙΚΟΝΟΜΙΑ

ΑΝΑΛΥΣΗ ΣΤΡΑΤΗΓΙΚΩΝ ΒΙΟΟΙΚΟΝΟΜΙΑΣ

Αννέζα Κολλάρου

Πειραιάς, Οκτώβριος 2020

Σε όσους με βοήθησαν να διευρύνω τους ορίζοντές μου και με ενέπνευσαν να αποκτήσω διαφορετική οπτική ζωής...

Acknowledgement

Significant for me was the guidance and the patience of my professor and supervisor, Prof. Constantinos E. Vorgias, to whom I express my gratitude and appreciation. The contribution of Ass. Professor Constantina Kottaridi, the director and coordinator of the master program, was also very important during my studies. I would like to express my appreciation for professors' willingness from both departments of Economics and Biology.

Besides, I would like to thank my dear colleagues for the happy and creative moments we have lived.

Finally, I could not fail to acknowledge the support I received from my family.

ANALYSIS OF BIOECONOMY STRATEGIES

Keywords: Bioeconomy, Circular Bioeconomy, Sustainability, National Strategies, Key Goals, Priority Areas, European Bioeconomy Strategy, Mediterranean Basin, France, Italy, Spain, Greece.

Abstract

During the last decades, our planet is dealing with more and more global challenges such as worldwide population growth, depletion of fossil raw materials, inadequate food production, climate change, and many environmental problems. As a result, the implementation of sustainable bioeconomy is considered a general solution through its nature.

However, bioeconomy is a multidimensional concept that includes economic, environmental, and social dimension, and there is no universally agreed definition. It depends on somebody's perspective and the field that he is involved in. Thus, international institutions and governments attempt to identify the notion of circular and sustainable bioeconomy. From those definitions, legislation, policies, and strategies are being developed and implemented continuously, which is exactly why defining bioeconomy is critical.

The concept of bioeconomy took several years to mature as a political strategy and a global idea. Therefore, a global upward trend in the growth of bioeconomy policy has continued since 2015. Basically, in order to achieve global implementation of sustainability, bioeconomy has to become the guiding concept at any country's level.

The development of the bioeconomy as a national strategy depends on the various interactions among the different factors such as public and private stakeholders, primary sectors, new technologies, human resources, innovating research, demand-side, and societal factors. Each country should follow a basic set of principles that include accountability, transparency, participation in Strategy Formulation, effectiveness, coherence, fairness, and policy initiatives.

As a result of the general bioeconomy concept, the first European Bioeconomy Strategy was announced in 2012 aiming at a sustainable, circular bioeconomy across Europe, an alignment of

economic-techno-socio- environmental landscape, optimize impact within sectors of the bioeconomy. In this way, bioeconomy strategy intends to provide a long-term balance of economic, environmental, and social profits combing the sustainable use of renewable resources for feed, food, bio-based products, and bioenergy, with the restoration and protection of biodiversity, ecosystems, and natural resources across water and land in Europe and beyond.

Considering the importance of the decentralized and local dimension of bioeconomy, three different European countries of the South and especially the Mediterranean basin – France, Italy, and Spain are analyzed. In particular, the bioeconomy-related strategy, the author, the key goals, the priority areas, the action plan, and measures for promoting the strategy of each country are listed.

In the last part of the thesis, it focuses on Greece as a European country and the bioeconomy perspective of Greece.

Taking into account the cruel financial crisis since 2009, bioeconomy-related strategies are presented as well as the key goals and the priority areas. Moreover, some proposals are identified which can support bioeconomy and strengthen Greece generally.

ΑΝΑΛΥΣΗ ΣΤΡΑΤΗΓΙΚΩΝ ΒΙΟΟΙΚΟΝΟΜΙΑΣ

Σημαντικοί Όροι: Βιοοικονομία, Κυκλική Βιοοικονομία, Βιωσιμότητα, Εθνικές Στρατηγικές, Βασικοί Στόχοι, Τομείς Προτεραιότητας, Ευρωπαϊκή Στρατηγική Βιοοικονομίας, Μεσογειακή Λεκάνη, Γαλλία, Ιταλία, Ισπανία, Ελλάδα.

Περίληψη

Τις τελευταίες δεκαετίες, ο πλανήτης μας αντιμετωπίζει όλο και περισσότερες παγκόσμιες προκλήσεις, όπως η αύξηση του πληθυσμού παγκοσμίως, η εξάντληση των ορυκτών πρώτων πόρων, η ανεπαρκής παραγωγή τροφίμων, η κλιματική αλλαγή και πολλά περιβαλλοντικά προβλήματα. Ως αποτέλεσμα, η εφαρμογή της βιώσιμης βιοοικονομίας θεωρείται ως μια γενική λύση από τη φύση της.

Ωστόσο, η βιοοικονομία είναι μια πολυδιάστατη έννοια που περιλαμβάνει οικονομική, περιβαλλοντική και κοινωνική διάσταση και δεν υπάρχει καθολικά συμφωνημένος ορισμός. Εξαρτάται από την προοπτική κάποιου και το πεδίο που εμπλέκεται. Έτσι, διεθνείς οργανισμοί και κυβερνήσεις, προσπαθούν να ορίσουν την έννοια της κυκλικής και βιώσιμης βιοοικονομίας. Από αυτούς τους ορισμούς, νομοθεσίες, πολιτικές και στρατηγικές, αναπτύσσονται και εφαρμόζονται συνεχώς, και αυτός είναι ακριβώς ο λόγος για τον οποίο ο ορισμός της βιοοικονομίας είναι κρίσιμος.

Η έννοια της βιοοικονομίας χρειάστηκε αρκετά χρόνια για να ωριμάσει ως πολιτική στρατηγική και παγκόσμια ιδέα. Ως εκ τούτου, μια παγκόσμια ανοδική τάση στην ανάπτυξη της πολιτικής βιοοικονομίας συνεχίστηκε από το 2015. Βασικά, για να επιτευχθεί παγκόσμια εφαρμογή της αειφορίας, η βιοοικονομία πρέπει να γίνει η κατευθυντήρια ιδέα σε επίπεδο κάθε χώρας.

Η ανάπτυξη της βιοοικονομίας ως εθνικής στρατηγικής εξαρτάται από τις διάφορες αλληλεπιδράσεις μεταξύ των διαφόρων παραγόντων όπως δημόσιοι και ιδιωτικοί φορείς, πρωτογενείς τομείς, νέες τεχνολογίες και ανθρώπινοι πόροι, καινοτόμες έρευνες, παράγοντες ζήτησης και κοινωνίας. Κάθε χώρα πρέπει να ακολουθεί ένα βασικό σύνολο αρχών που περιλαμβάνει λογοδοσία, διαφάνεια, συμμετοχή στη διαμόρφωση στρατηγικής,

αποτελεσματικότητα, συνοχή, δικαιοσύνη, καθώς και να αναπτύσσει τις πολιτικές της πρωτοβουλίες.

Ως αποτέλεσμα της γενικής έννοιας της βιοοικονομίας, η πρώτη Ευρωπαϊκή Στρατηγική Βιοοικονομίας ανακοινώθηκε το 2012 με στόχο μια βιώσιμη, κυκλική βιοοικονομία σε ολόκληρη την Ευρώπη, μια ευθυγράμμιση του οικονομικού-τεχνο-κοινωνικο-περιβαλλοντικού τοπίου, βελτιστοποίηση των επιπτώσεων σε τομείς της βιοοικονομίας. Με αυτόν τον τρόπο, η στρατηγική βιοοικονομίας σκοπεύει να προσφέρει μια μακροπρόθεσμη ισορροπία οικονομικών, περιβαλλοντικών και κοινωνικών κερδών, συνδυάζοντας τη βιώσιμη χρήση ανανεώσιμων πόρων για ζωοτροφές, τρόφιμα, βιολογικά προϊόντα και βιοενέργεια, με την αποκατάσταση και προστασία της βιοποικιλότητας, των οικοσυστημάτων και φυσικών πόρων σε νερό και γη στην Ευρώπη και πέραν αυτής.

Λαμβάνοντας υπόψη τη σημασία της αποκεντρωμένης και τοπικής διάστασης της βιοοικονομίας, αναλύονται τρεις διαφορετικές ευρωπαϊκές χώρες του Νότου και συγκεκριμένα της Μεσογειακής λεκάνης, της Γαλλίας, της Ιταλίας και της Ισπανίας. Συγκεκριμένα, παρατίθενται η στρατηγική που σχετίζεται με τη βιοοικονομία, ο συντάκτης της, οι βασικοί στόχοι, οι τομείς προτεραιότητας, το σχέδιο δράσης, καθώς και τα μέτρα για την προώθηση της στρατηγικής κάθε χώρας.

Στο τελευταίο μέρος της διατριβής, δίνεται έμφαση στην Ελλάδα ως ευρωπαϊκή χώρα καθώς και στην προοπτική της βιοοικονομίας της Ελλάδας.

Λαμβάνοντας υπόψη τη σκληρή οικονομική κρίση από το 2009, παρουσιάζονται στρατηγικές που σχετίζονται με τη βιοοικονομία, καθώς και οι βασικοί τους στόχοι και οι τομείς προτεραιότητας. Επιπλέον, εντοπίζονται ορισμένες προτάσεις που μπορούν να στηρίξουν τη βιοοικονομία και να ενισχύσουν την Ελλάδα γενικά.

Table of Contents

Tables

Figures

CHAPTER 1

INTRODUCTION ON BIOECONOMY

1.1 Introduction

Nowadays, bioeconomy as a notion sounds widely but is not fully understood. It is a multidimensional concept. The necessity of defining bioeconomy has come of the following fundamental problems globally: worldwide population growth, depletion of fossil raw materials, inadequate food production, climate change, and many environmental problems.

A lot of definitions related to bioeconomy have revealed the last two decades, depending on somebody's perspective and the field that he is involved in. According to OECD, bioeconomy defines as "transformation of life science knowledge into new, sustainable, eco-efficient, and competitive products" while Communiqué of the GBS2015 defines it as "the knowledge-based production and utilization of biological resources, innovative biological processes, and principles to sustainably provide goods and services across all economic sectors."

At the same time, the notion of sustainability is defined as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Hence, Sustainable Bioeconomy includes an environmental, economic, and social dimension. Moreover, the circular bioeconomy establishes an economy with the following features: recyclable, less polluting, and less dependent on non-renewable resources, and more resource restorative and efficient by nature.

Consequently, sustainable bioeconomy can deal with global challenges through its nature as an economy building on innovation, biological knowledge, renewable resources, and holistic approaches that support value chains and value nets.

In order to achieve global implementation of sustainability, bioeconomy has become the guiding concept for the country's level so urgently needed.

1.2 Understanding & Definition of Bioeconomy

Defining bioeconomy is a crucial first step. This concept is used to deal with worldwide population growth, depleting fossil raw materials, climate change, and many environmental problems. Thus, before analyzing bioeconomy and its implementation, the notion itself should be defined.

There is no universally agreed definition of "bioeconomy" or bio-based economy. Many governments, scientists, and international institutions present their definitions. Economists, industrialists, farmers, and ecologists sometimes have distinct, even contracting definitions of bioeconomy. From those definitions, legislation, policies, and strategies are being developed and implemented continuously, exactly why defining bioeconomy is critical (Sillanpää and Ncibi 2017).

Bioeconomy is a multidimensional concept, and its definition basically depends on who is defining. For instance, decision makers adopt action plans for years forward based on the "governmental" perception of bioeconomy. On the other hand, industrials, have another vision of the whole concept. The implementation is difficult and demanding, especially within an international network (Lamers, et al. 2016).

At this point, they are the widely known definitions related to bioeconomy. According to the European Union, bioeconomy "encompasses the production of renewable biological resources and their conversion into food, feed, bio-based products, and bioenergy. It includes agriculture, forestry, fisheries, food, and pulp and paper production, as well as parts of chemical, biotechnological, and energy industries" (European Commission 2012).

Within the European Union, several countries following their national strategies aiming at its developing bioeconomy also adopted other definitions.

Consistent with the OECD, the "bioeconomy" refers to the set of economic activities in which biotechnology contributes centrally to primary production and industry and constitutes the "transformation of life science knowledge into new, sustainable, eco-efficient and competitive products." These activities are associated with the invention, development, production, and use of biological products and processes (OECD, The Bioeconomy to 2030: Designing a policy agenda 2009). In the view of this work, bioeconomy is defined as the economic, environmental, and social activities related to the production, harvest, transport, processing, conversion, and use of biomass for bioproducts, bioenergy, and biofuels (Lamers, et al. 2016). Within a bioeconomy cycle, biomass

is used for the sustainable and synergetic production of food, feed, bioenergy (power, heat, and biofuels), and biobased products (chemicals and materials) (NEA 2014).

1.3 The colors of Bioeconomy

Bioeconomy technologies are derived from the isolated characteristics of biotechnology activities. The most important classification of biotechnologies is by area of application. Thus, applied biotechnology areas are often approached by colors such as white, red, blue, and green biotechnology (Székács 2017). This "color" method was firstly proposed in 2003 by Dr. Rita R. Colwell. Each of them corresponds to a certain branch of economic activity (Matyushenko, Sviatukha and Grigorova-Berenda 2016).

The most developed segments among those are presented in Table 1.1.

Table 1.1 Color type of biotechnology & area of activities

Color	Biotech Activities
Red	Health, Biomedicine, Biopharmaceutics & Medical Diagnostics
Yellow	Food Biotechnology, Nutrition Science
Blue	Aquaculture, Coastal & Marine Biotechnology
Green	Agricultural Biotechnology, Biofuels, Biofertilisers, Bioremediation, Geomicrobiology
Brown	Arid Zone & Desert Biotechnology
Dark	Bioterrorism, Biowarfare, Biocriminology, Anticrop Warfare
Purple	Patents, Publications, Inventions, Intellectual Property Rights (Legal, Ethical & Philosophic Issues)
White	Industrial Biotechnology (Gene-based Bioindustry)
Gold	Bioinformatics, Nanobiotechnology
Grey	Grey Environmental (Ecological) Biotechnology

Source: (Polívka and Ürgeová 2007)

The "Red" economy is the most significant area deals with modern biotechnology that includes the production of drugs and diagnostics under the charge of genetic engineering and cellular technology (Matyushenko, Sviatukha and Grigorova-Berenda 2016).

The "Blue" bioeconomy is released by Gunter Pauli, which is ground on applying principles and nature's mechanisms for humankind's progress. It is focused on the efficient use of marine resources such as seaweed, algae, by-products from fisheries and aquaculture, as well as marine compounds including enzymes, polymers, and carbohydrates as an alternative feedstock for

biobased products (food, technical, medical, and biologically active substances) (Fund, Patermann and El-Chichakli 2018). Moreover, the primary goal is to identify examples in nature where organic recycling or upcycling occurs and mimic these processes to determine where and how the waste we generate can be innovatively used again. The new product creates a new stream for generating revenue, which means the Blue Economy balances environmental sustainability by building up raising income, social capital, and creating jobs.

The “Green” economy is defined as a part of an integrated bioeconomy concept based on green energy, green industries, and green technologies promoting a triple bottom line: sustaining economic, environmental, and social well-being. It is based on six sectors: Renewable energy, Sustainable transport, Green buildings, Land management, Water management, Waste management. The “Green” economy contains energy generation grounded on renewable energy in order to substitute fossil fuels and energy conservation, aiming to efficient energy use (Socaciu 2014). Actually, this economy aims at reducing environmental risks and ecological scarcities for sustainable development without degrading the environment.

The “Brown” economy (or “Black” economy) depends only on petrochemicals such as coal, petroleum, and natural gas for economic growth. In the process of this way of production, considerable amounts of carbon dioxide and soot are released into the atmosphere. Economic development depends on restricted resources as well as environmental pollution is unavoidable and severe.

The “Purple” economy considers the cultural aspects of economics. It defines an economy that adapts to the human diversity in globalization and depends on the cultural side to give value to services and goods. This economy is part of the economy, contributing to sustainable development by promoting goods and services' cultural potential. The “Purple” economy is multidisciplinary, taking into account all goods and services by capitalizing on the cultural dimension inherent to every sector. In the aspect of “Purple” biotechnology, this involves ethical, legal, and philosophical issues of the biotech industry that deserve particular consideration (Matyushenko, Sviatukha and Grigorova-Berenda 2016).

The “White” economy relies on industrial biotechnology, which concentrates on the processing and manufacturing of goods such as chemicals, materials, and energy previously produced by the chemical industry. The whole-cell and biological system, synthetic cells – the products of

synthetics, GMO's, enzymes are used. This area combines the knowledge of different scientific disciplines (Polívka and Ürgeová 2007).

The "Golden" Economy is also known as the Sunshine Economy. It is explained as a kind of sustainable economy that uses non-fossil energy such as solar energy, water, marine energy, wind energy, biomass energy, geothermal energy as primary energy supply. This economy encourages the widespread and public distribution of all facilities, such as solar cookers, solar heaters, solar water heater, and solar photovoltaic, in order to improve the currently existing energy structure.

The "Grey" or informal economy is the diversified set of economic activities, enterprises, workers, and jobs, that fall outside of the country's rules and regulations or not protected by the state. This concept was initially applied to self-employment in small, unregistered enterprises. After that, it has been expanded to include wage employment in unprotected jobs and is a part of an economy neither taxed nor monitored by any form of government. It contrasts with the formal economy; activities of the "Grey" economy are not included in the gross national product (GNP) and gross domestic product (GDP) of a country. The informal economy tends to be marked out as "underground," "illegal," "black market," or "grey market." It is regularly called the "shadow economy" and is characterized as an illegal or unethical activity.

In the view of biotechnology, "Grey" biotechnology involves technologies and drugs protecting the environment. Especially, the main goal is pollution abatement, soil recultivation, waste management including utilization and recycling of industrial waste, degradation of toxicants supporting biologically active agents and their bioprocesses (Matyushenko, Sviatukha and Grigorova-Berenda 2016).

Last but not least is the "Silver Economy", a recently established economy of the 50 plus age group, including their economic demands, activities, products, and expenditures. Until lately, the 50 plus generation was not considered strong market potential, so their services and products were not prioritized. Nowadays, in an unstable economic environment, older people and pensioners present one of the most important buying power groups. This group is a major economic growth factor (Zsarnoczky 2016).

The Silver economy focuses on developing, promoting, and immediate strategies in order to face new challenges related to the aging population, especially regarding technology services. The main involved sectors are Health, self-health management, social care, and tourism. This kind of

service's primary goal is to support well-being and health through monitoring, such as robotic assistance, health sports, or electrical mobility, including green care and web-based home care solutions as well as health tourism.

Source: (Zsarnoczky 2016)

Figure 1.1 Economic segments of the silver economy

1.4 The Role of the Bioeconomy at global challenges

Bioeconomy is innovative as well as sustainable use of biomass and biological knowledge in order to provide food, feed, bioenergy, industrial products, ecological and other kinds of services. Therefore, its primary function is to provide adequate quality and enough quantity of food and renewable resources to an increasing population making sustainable use of natural resources at the same time.

The bioeconomy meets global challenges in the following ways:

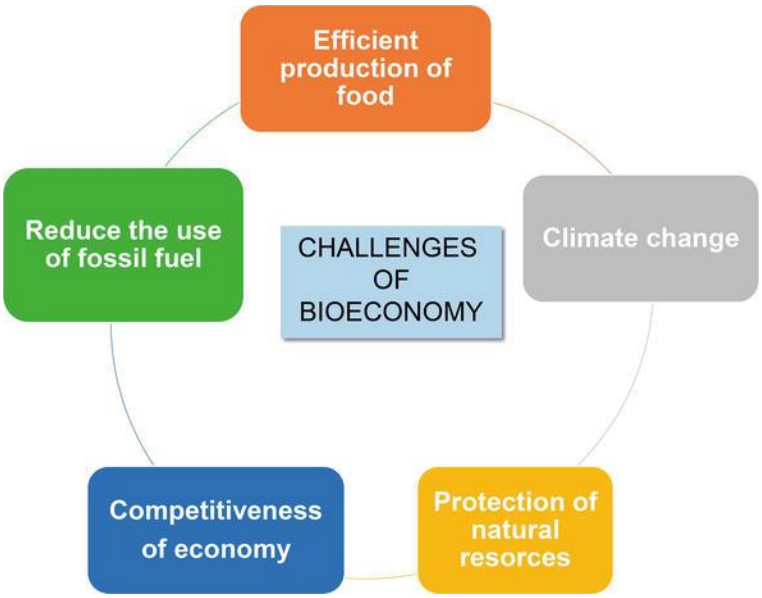
- As non-renewable fossil resources are finished and create a great impact on climate change, it is obviously necessary for us to meet our demands for food, energy, and products through

renewable resources. The global demand for higher quality and more food, as well as the limited availability of natural and land resources, demands an innovative view and use of agricultural, forestry, aquaculture forms of biomass production. This fact can result in more efficient resource-consuming production methods along biobased value chains.

- Foodstuffs and renewable materials can only be provided by biomass from forestry and agricultural production as well as from aquaculture. Through a knowledge-based approach, more sustainable and efficient production methods have to be implemented in order to increase productivity and manage natural resources sustainably.
- On the other hand, renewable energy, to which bioenergy presently contributes 73%, can be supplied through the wind, solar, geothermal, hydro, or tidal energy.
- At this point, in a sustainable bioeconomy, the usage of biobased resources should be optimized according to the following criteria. Primary, the demand for high-quality food should be satisfied with the whole world's population. Secondly, the remaining biobased resources should be reused and ideally be allocated, aiming at the maximum amount of economic, ecological, and social benefit.
- In the view of this holistic approach, resource allocation is a fundamental pillar of a sustainable bioeconomy that can serve as a blueprint for general and sustainable resource allocation strategies (Lewandowski 2018).
- It is general accepted that land usage contributes 24% of anthropogenic GHG emissions presently. Thus, factors such as the large part of biodiversity losses, forestry, and agricultural land use management should be improved sustainably and optimized accordingly. Climate-smart production methods are required to be applied, using innovative technologies and soil carbon sequestration reducing emissions and ecological impacts. These results greatly impact GHG mitigation and are often connected with lower costs, improved efficiencies, and environmental co-benefits (Netz, et al. 2007). In the bioeconomy, resource supply should be sustainable. Hence, the use of biobased resources should only be implemented where these carry out more sustainably than the alternative of fossils.
- The nature of biomass offers possibilities for creating modern jobs in rural areas. As a result, both the current concentration of jobs in urban areas and the limited geographical

distribution of accessible fossil resources are limited. Therefore, the bioeconomy gives the means for areas poor in fossil but rich in biobased resources to get better income and development opportunities. The growth of innovative technologies also generates new jobs with a modern profile (e.g., digitalization).

- The limited and partly already overstretched planetary boundaries create an imperative need for a more sustainable economy, making a responsible and efficient use of the Earth's resources. The shift to a sustainable economy presupposes the awakening of people. Both consumers should be environmentally aware and conduct economic activities through their targeted choices and preferences, and stakeholders should follow an overall sustainability-conscious behavior.
- The bioeconomy concept supports the idea of creating a biobased economy. Moreover, it builds on sustainable development through the application of systems and biological knowledge as well as the creation of innovations to develop a sustainable economy. Therefore, the bioeconomy is a forward-looking and integrated approach attempting for overall economic system optimization. The bioeconomy can deal with global challenges through its nature as an economy building on innovation, biological knowledge, renewable resources, and holistic approaches that support value chains and value nets. In a sense, the bioeconomy reacts more than just following traditional biomass production pathways, conversion, and use. Firstly, it has to lead the way towards sustainable and innovative use of the Earth's limited resources. Moreover, it must provide guidance for the societal transition towards sustainable development.
- Bioeconomy has become the guiding concept for the country's level, so urgently needed to achieve this goal (Lewandowski 2018).



Source: **(Laínez and Periago 2019)**

Figure 1.2 The five main challenges of bioeconomy

1.5 Bioeconomy and Sustainability

World Commission on Environment and Development defines sustainable development with the following statement: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987).

The above definition includes many interpretations, able to accommodate essentially different assumptions about the role of economic growth and natural resources in achieving sustainability as well as human well-being (Belyazid and Bennich 2017).

The Communique´ of the Global Bioeconomy Summit, in its report "Making Bioeconomy Work for Sustainable Development" of 2015, states the following:

"bioeconomy aims to the knowledge-based production and utilization of biological resources, innovative biological processes and principles to sustainably provide goods and services across all economic sectors" (Bioeconomy Summit 2015).

The concept of sustainability and the notion of "sustainable development" were initiated by a major global action program called "Agenda 21". The reference for sustainability can replace the context of sustainable development. Agenda 21 promoted three dimensions of sustainability: economic, environmental, and social dimension. Therefore, the principle that the bioeconomy

should be sustainable covers not only the economic dimension but also the environmental and social dimension (Lewandowski 2018).

1.6 The Shift to Sustainable Bioeconomy

Nowadays, it is generally accepted that humanity and the planet are suffering from a severe case of intoxication with fossil fuels as well as addiction to them. For this reason, sustainable bioeconomy is more than a necessity. We should piece together our force to heal the planet and ourselves.

The problem has been realistically identified; thus, the next step is finding a solution quickly. Actually, the "therapy" – solution of our planet has already been found and called sustainable bioeconomy. This is exclusively made out of biological resources from both sea and land (Sillanpää and Ncibi 2017).

Nevertheless, despite finding the solution, starting the global implementation of sustainability takes too much time for two essential reasons. Originally, the problem was falsely diagnosed or at least underestimated from the start. Secondly, the initial and one-sided solutions were localized; however, a general solution should be considered for the whole planet.

How should we proceed then to use sustainable bioeconomy as a general solution to our planet?

Humanity suffers from prolonged exposure to fossil fuels and petroleum. The healing process includes two phases: "detoxification" and "rehabilitation."

The first process aims at a gradual reduction of exposure to fossil fuels. At this stage, it is out of the question to stop using fossil fuels as raw material suddenly. The current economies are too dependent on fossil fuels as well as too weak for such a drastic approach. Moreover, sustainable bioeconomy as a concept is not mature enough and could not be applied except at gradual and small doses.

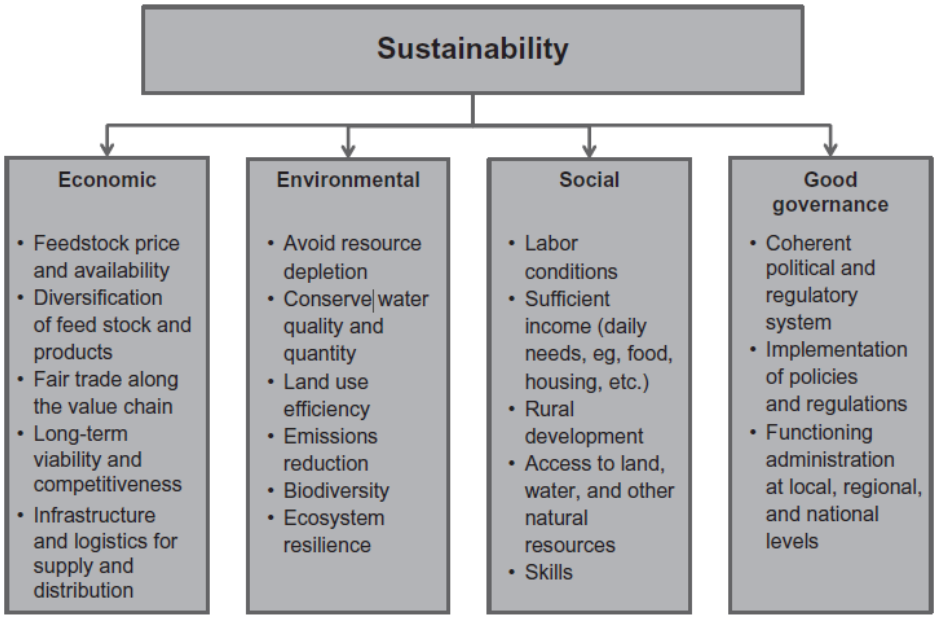
The second step is rehabilitation. The main goal is the discontinuation of fossil fuels as a basic resource and replacement by the use of renewable bioresources through a wide implementation of bioeconomy.

By the time earth can regain its "sobriety," little or no petroleum will be remained, thus no worries about relapse (Lewandowski 2018).

On the other hand, sustainability is not a fixed target or steady state. The assessment of sustainability involves not only comparing the relative advantages of different options but also the achievement that allows for continued adjustment in response to changing conditions, priorities, and knowledge (Lamers, et al. 2016).

The assessment and concept have developed from an environmental position to an integrated one that includes economic, environmental, social, and policy governance (Diaz-Chavez 2015). Sustainability evaluation is a general tool that uses different approaches to emphasize synergistic or adverse, as well as short- or long-term effects of different alternatives (OECD, Conducting Sustainability Assessment 2008).

Figure 1.3 demonstrates the aspects of sustainability issues.



Source: (Lamers, et al. 2016)

Figure 1.3 Four areas of sustainability and their key issues

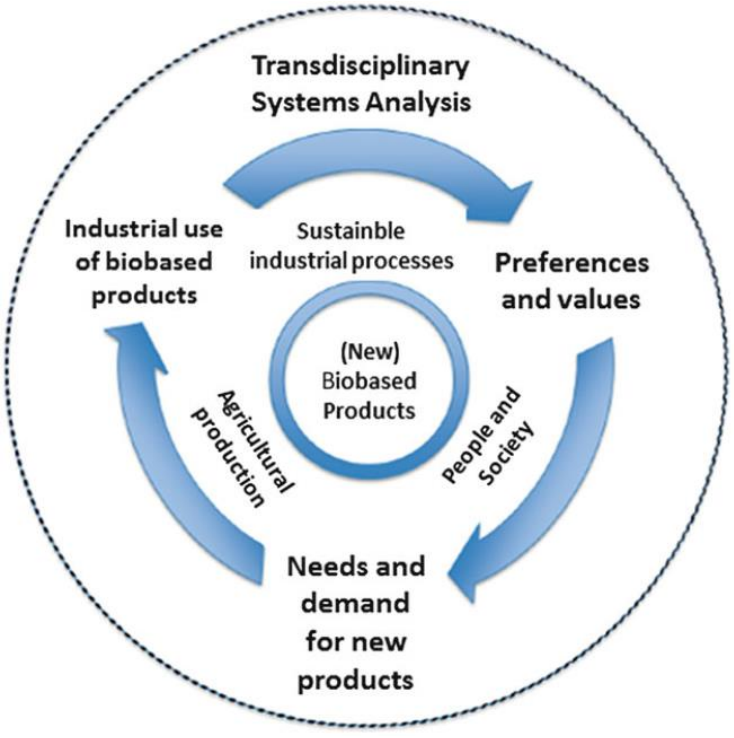
There is not a common harmonized assessment framework. This framework could help governments and industry to identify, evaluate and support the production of bioproducts which are likely to be more sustainable than their fossil parts, according to the report from the Organization for Economic Cooperation and Development (OECD, Towards the Development of OECD: Best Practices for Assessing the Sustainability of Bio-Based Products 2010).

Such a framework should focus on applying specific methodologies or minimum criteria. Assessments must be carried out on a lifecycle basis as much as possible, starting from biomass stock and extending to the end-of-life of products made of its biomass feedstocks.

The key requirements in order to communicate sustainability results to stakeholders and the public are both consistency and transparency. The target group using sustainability assessment results includes businesspeople, policymakers, and stakeholders in all stages of the supply chain, starting from waste suppliers or land managers to those connected to logistics, conversion facilities, and end-users (Lamers, et al. 2016).

1.7 The holistic concept of bioeconomy

As shown from the above definitions, the bioeconomy concept was initially focused on the supply side of goods and services based on biotechnological processes and biological resources. Nowadays, more emphasis is given on the demand side of the bioeconomy and, by extension, on the role of the bioeconomy in society (Regina Birner 2018).



Source: University of Hohenheim (2013)

Figure 1.4 Holistic concept of the bioeconomy

One team from the University of Hohenheim at the Master's program "Bioeconomy" developed the diagram above.

As shown in the diagram, it represents a more holistic view of the bioeconomy in that people are considered consumers and citizens, where their preferences and values can be translated into needs and demands for new bio-based products. This view requires transdisciplinary systems analysis.

1.8 Circular Bioeconomy

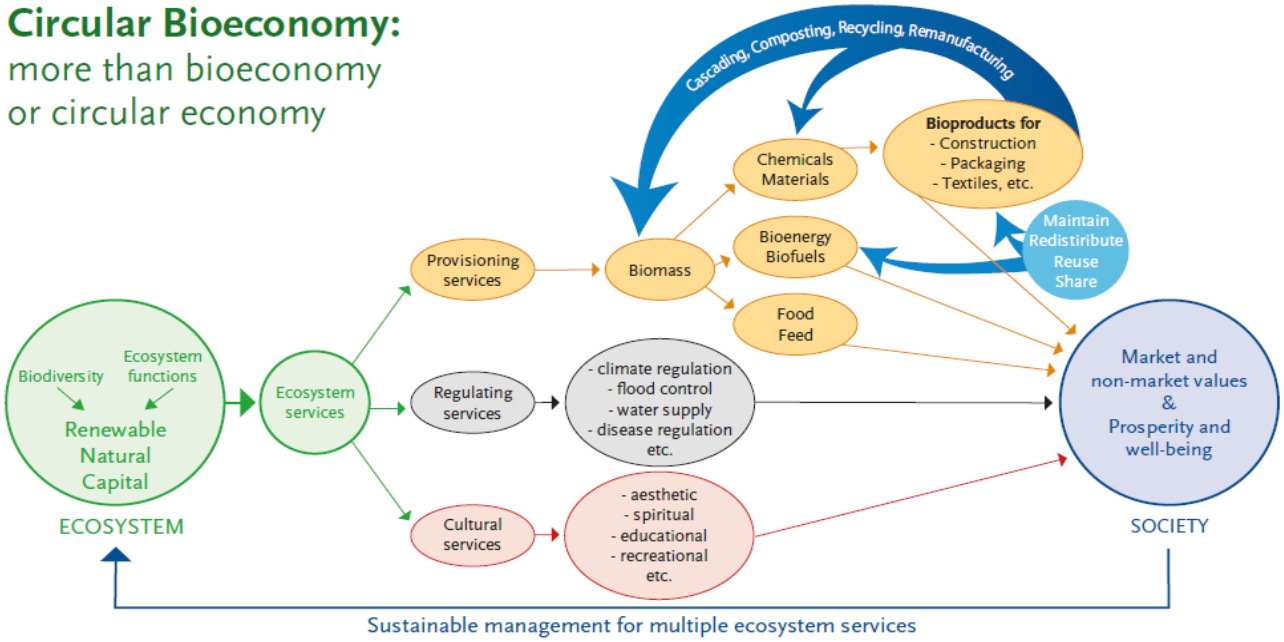
Ellen MacArthur Foundation defines the circular economy as "one that is restorative and regenerative by design, and which aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles."

A circular economy intends to design products for a cycle of dismantling and reuse and disassembly, eliminating waste. A bioeconomy offers the opportunity to substitute fossil-based, non-bio gradable, and non-renewable materials with bio gradable and renewable ones. Moreover, it can provide new capacities to biobased materials, such as a higher endurance, a longer lifespan, less or no toxicity. It is important to combine the two concepts: bioeconomy and circular economy (Antikainen, et al. 2017).

The circular economy and bioeconomy have to be made sustainable. Thus, the production of biobased products must not create competition with food production. It does not harm other ecosystem services such as climate change mitigation, biodiversity, protection against natural hazards (Hetemäki, et al. 2017). In parallel, the circular economy must reduce its dependence on non-renewable and fossil-based materials with high environmental footprints. A vital part of creating synergies is to evaluate how biodegradable materials and biomass behave in a circular economy. They must consider reusability and recycling need in the design stage when new bioproducts are being planned.

Biobased solutions are more regenerative and restorative by nature. They can moderate climate change and increase resource safety compared to fossil- based options, therefore better adapted to circular designs.

Consequently, the bioeconomy can establish an economy that is more easily circular, recyclable, less polluting, and less dependent on non-renewable resources. At the same time, the circular economy can make the bioeconomy more resource restorative and efficient by nature (Hetemäki, et al. 2017).

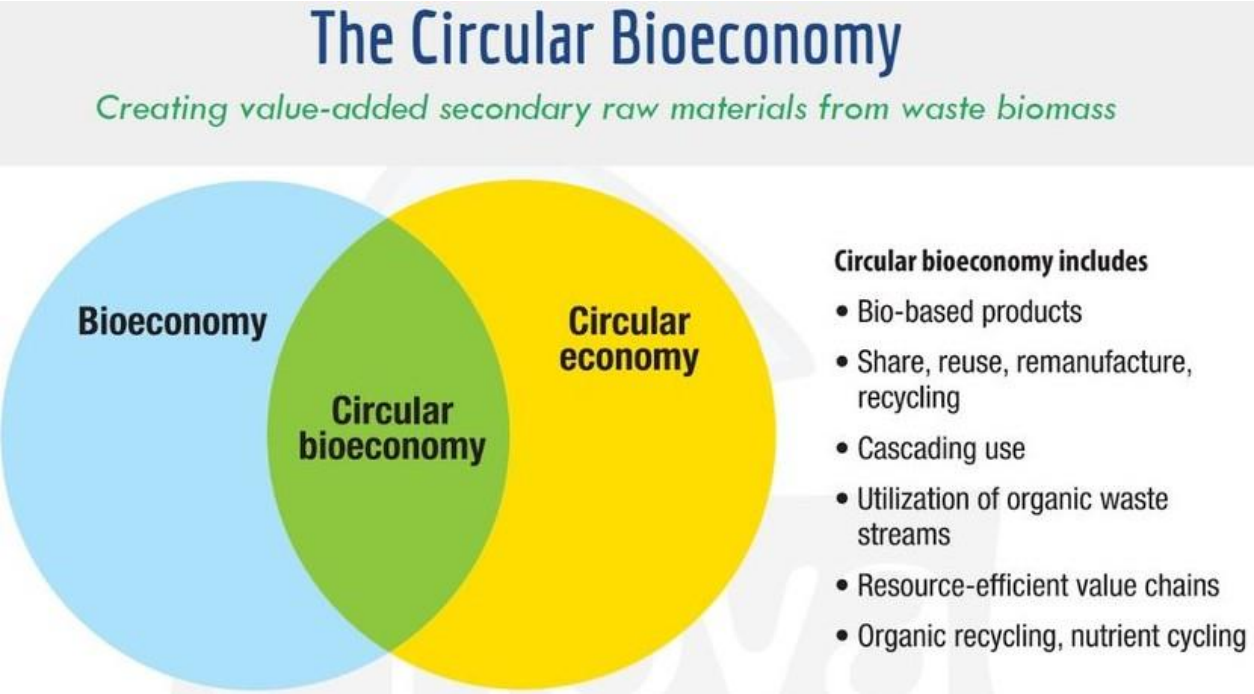


Source: (Hetemäki, et al. 2017)

Figure 1.5 Illustration of circular bioeconomy flows

The concepts of circular economy and bioeconomy reinforce each other. However, they need to be strategically combined.

The Paris Climate Agreement gave global, fundamental societal objectives for future decades. The critical question is how to reach these goals. A necessary part of this answer gives a circular bioeconomy, a tool that can be a strategy to reach climate change mitigation and adaptation.



Source: (Carus and Dammer 2018)

Figure 1.6 The circular Bioeconomy

1.9 The rise of the Bioeconomy - a Global Concept

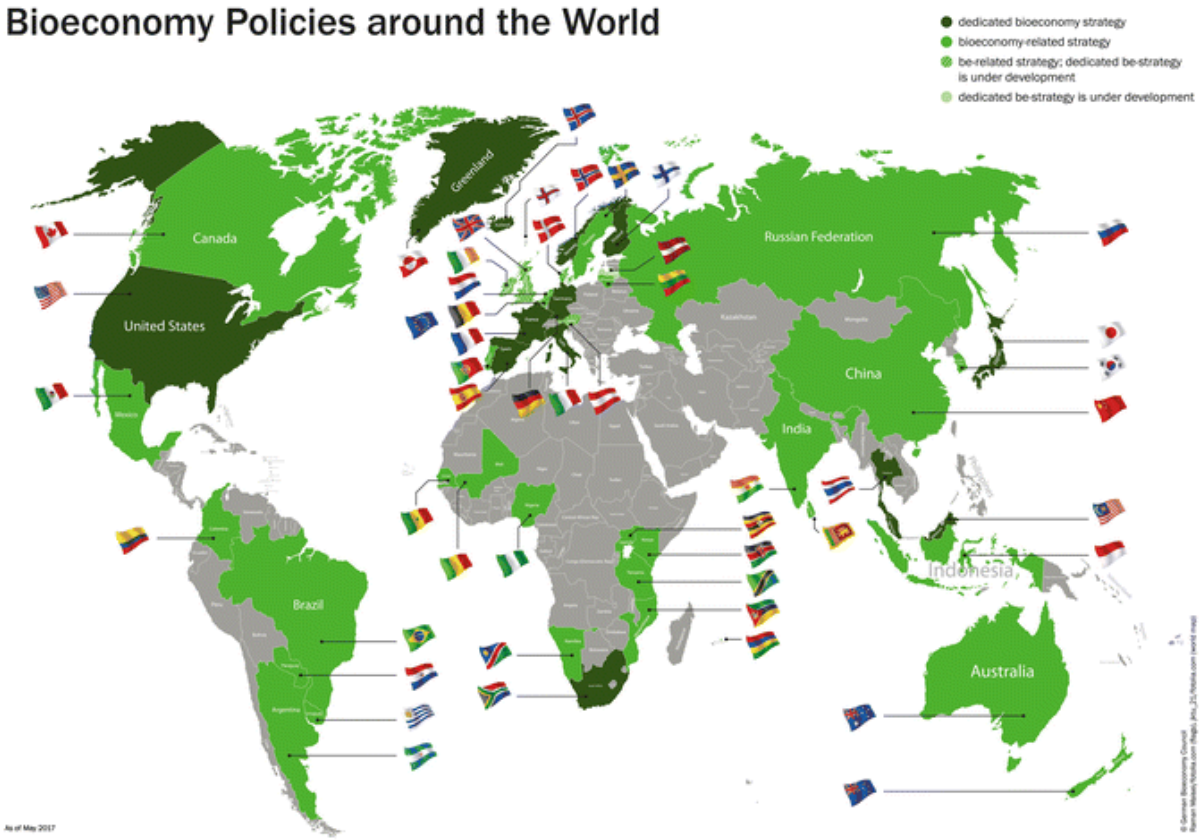
In 1997, the term bioeconomy was initially used at a meeting for the Advancement of Science of the American Association. The bioeconomy as a notion received attention early this century in the European Union. More global interest was created with the OECD policy paper on bioeconomy 'The Bioeconomy to 2030 – Designing a policy agenda (OECD, The Bioeconomy to 2030: Designing a policy agenda 2009).

Since then, the concept of bioeconomy took several years to mature as a political strategy as well as a global idea. For instance, the USA released an official strategy on the bioeconomy called "National Bioeconomy Blueprint" in 2012. Other countries, both industrialized and developing ones, published strategies and bioeconomy related policies within the first two decades of the twenty-first century (Lewandowski 2018).

In particular, a global upward trend in the growth of bioeconomy policy has continued since 2015. Realistically, more and more countries are deciding to adopt or develop a holistic national bioeconomy strategy rather than strategies related to specific policy areas. Governments in Spain,

France, Italy, Norway, Latvia, Ireland, and Thailand have followed dedicated bioeconomy strategies since 2015. Taking this into account, 15 countries, including the West Nordic Countries and the European Union, have developed dedicated bioeconomy policy strategies. Moreover, 49 countries worldwide have created policy strategies related to bioeconomy development so far. In general, the bioeconomy is receiving more and more attention at the regional level (Lewandowski 2018).

Figure 1.6 is presented a global overview of the status of bioeconomy strategy development succeeded in 2017. There is a great number of countries that have strategies related to renewable resources and biotechnology. Nevertheless, the number of countries with dedicated bioeconomy policies is still limited, as mentioned. However, it is expected to be increased soon because the importance and special role of bioeconomy have been started to be recognized widely and, the trend is rising.



Source: (BÖR 2017)

Figure 1.7 Global Bioeconomy map

Moreover, it is provided a chronological list of bioeconomy already existing strategies in the world at the table below.

Table 1.2 Bioeconomy strategies in chronological order

Country	Strategy	Year
OECD-countries	The Bioeconomy to 2030 – Designing a policy agenda	2009
EU	Innovating for Sustainable Growth – A Bioeconomy for Europe	2012
The Netherlands	Framework Memorandum on the Bio-Based Economy	2012
Sweden	Swedish Research and Innovation – Strategy for a Bio-Based Economy	2012
USA	National Bioeconomy Blueprint	2012
Malaysia	Bioeconomy Transformation Program – Enriching the Nation, Securing the Future	2013
South Africa	The Bio-economy Strategy	2013
Germany	National Policy Strategy on Bioeconomy	2014
Finland	Sustainable Growth from Bioeconomy – The Finnish Bioeconomy Strategy	2014
West Nordic countries*	Future Opportunities for Bioeconomy in the West Nordic Countries	2014
France	A Bioeconomy Strategy for France	2016
Italy	BIT – Bioeconomy in Italy	2016
Spain	Spanish Strategy on Bioeconomy Horizon 2030	2016
Norway	Familiar Resources – Undreamt of Possibilities	2016

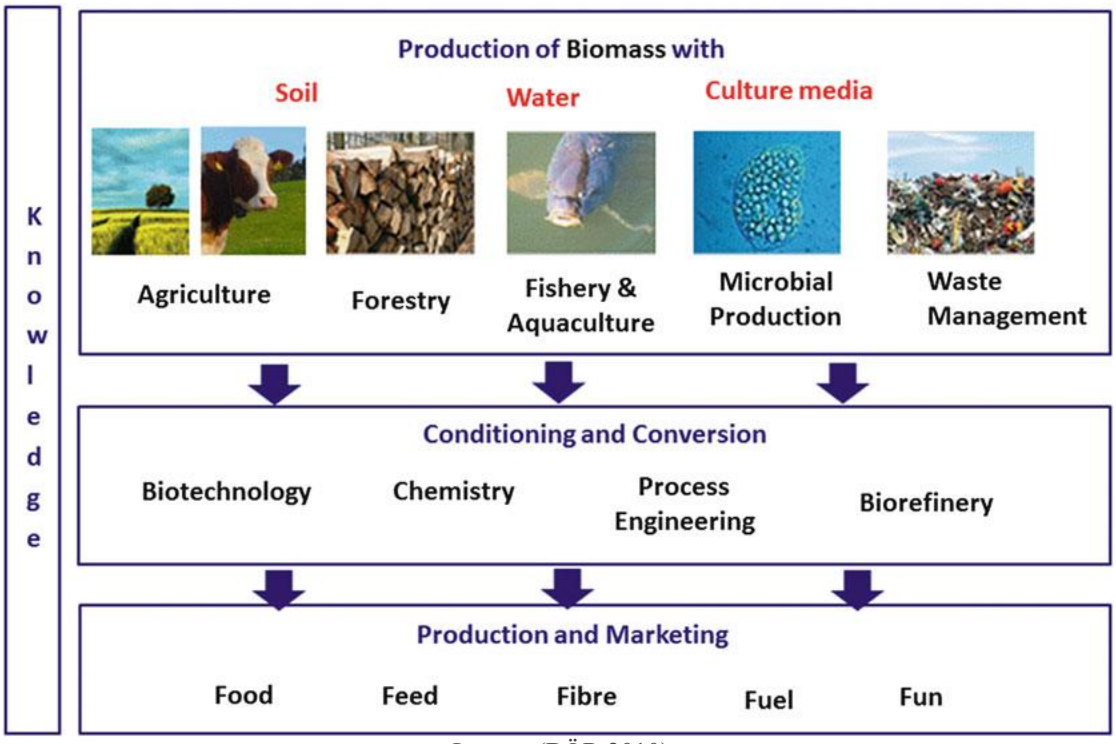
Source: (Priefer, Jörissen and Frör 2017)
*West Nordic countries comprise Greenland, Faroe Islands, and Iceland.

According to this development, the term bioeconomy has become more popular in policy papers and strategies globally. Generally, bioeconomy strategies launched since 2015 aim to succeed Sustainable Development Goals, with green growth as a key goal.

1.10 Perspectives on the Bioeconomy

Two perspectives defined the development of the concept of the bioeconomy.

Both the resource substitution perspective and the biotechnology innovation perspective are required and change over time. Although in the first decade of the twenty-first century, the resource substitution perspective was more distinguished, the biotechnology innovation is still recognized as an opportunity for the bioeconomy (Lewandowski 2018).



Source: (BÖR 2010)

Figure 1.8 The resource substitution perspective of the bioeconomy

As shown, in Figure 1.7, the resource substitution perspective of the bioeconomy is illustrated. The German Bioeconomy Council created it in 2010 (BÖR, bio-economy innovation 2010).

The primary components - procedures of the bioeconomy is the following:

1. *the production of biomass* in various forms by making good use of agriculture and forestry products, waste management, microbial production
2. its *conditioning and conversion* using different procedures, such as biotechnology and chemistry,
3. and as a final goal the production, and marketing of four 4F:

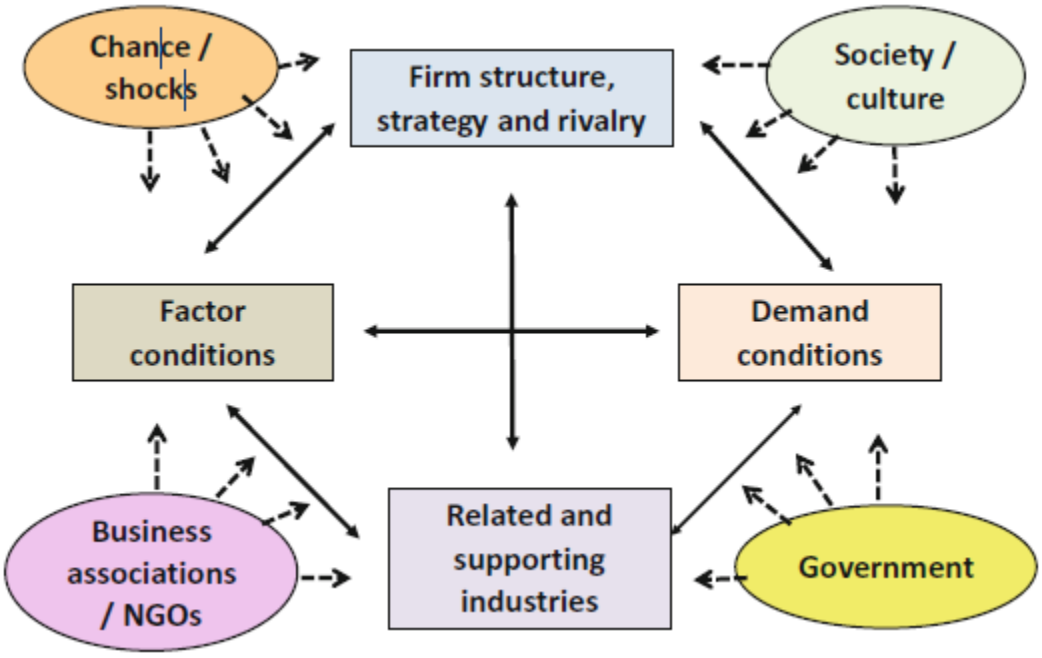
   Feed, Food, Fibre, Fuel.

   The term fun can also be used as it is referred to products such as flowers.

1.11 Primary Elements of a Bioeconomy Strategy

The fundamental factors of the model, which can promote bioeconomy development of a country are the following:

- factor conditions
- demand conditions
- firm structure, strategy, and rivalry
- related and supporting industries



Source: (Birner, et al. 2014)

Figure 1.9 The diamond model of comparative advantage

The development of the bioeconomy depends on diverse interactions among the different factors. The different factors may have conflicting or converging interests, which reveal economic and political processes that may be more or less contributory to the bioeconomy (Lewandowski 2018).

1.12 Constructive questions for a Bioeconomy Strategy

The following questions are required in order to create a Bioeconomy Strategy (Bracco, et al. 2018):

- **Bioeconomy Definition**

How does a Country define bioeconomy?

Which sectors are included in a country's bioeconomy strategy?

(agriculture, automotive and mechanical engineering, chemistry and bioplastics, Biofuels/bioenergy, construction industry, consumer goods such as cosmetics and cleaning products, Feed, Fisheries, Food, and Beverage industry, Forestry, health, Knowledge and innovation, Mining, Pharmaceuticals industry, pulp and paper, textiles)

- **Objectives/Priorities**

Which are the objectives/priorities of a country strategy?

(food security, energy security, fossil fuel reduction, rural development, economic growth, employment, mitigation and adaptation to climate change)

Which are the strengths/weakness of a country?

- **Measurement, Monitoring, and Reporting Framework**

Does a country strategy include criteria to measure the contribution of bioeconomy to the overall economy? If yes, which ones?

Which approach does a country use to measure bioeconomy contribution?

(GDP approach, Input-Output matrix, Computable General Equilibrium (CGE) Model, Partial Equilibrium (PE) Model or other Models)

Does a country measure the impact of bioeconomy on the following areas?

(Value added, Job creation, Market development, Investments, Intellectual property, R&D spending, Trade balance, Poverty Alleviation, Food security and sustainable agriculture, health, and well-being, Education, Gender equality, Availability and sustainable management of water, Access to affordable, reliable, sustainable and modern energy, Inclusive and sustainable industrialization and innovation, Inequality and inclusiveness, Inclusive, safe, resilient and sustainable cities, Ensure Climate change, sustainable consumption and production patterns, Terrestrial ecosystems, forests, land degradation, biodiversity, Oceans, seas, and marine resources)

1.13 Summary

In this chapter, an approach has been taken to define the following notions: bioeconomy, circular bioeconomy, and sustainability, including the first two concepts.

Reduction of non-renewable fossil fuel usage, use of renewable materials and biobased resources, increase of renewable energy production, efficient production of food, protection of natural resources, climate change, job opportunities constitute fundamental pillars of a sustainable bioeconomy globally.

As this concept has developed from an environmental position to an integrated one that includes economic, environmental, social, and policy governance, sustainable bioeconomy is considered as a general solution for our planet.

That is why it is a necessity for each country to develop its bioeconomy strategy.

1.14 Aim

The bioeconomy and the conditions that surround it concern an increasingly evolving area, both in Greece and worldwide. Taking into consideration the primary global challenges like climate change, efficient production of food, protection of natural resources, reduce the use of fossil fuel, bioeconomy has become the guiding concept for the country's level so urgently needed. In essence, sustainable bioeconomy appears as the best solution to deal with them providing an and effective management of these serious issues.

The basic aim of the present thesis is the analysis of bioeconomy strategy for three different European countries of the South, France, Italy, and Spain. This is the first comprehensive study for the approach of the strategy on the bioeconomy in countries with similar possibilities and challenges with Greece. The innovative part of the study is twofold. Firstly, it is initiated the idea of searching bioeconomy strategies at regional level such as the Mediterranean basin. Secondly, Greek bioeconomy strategy should be developed analyzing strategies of countries in the Mediterranean basin. Finally, Greek proposals for bioeconomy development are presented.

CHAPTER 2

BIOECONOMY IN EUROPE

2.1 Introduction

Globally, each government can promote sustainable bioeconomy development by innovating research, developing new technologies and human resources, promoting commercialization processes, and addressing the demand-side.

In order to achieve good governance, a basic set of principles that includes accountability, transparency, participation in Strategy Formulation, effectiveness, coherence, and fairness should be followed by each country. Moreover, the vital cooperation of political, social, and economic stakeholder actions is required for developing a sustainable bioeconomy within a country. Finally, policy initiatives – macro-regional, sub-regional, and industry-driven policies- promoted by private and public stakeholders play a major role in bioeconomy development and promote its country's vision of bioeconomy.

As a result of the bioeconomy concept, the first European Bioeconomy Strategy was announced in 2012. It was revised in 2018 aiming to a sustainable, circular Bioeconomy across Europe, an alignment of economic-techno-socio- environmental landscape, optimize impact within sectors of the Bioeconomy. In this way, Bioeconomy Strategy intends to provide a long-term balance of economic, environmental, and social profits combing the sustainable use of renewable resources for feed, food, bio-based products, and bioenergy, with the restoration and protection of biodiversity, ecosystems, and natural resources across water and land in Europe and beyond.

Taking into account the importance of the decentralized and local dimension of bioeconomy, it is presented this implementation by three different European countries of the South and especially the Mediterranean basin – France, Italy, and Spain. In particular, the bioeconomy-related strategy, the author, the key goals, the priority areas, the action plan, as well as measures for promoting the strategy of each country, are listed.

Regarding France, it is known that it constitutes one of Europe´s largest agricultural exporters and producers and provides one of the world's biggest biorefineries. It has developed a dedicated national bioeconomy strategy, setting the foundations of a long-term bioeconomy policy. Its main goal is to balance trade and international competitiveness as well as increased employment. It also promotes food sovereignty, independence of fossil fuel imports, and a self-sufficiency argument by reinforcing regional and rural development. The primary industry and its innovation consider as main priorities contributing to the efficient and sustainable production and utilization of bioresources. Finally, the French strategy highlights international collaboration in the bioeconomy.

Italy, the second country, has also developed a dedicated bioeconomy strategy. It aims to raise competitiveness by promoting green growth and innovation, and the primary goal is to restrict the dependency on fossil fuels and non-renewable. The main key objectives consist of an ecosystem's protection, biodiversity loss prevention as well as positive rural and coastal development. As far as stakeholders, the chemical industry is in the first line expecting the transition to green or plant-based chemistry. Agri-food, forestry, and agriculture sector, as well as biobased industries and the marine bioeconomy are considered priority areas. Eventually, the strategy emphasizes the social dimension of bioeconomy and the necessity of training, education, and societal participation.

The last country, Spain, holds a strong position in sustainable production and biological resources. The strategy underlines environmental sustainability and the "food-first-principle" as the key goals of the national bioeconomy, identifies the transition to a sustainable bioeconomy by innovations in the biosciences and digitization, and emphasizes the triangle of science – economy – society. The main focus is the use of biological resources to produce feed and food as well as faces a great societal challenge of global food security and climate change.

2.2 Good Governance Principles

Governments play a considerable role in advocating sustainable bioeconomy development. They place the foundations for investment and policy support by adopting bioeconomy or bioeconomy - related policy strategies. This makes innovating research, expedites the development of advanced and new technologies, advocates human resources development, promotes commercialization processes, and addresses the demand-side.

Although these policy strategies show diverse differences, the primary goal is the decisional role in promoting bioeconomy development. However, they vary in scope and depth and aim at different objectives (BÖR 2018).

The significant challenge to bioeconomy development is the coordination of bioeconomy actors and their different interests.

The initial set of principles of good governance was developed by the United Nations Development Program in 1997. On this basis, a selection of good governance principles is listed (Devaney, Henchion and Regan 2017):

- Accountability
- Transparency
- Participation in Strategy Formulation
- effectiveness
- coherence
- fairness

Worth noting that coordination of political, social, and economic stakeholder actions should apply the above principles that are increasingly considered prerequired for developing a sustainable bioeconomy.

In conclusion, good governance pays attention to conferences and workshops (Von Braun 2017), as well as in political memoranda and the publication of scientific papers (Devaney, Henchion and Regan 2017).

2.2.1 Accountability

From the point of view of bioeconomy development, a growing number of governments worldwide such as Argentina, Australia, Canada, the USA, New Zealand, Brazil, China, France, Italy, Latvia, Spain, UK are taking specific measures. Especially, they promote measuring activities in order to monitor new technologies and biotechnologies, biomass demand and supply, as well as biobased products and services and their ecological, economic, and social impacts (BÖR 2018).

Other countries promote the assessment of policy programs to account for their decisions and to integrate feedback and learning cycles in bioeconomy policymaking. For instance, the evaluation process of the Finnish bioeconomy strategy was launched in 2016. Both the Finnish Bioeconomy

Panel and the Ministry of Employment led this project. Every citizen was able to make a public call for tender of the evaluation project, while a strategy document already provided the basis for the evaluation (Davies, et al. 2016).

Another way the issue of accountability to be addressed is the establishment of dedicated bioeconomy advisory councils. Many countries follow this way. They usually represent private, public, and civil society stakeholders providing advisory services for bioeconomy policy development. For example, Germany has nominated such panels (BÖR 2018).

The European Commission has funded several activities in order to monitor bioeconomy development in Europe under the "Bioeconomy Observatory." This project was led by the Joint Research Center (JRC). In 2016, the results were published in the Bioeconomy Policy Report, and it is publicly available (Joint Research Center 2016). In the same year, the European Commission set up a new Bioeconomy Panel. This panel aims to ensure further stakeholder cooperation within the EU as well as monitors the implementation of the bioeconomy strategy (European Commission 2016). Moreover, the Stakeholder Panel published a Manifesto in November 2017 that provides guidance for developing a sustainable bioeconomy in Europe (European Bioeconomy Stakeholder Panel 2017).

2.2.2 Transparency

In order to raise the transparency of governmental activities, diverse countries support dialogue and public reporting. For instance, countries such as Germany, the European Union, Malaysia, the USA, and Argentina, have published progress reports to point out the key achievements of political programs. Moreover, countries such as Greece, Finland, Austria, the countries in Latin America, and the Caribbean, the European Union have set up information platforms to growing public awareness of bioeconomy (BÖR 2018).

2.2.3 Participation in Strategy Formulation

Regarding the process of strategy formulation, most of the countries approach it, involving industry and civil society representatives. In fact, almost all of the countries aim to a public consultation process to involve key stakeholders and create a common vision of bioeconomy (BÖR 2018).

Stakeholder conferences, workshops, or online surveys take place as a consultation process in order to create a final strategy document considering integrating public feedback.

2.2.4 Policy Coherence & Effectiveness

In order to succeed policy coherence and effectiveness, inter-ministerial collaboration, as well as federal-state cooperation, are considered critical for a country's bioeconomy policy. For instance, bioeconomy strategies in Italy, Spain, Australia, Thailand, Argentina, and the United States suggest establishing inter-governmental working groups apart from exchanges of personnel and memoranda among governmental authorities.

Moreover, some countries, including countries in Eastern Europe and the Nordic European countries, organize regular regional bioeconomy events and symposia in order to encourage inter-regional coordination and best practices (BÖR 2018).

2.2.5 Fairness

Although there is a need for bi- and multi-lateral cooperation among countries for the promotion of R&D cooperation and other issues, it is mentioned that international collaboration in bioeconomy reasons is not a major topic in most policy strategies.

Substantially, less importance is given to issues regarding the good governance principle of fairness. For example, conversations and measures on harmonizing policy frameworks and international trade, promoting technology transfer, and knowledge sharing among countries should be considered in policy strategies.

The global interconnectedness of the bioeconomy with respect to trade in biomass resources, global industrial value chains, and the transfer of technologies has hardly been addressed in policy strategies so far.

Therefore, the global interconnectedness of the bioeconomy with regards to global industrial value chains and the transfer of technologies, as well as trade in biomass resources, has hardly been addressed so far (BÖR 2018).

2.3 Policy Initiatives

In general terms, the dynamic development of bioeconomy should not be restricted to national policy-making only. It must further reflect the increasing number of bioeconomy related initiatives. These initiatives are such as industry and research clusters. Stakeholders from business and industry in some countries play a major role in bioeconomy development and promote their country's vision of bioeconomy (BÖR 2018).

2.3.1 Macro-regional Policy Initiatives

There is a growing number of regions active in bioeconomy policy. Particularly, macro-regional policy approaches have come up among neighboring countries with similarities in their economic conditions and resource endowment.

As part of the European Union's Cohesion Policy reform, European regions are fostered to build on their comparative advantages and encouraged on an integrated and sustainable economic growth with the assistance of the European Structural Investment Funds (ESIF) (European Commission 2017). ESIF provides financial support for macro-regional initiatives. A specific example is establishing the Central and Eastern European Bioregions Forum as a follow-up to the European Bioeconomy Congress in Lodz in 2016. The Lodz Declaration of Bioregions was then published by Central and Eastern European Regions and stakeholders from academia, civil society, and business. This declaration shows up a strategic document for bioeconomy development at the local level called "biocommunities," including bioregions, biocities, and biovillages (Bioeconomy Congress EBCL 2016). In Eastern Europe, furthermore, the Central-Eastern European Initiative for Knowledge-based Agriculture, Forestry and Aquaculture in the Bioeconomy (BIOEAST) promotes a strategic perspective for bioeconomy development (Research Institute of Agricultural Economics 2018)

2.3.2 Sub-regional Development

Primarily, the regional authorities intend to create a suitable policy framework for bioeconomy development, taking into consideration local specialization, challenges, and opportunities. In this way, sub-regional bioeconomy strategies are developed in many European Union member states.

In particular, bioeconomy is expected to raise the value-added from local bioresources, increase income, and create jobs in rural areas with a primary production sector.

Moreover, within the funding framework of ESIF, a lot of sub-regions in the European Union have begun to connect bioeconomy growth to their Research and Innovation Strategies for Smart Specialization (RIS3). They include, for instance, Crete (Greece), Norte (Portugal), Galicia and the Basque Country (Spain), Haute de France (France), Emilia Romagna (Italy) (European Commission 2016).

2.3.3 Industry-driven Initiatives

Since 2015, the more bioeconomy policies are developed, the more private stakeholders have become active in bioeconomy policy.

Within Europe, a public-private partnership called the Bio-Based Industries Joint Undertaking (BBI JU) is taking a leading role in promoting bioeconomy development.

Its primary aim is on sustainable biomass and the efficient conversion into high-value biobased products. It encourages the market development of biobased products and services as well as intend to create bioeconomy-friendly policy framework conditions (BBI JU 2018).

2.4 Bioeconomy in Europe

The European Commission establishes the foundation for national bioeconomy policy development by introducing the European Bioeconomy Strategy in 2012. Since then, an especial review of the European bioeconomy strategy was presented again in November 2017 (European Commission 2017). As a result, in the 3rd quarter of 2018, the Commission announced a revised action plan and the development of a strategy update (European Commission 2018).

Source: https://www.dreamstime.com/stock-photography-map-european-union-eu-flag-image8573352#

Picture 2.1 European Union map

Specifically, the European Bioeconomy Strategy of 2012 focused on "pave the way to a more innovative, resource-efficient and competitive society that reconciles food security with the sustainable use of renewable resources for industrial purposes,

while ensuring environmental protection." In 2017, through the review of this Strategy, the Commission concluded that the Strategy provides not only key actions but also opportunities offered by the Bioeconomy in Europe and beyond. However, it still required a refocusing of the actions and re-assessment of the scope of the Strategy in order to ensure that its framing and scope are better focused and aligned with future challenges and the EU political priorities.

Consequently, the updated Bioeconomy Strategy aims to the following:

- provide better alignment to the current economic-techno-socio- environmental landscape and rapidly evolving global and European political context,
- optimize impact within sectors of the Bioeconomy, and
- respond in a better way to political priorities connected with the Sustainable Development Goals and the Paris Climate Agreement. Moreover, pay bigger attention to European political initiatives such as EU Plastics Strategy (COM(2018)), the Commission Work Programme for 2018-2020 (COM(2017)), the EU Communication on the Future of Food and Farming (2017), the Energy Union, the renewed EU Industrial Policy Strategy (COM(2017)), the FOOD 2030 Research and Innovation agenda (SWD(2016)), the EC Communication on Accelerating Clean Energy Innovation (ACEI) COM(2016)), the ongoing implementation of the EU Action Plan for the Circular Economy (COM(2015)) and the proposals for new waste legislation, the Common Fisheries Policy, the EU Biodiversity Strategy Mid-Term Review (COM/2015/0478), the EU Forest Strategy (COM(2013)), the Blue Growth Strategy (COM(2012)), Multiannual Implementation Plan (SWD(2015)) and Mid-term Review, the Convention on Biological Diversity.

The achievement of the above goals could lead to a bigger impact of the Strategy revealing effective results in all relevant policy areas. In this way, higher policy coherence and a sustainable, circular Bioeconomy across Europe can be succeeded (European Commission 2018).

The challenge of establishing a sustainable economy through the replacement of non-renewable resources with natural and biological resources in industrial and energy processes still remains and should be aligned with the need that biodiversity is not adversely impacted, and ecosystems are in good condition and carry on supplying their services in the long term.

The followings are required in order to reach the big challenge:

- reinforce investment in research, knowledge, and innovation
- manage potential bottlenecks to dissemination and transfer of technology and innovation
- facilitate market uptake through the suitable framework conditions, including the regulatory framework at national and European levels
- facilitate an improved interaction among a wide variety of stakeholders and all levels of governance in order to improve the sustainability of the system
- develop the efficient performance monitoring and assessment SMART (Specific, Measurable, Achievable, Realistic, Timely) indicators
- realize the environmental and other impacts of biomass production as well as indirect and direct impacts of the Bioeconomy on natural resources (such as soil, forests, water, biodiversity, and ecosystem services, land-sea interactions, and land-use changes) and existing sectors using biomass.

It is important to mention that Europe and its sea- and land-based food systems are probably to be influenced by global interconnected challenges, such as biodiversity loss, climate change, global demographic growth, unsustainable production and consumption patterns, urbanization, migration, the double burden of undernutrition and malnutrition as well as the evolving trend and behavior of European consumers.

The Union takes the overall competence to coordinate, support, or supplement Member States' actions regarding their research and technological development activities. Furthermore, the Union takes the competence to protect, preserve, and improve the environment's quality and rational utilization of natural resources. The Strategy and Action Plan update further replies to the Circular Economy Action Plan (COM/2015/0614).

In conclusion, Bioeconomy Strategy should provide a long-term balance of economic, environmental, and social profits combing the sustainable use of renewable resources for feed, food, bio-based products, and bioenergy, with the restoration and protection of biodiversity, ecosystems, and natural resources across water and land. Moreover, it will deal with trade-offs between sectors, reinforcing circularity and sustainability and allocating jobs and growth in the framework of assessing local resources and adapted to local needs. It should also provide the context for a secure, sustainable, and cost-effective biomass supply for the bioenergy and bio-based sectors by using forestry, waste, aquatic, and other resources without competing for food

production. At the same time, it will preserve productive and healthy land and oceans involving more effectively primary producers in the value created and supply chain (European Commission 2018).

The European Commission summarized some positions reports on matters related to developed strategic visions and bioeconomy about fostering the implementation of the updated Bioeconomy Strategy and Action Plan.

Overall, by fostering bioeconomy, Europe is endeavoring to:

- Reinforce support for the training and education of an experienced workforce in the Bioeconomy and related fields.
- Support strategic innovation and research through the EU, paying attention to regional and national investments as well as private funds for areas that are key to the Bioeconomy with the ambition to implement it.
- Support the update, adoption, and coherence of regional and national Bioeconomy Strategies throughout Europe, and encourage the EU urban, rural, and coastal areas in taking advantage of opportunities offered by new and existing bioeconomy value chains, with citizens involvement.
- Reinforce the understanding and resilience of sea and land ecosystems, with the perspective to enhance resource efficiency, maximizing co-benefits of the bioeconomy, and minimizing harmful impacts through innovation and research, guidance, policy action, foresight, and awareness raising.
- Mobilize investments for improving existing technologies and developing new ones, as well as industrial demonstrators.
- Develop efficient performance monitoring and assessment frameworks, using SMART indicators, to evaluate the policy developments and the progress of the Bioeconomy across relevant sectors.
- Upscale and strengthen the bio-based sectors in order to convert forestry, agriculture-, marine- and waste-based resources sustainably, maintaining the Circular Bioeconomy, with equitable sharing for primary producers and all stakeholder's engagement.

- Support the creation of markets for innovative, sustainable, and circular bioeconomy processes and products through regulatory frameworks, including certification schemes, labels, standards, implementation of waste legislation, food, and bio-based products.

The two last strategic objectives related to the industry are definitely the most important goal with regards to the implementation of biorefinery as it encloses, indirectly or directly, other objectives. Totally, the European global market leadership will be equal to the grade of implementation of bioeconomy in the industrial sector of the continent as well as the efficiency, cost-effectiveness, and innovation of its biorefining processes and technologies on the one hand and competition of the generated bio-based products, considering both quality and quantity, on the other hand (Sillanpää and Ncibi 2017).

In this respect, many European consultants are emphasizing the necessity of incorporation industrial biotechnologies such as white and green biotechnologies in bioeconomy implementation scenarios and the requirement to invest in such sustainable technologies substantially (Bevan and Franssen 2006, Scarlat, et al. 2015).

Important attention to white biotechnology is clearly recognized in European technological and scientific circles as well as research-based industries, mainly in the pharmaceuticals, chemicals, and energy sectors (Frazzetto 2003, Kirk, Borchert and Fug 2002, Jegannathan and Nielsen 2012). This kind of technology, based on the use of microorganisms and enzymes, has a promising potentiality to produce diverse bio-based products from natural resources and municipal and agro-industrial wastes at competitive costs, including biochemicals, biofuels, food and feed, pulp and paper, and textiles (McCormick and Kautto 2013).

2.5 National Perspectives in Bioeconomy of Europe – The Mediterranean basin

After presenting the updated European Bioeconomy Strategy and Action Plan and considering the importance of the decentralized and local dimension of bioeconomy, it is worthwhile to study the perspectives and visions about such implementation from three different European countries of South and especially Mediterranean basin actively involved in sustainability and bioeconomy (Sillanpää and Ncibi 2017).

Since 2015, three new dedicated bioeconomy policy strategies have been adopted in France, Italy, and Spain. However, most recently published strategy documents focus on producing and utilizing bioresources (BÖR 2018).

2.5.1 France

France appears to have a lasting tradition in bioeconomy development and policy support. Apart from the fact that it is one of Europe´s largest agricultural exporters and producers and provides one of the world's biggest biorefineries, it has also established the large "Industries & Agro-Ressources" (IAR) Competitiveness Cluster (German Bioeconomy Council 2015).

Source: https://www.dreamstime.com/royalty-free-stock-image-focus-france-image20065746

Picture 2.2 France map

2.5.1.1 Bioeconomy-related strategy developed since 2015

In 2017, the government published "A Bioeconomy Strategy for France" (Republic of France 2017), a dedicated national bioeconomy strategy, setting the foundations of a long-term bioeconomy policy.

Moreover, the Economic, Social and Environmental Council (CESE), which is a constitutional consultative assembly, represented its suggestions for a sustainable bioeconomy via the document "Versune bioéconomie durable" (CESE 2017) in March 2017. This document especially mentions the social and environmental challenges of the bioeconomy adopting new ways of sustainable production and consumption.

Last but not least, a European workshop on bioeconomy took place in June 2017 at the public research institutes INRA and Irstea. At least 300 European and international bioeconomy experts have attended it. As a result of this event, recommendations on bioeconomy-related development and research were published. It is mentioned the importance of promoting multi-disciplinary and multisector cooperation, implementing bioeconomy-related policies as we as modeling the externalities of the bioeconomy (BÖR 2018).

2.5.1.2. The term “bioeconomy” or “biobased economy”

Since 2017, the term bioeconomy appeared in France's political process as a result of the development of the dedicated bioeconomy strategy. In the previous years, the nation of the biobased economy was widely used with regards to a green economy or industrial ecology (German Bioeconomy Council 2015).

In the French context, the bioeconomy definition includes “ (…) the whole range of activities linked to the production, use, and processing of bioresources”. The circular bioeconomy by reusing and recycling biobased resources is the main pillar of the strategy.

2.5.1.3. The author of the strategy

Since 2015, the Ministry of National Education and Research, the Ministry of Ecology, Sustainable Development and Energy, the Ministry of Agriculture, Agrifood and Forestry, and the Ministry of the Economy, Industry, and the Digital Sector cooperated in the strategy development process. Furthermore, a lot of stakeholder workshops at the regional and national levels contributed to it (BÖR 2018).

In 2017, a strategic committee on bioeconomy was established to support the implementation.

2.5.1.4. The key goals of the strategy

Primarily, the French government aims to promote sustainable economic growth. Especially, the dedicated national bioeconomy strategy expects an improved balance of trade and international competitiveness as well as increased employment. It also promotes food sovereignty, independence of fossil fuel imports, and a self-sufficiency argument by reinforcing regional and rural development (BÖR 2018).

2.5.1.5. The priority areas of the strategy

The French bioeconomy strategy prioritizes primary the industry and its innovation contributing to the efficient and sustainable production and utilization of bioresources. For instance, it promotes sustainable resource management practices such as precision farming as well as adopts innovative crop production systems such as organic farming, agroforestry, and agroecology. Another goal

concerns the increase of biomass resources' mobilization by taking advantage of abandoned farmland and uncultivated land apart from maritime and aquatic areas. In this regard, the strategy focuses on the utilization of residues and waste resources from primary industries, as well as industrial and urban wastes for energy production mainly. Finally, the action plan highlights the development of new value chains based on animal by-products.

On the other hand, this strategy's particular characteristic is its attention to the bioeconomy's local dimension and the conversion of produced biomass locally into high-value biobased products, such as chemicals, biomaterials, and bioenergy, food, and feedstuffs.

Simultaneously, both biorefinery development and the integration of chemical and biological processes and technologies using nanotechnology and biotechnology expect to guarantee sustainable and efficient biomass resource conversion. For instance, the emphasis is on bioenergy obtained from organic and wood waste resources. In addition, lignocellulosic resources are considered important for chemical applications in the food and pharmaceutical industries.

Regarding society's role and involvement, it seems that it is considered a prerequisite for successful modification to a bioeconomy. For example, the strategy document recognizes changing trends in consumer diets, which need investigation by conducting further research into consumer preferences and behavior. The strategy also emphasizes alternative and new food resources, which could be identified to reserve the future protein supply. Moreover, special consideration is given to overseas regions and their enormous deposits of biological resources. In this regard, the focus is on identifying overseas bioresources and assessing their potentiality for industrial use (BÖR 2018).

2.5.1.6 A dedicated action plan - quantitative targets

In February 2018, a dedicated action plan was published as a result of a stakeholder consultation process. It actually provides measurements for promoting bioeconomy progress from 2018 to 2020. More specifically, the plan focuses on five areas of action, including the raising of public awareness on biobased products and bioeconomy, the improvement of knowledge, the sustainable production and utilization of biobased resources, the promotion of the demand and supply side, as well as new financing mechanisms (République Française 2018). A concrete budget does not identify for implementing the measures proposed.

2.5.1.7 Measures - actions for promoting the strategy

The French bioeconomy strategy follows a comprehensive approach to promote bioeconomy development. Principally, it focuses on increasing private and public R&D investment promoting innovation.

Since 2010, the French government has been providing funds for bioeconomy-related research and innovation programs. For instance, the “Future Investments” funding program, which is under the third funding phase, centers on promoting cutting-edge technology. This program will provide EUR 1.5 billion/USD 1.8 billion for research, infrastructure, and training in agricultural science, biotechnology, nanobiotechnology, and bioinformatics over a period of ten years (French National Research Agency 2018).

Furthermore, the national research agency INRA will continue the funding for the eight interdisciplinary meta-programs on nutrition, environment, and agriculture. INRA’s budget supports these meta-programs by 30% for a period from 2010 to 2020. The ninth meta-research program was launched in 2018 regarding organic farming and food (INRA 2018).

It is important to mention the European Center for Biotechnology and Bioeconomy (CEBB) was set up in 2015 (CEBB 2017). Its mission is to contribute to multi-disciplinary research regarding the sustainable production of biological resources as well as to encourage biorefinery development and the agro-food industry.

It will pay attention to a better comprehension of metabolism, photosynthesis, and environmental interactions regarding public R&D. By taking into account the progress in genetics, this could increase the overall efficiency of production systems. Moreover, innovative cooperation between the chemical industry and stakeholders in the primary sector should be supported.

Reinforce of infrastructure development focuses on the funding of biorefinery development and shared R&D facilities. The development of clusters is also highlighted, aiming for the creation of synergies between the industrial and agrifood sectors (BÖR 2018).

In addition, the workforce's education and training for the future bioeconomy is considered extremely important for the government. In particular, capacity development and inter-disciplinary education, including technical and professional training as well as life-long learning chances, make up the main focus. The technical and scientific expertise of CentraleSupélec, AgroParisTech, the University of Reims Champagne-Ardenne, and the NEOMA Business School has been used by

establishing the European Center for Biotechnology and Bioeconomy. Furthermore, the support for bioeconomic-relevant academic programs in the field of biomaterials, biotechnology, and green chemistry, has been enhanced.

Tools regarding the promotion of commercialization reinforce biobased products to the market. For example, the website www.agrobiobase.com provides information on biobased product origin around the world and the product's environmental benefits. Simultaneously, it allocates a B2B platform for growing the market for biobased products. Moreover, feasibility studies, demonstration platforms, and living labs take place to advocate commercialization.

It is important to mention the action plan of 2018 highlights the need to encourage access to capital for biobased companies and increase awareness of potential investors, such as business angels, banks, pension or investment funds, funds. Public-private bioeconomy projects should be sponsored by the Biobased-Industries Consortium (BBI). In the context of the development of a "Grand Investment Plan," it will be specified, all the above measures are proposed to foster commercialization.

The demand side of the bioeconomy is also emphasized on the strategy document via a variety of tools such as certifications and labels and raising awareness of biobased products through standards. Furthermore, the French law review should be considered regarding public procurement and biobased characteristics. The usage of biofuels should be supported by subsidies, favorable taxation, and price-setting measures (BÖR 2018).

The action plan of 2018 aims to the demand-side by proposing specific measures as well. For instance, it anticipates establishing a bioeconomy website providing information on R&D projects and success stories for the bioeconomy professionals and the general public. It also refers to creating an exhibition concept with regards to the bioeconomy in everyday life and sets up a bioeconomy award for successful companies and projects. Regarding the Olympic Games in 2024, the building of a biobased Olympic village with biobased materials in construction, such as wood, flax fiber, hemp, is a flagship project.

The policy coherence at the regional, national even EU levels is a prerequisite and critical point for bioeconomy development. The strategy proposes not only regulations promoting the use of biobased and biofuels, compostable plastic bags but also regulations fostering the usage of biobased innovation in the construction sector to create bioeconomy-friendly framework conditions. The

government also expects to develop a national biomass strategy (SNMB) to achieve sustainable biomass production and utilization.

In the light of good governance, the strategy intends to nominate a national bioeconomy council consisting of stakeholders from industry, academics and research institutes, NGOs, and local, regional, and national decision-makers. It is required to support multi-stakeholder dialogues, especially at the local level, to foster outreach and participation. It is also a priority to monitor biomass resources by reinforcing the national resource observatory (ONRB).

Finally, the French strategy highlights international collaboration in the bioeconomy. France aims to actively participate in bioeconomy-related discourses conducted on international research and policy within the European Union, the International Energy Agency, the United Nations Environment Program, the Organization for Economic Cooperation and Development (OECD), and the UN Food and Agriculture Organization. Last but not least important, it is the French commitment regarding the Paris climate agreement by emphasizing the bioeconomy's potential contribution to the mitigation of climate change (BÖR 2018).

2.5.2 Italy

In Italy, bioeconomy development has taken place mainly by some regional clusters and by companies in green chemistry in recent years.

Source: https://www.dreamstime.com/canada-infografics-image150889117

Picture 2.3 Italy map

2.5.2.1 Bioeconomy-related strategy developed since 2015

The Italian Agency for Territorial Cohesion published a draft of the first dedicated bioeconomy strategy in November 2016. The Ministry for Economic Development presented it officially at the Ecomondo 2016 exhibition. One year later, the Italian government presented the revised strategy document with the title "Bioeconomy in Italy: A unique opportunity to reconnect economy, society, and environment" (Bonaretti, P. et al. 2017).

The Autonomous Provinces of Italy and the Conference of Regions have proceeded a cooperative position paper on bioeconomy development at the regional level. More than 20 regions

have worked together on determining strategic positions in the area of agri-food and biobased industries as well as marine bioeconomy. European funds will co-fund on regional bioeconomy development aiming at the Research and Innovation Strategies for Smart Specialisation (RIS3) (Conference of the Italian Autonomous Regions 2016).

2.5.2.2. The term “bioeconomy” or “biobased economy”

In the Italian framework, bioeconomy development focuses on growing the added value from the primary production sectors. Bioeconomy encloses the integration of “the sustainable production of renewable biological resources and the conversion of these resources and waste streams into value-added products such as food, feed, biobased products and bioenergy,” according to the strategy document. Moreover, the latest strategy document mentions the importance of the circular economy concept within EU policy. As a result of it, the revised policy paper highlights a transition towards a circular bioeconomy reflecting a vision “where the production and use of renewable bioresources and their conversion into value-added products is part of a circular system that will make businesses more economically viable and sustainable in the long term.” (BÖR 2018).

2.5.2.3. The author of the strategy

The strategy development consists of an interministerial effort of the following ministries and agencies: the Ministry of Agriculture, Food and Forestry, the Ministry for Economic Development, the Ministry of the Environment, Land, and Sea, the Ministry for Education, University and Research, the Agency for Territorial Cohesion, the Committee of Italian Regions and the Italian Technology Clusters for Green Chemistry and AgriFood. Actually, the Italian Presidency of the Council of Ministers is the leader and the coordinator.

A public consultation process was initiated in November 2016 among citizens and bioeconomy stakeholders who were asked to provide an opinion on the strategy draft. Since then, a lot of workshops took place to analyze and discuss the comments and general feedback. Thus, the final strategy document was published in April 2017 (BÖR 2018).

2.5.2.4. The key goals of the strategy

Italy's strategy clearly intends to raise competitiveness by promoting green growth and innovation. Its primary goal is to restrict the dependency on fossil fuels and non-renewable. The main key objectives of the bioeconomy strategy consist of the ecosystem's protection, biodiversity loss prevention as well as positive rural and coastal development (BÖR 2018).

2.5.2.5. The priority areas of the strategy

For years, stakeholders in the chemical industry have led Italian bioeconomy development expecting the transition to green or plant-based chemistry. Both biomaterials and bioproducts are produced by such companies combining agricultural, chemical, and environmental expertise. Moreover, diverse biobased innovation clusters and centers play a vital role in developing bioindustry (Bonaccorso, M. 2017a). Therefore, the core sectors of "an integrated Italian bioeconomy ecosystem" are considered the agri-food, forestry, and agriculture sector as well as biobased industries and the marine bioeconomy. The strategy intends to develop networks among diverse bioeconomy sectors and their value chains, produce value from circular economy approaches and local biodiversity, and increase the sustainability and efficiency of biobased value chains. In addition, it aims to strengthen sustainable bioeconomy within the wider Mediterranean area.

According to the strategy document, the implementation process of both the Italian National Strategy for Sustainable Development and the National Smart Specialization Strategy play an active role in the bioeconomy strategy concept. Within this context, Italy has designed strategic plans for the biobased and agri-food industry. The Italian bioeconomy strategy considers integration with structural and smart specialization interventions as well as EU-funded R&I (BÖR 2018).

Government support for the forestry and agricultural sector will focus on promoting a more resilient and sustainable primary production by examining the role of peri-urban and urban agriculture and by exploring the sustainability potential of different forestry and agricultural models. Generally, the strategy emphasizes the need to improve forest management in the forestry area. It also highlights the requirement of modernizing the wood industry to develop new products and grow the use of high-tech wood-based materials in the construction sector. Regarding the

development of the biobased industry, the strategy concentrates on producing next-generation bioplastics and biofuels, promoting biobased building materials, developing biopharmaceuticals and cosmetics, and increasing the production of biolubricants, biofertilizers, and essential amino acids for feed production.

With regard to marine bioeconomy, the strategy not only identifies the environmental challenges of the Mediterranean region but also recognizes opportunities for blue growth and jobs. Particularly, the Italian government has already initiated a lot of initiatives such as the BLUEMED and PRIMA, promoting food systems and sustainable water management in the Mediterranean region.

Furthermore, the national strategy recognizes the need for better coordination among regional, national, and EU initiatives and policies. It highlights the role of the Italian regions in economic and social development. For the implementation of circular economy activities and improvement of environmental resilience and adaptation to climate change, regional approaches are crucial. In this regard, the promotion of digitization and precision farming, as well as key technologies, such as environmental and industrial biotechnologies, 'omics,' and big data, is considered vitally important (BÖR 2018).

2.5.2.6 An action plan - quantitative targets

Basically, Italy's bioeconomy strategy does not reveal a dedicative action plan. It includes several actions based on two primary goals by 2030. Firstly, bioeconomy turnover should raise from EUR 250 billion (2015)/ USD 300 billion to EUR 300 billion/ USD 360 billion. In addition, the entire bioeconomy sector should provide 2 million jobs at least (BÖR 2018).

The R & I agenda's key topics are defined mainly by proposed actions and by some support measures derived from a comprehensive analysis of opportunities and challenges of the Italian Bioeconomy.

In order to monitor the strategy's implementation process, the strategy has set some concrete indicators based on the sustainability indicators proposed by the EU initiative29 and the EU key performance indicators (KPI) (Bonaretti, P. et al. 2017). As a matter of fact, these indicators are related to biomass availability, employment structure, productive structure, innovation, investment, human capacity, demographics, markets, managing natural resources, ensuring food security,

coping with climate change, reducing dependency on non-renewable resources, and enhancing economic growth.

Finally, a dedicated action plan with implementation timetables is expected (BÖR 2018).

2.5.2.7 Measures - actions for promoting the strategy

The Italian strategy provides supportive measures to encourage bioeconomy development. Firstly, the strategy intends to leverage publicly funded programs at the regional, national, and EU level in the field of research and innovation. This can be succeeded by providing direct funding and tax incentives. Public investments should focus on improving resource management by increasing photosynthesis capacity and carbon dioxide sequestration and implementing forestry and farming systems to improve water quality and soil fertility. R&I investments' main goal should depend on creating value from resources, circularity, and local biodiversity, leveraging abandoned land and industrial sites at the same time. Further future R&I investments should concentrate on the sustainable exploitation of marine resources such as phytoplankton, seaweed, by-products for producing food, energy, and fine chemicals while protecting the marine biodiversity and environment.

Regarding the development of a sustainable and competitive agri-food sector, another main topic of the R&I agenda is the improvement of food safety and promotion of healthy diets by identifying both consumer preferences and alternative food resources and novel food microbes as well as by developing smart nutrition solutions. It also highlights the need to increase food production efficiency by considering the potentiality of food wastes for biofuels and biochemicals (BÖR 2018).

Moreover, the strategy emphasizes the social dimension of bioeconomy and the necessity of training, education, and societal participation. Measures for professional training and cross-disciplinary education are required to increase awareness and develop a skilled workforce for the bioeconomy. As a result, the proposed measures include new technical programs for schools, academic bioeconomy courses as well as post-graduate education in bioeconomy. In this regard, the first European master’s program in “Bioeconomy in the Circular Economy” was initiated in Bologna und Naples, Milan, and Turin in January 2017. This master comes from a public-private

partnership among four Italian universities, an Italian banking group, and three industrial partners (Bonaccorso, M. 2017b).

Measures for infrastructure development aim to invest in R&D facilities, demonstration plants, and technology clusters to promote new biobased products and process technologies.

By aligning regional, national, and EU activities and policies, a bioeconomy-friendly framework is ensured. For instance, this includes not only a review of regulations designed to support the development but also the commercialization of biobased products and the industrial use of residues and wastes.

The strategy indicates fostering demand for biobased services and products by implementing measures such as labeling, standard-setting, communication campaigns, and green public procurement. Ecodesign approaches and life cycle thinking should be promoted. A methodological framework is expected to be developed for companies to reveal cost-benefit analyses of biobased products demonstrating the comparative advantages to buyers. Consumer communication and information are considered important measures to increase public awareness.

Regarding good governance, a permanent bioeconomy working group has to be set in order to ensure better stakeholder coordination and support the strategy implementation process. The strategy recommends nominating representatives from national technological clusters, ministries, and relevant public agencies (BÖR 2018).

2.5.3 Spain

Spain holds a strong position in sustainable production and the use of biological resources for human consumption purposes, even in long periods of water scarcity of the territory.

The continuous development of the bioeconomy as a necessity and an opportunity both for the Spanish industrial sectors and for society remains at the center of the bioeconomy strategy.

Source:https://www.absolutvision.com/photo/2530/three-dimensional-map-of-spain-with-flag

Figure 2.4 Spain map

Moreover, Spain is one of the 40 countries with a huge interest in promoting this field. This could make an important contribution to economic growth (Laineza, et al. 2017).

2.5.3.1 Bioeconomy-related strategy developed since 2015

In January 2016, the Spanish government launched its first national bioeconomy strategy with its first Action Plan. The document entitled “Horizon 2030” reflects the government’s main goal to grow a sustainable Spanish bioeconomy in the next 15 years (Spanish Ministry of Economy, Industry and Competitiveness 2015).

Furthermore, it is mentioned the development of specific strategies in the Autonomous Regions. Several Autonomous Regions are working on their specific bioeconomy strategy. Thus, meetings have taken place with Regional Administrations discussing the scope of current regional initiatives. This includes the case of Andalucía, Castilla- León, Comunidad Valenciana, and Extremadura at the regional level (Laineza, et al. 2017).

Specifically, in the case of Extremadura, bioeconomy policy is applied under the circular and green economy. In this framework, the regional government declared the “Extremadura 2030” policy strategy in 2017. This includes various bioeconomy related topics (Junta de Extremadura 2017). Moreover, a dedicated Andalucian bioeconomy strategy had been published (Government of Andalucía 2018).

2.5.3.2 The term “bioeconomy” or “biobased economy”

In the context of Spanish strategy, bioeconomy defines as “the set of economic activities based on products and services, generating economic value, making efficient and sustainable use of resourcesμof biological origin as fundamental elements.”

This strategy's main objective is to produce and commercialize food, forestry, and biobased products and bioenergy, through chemical, biochemical, physical, and biological processes with respect to the environment. The strategy underlines environmental sustainability and the “food-first-principle” as the key goals of the national bioeconomy (Lainez, M. 2016).

Regarding the Extremaduran strategy document, the term bioeconomy is the same as the European Union's definition. Basically, it identifies a set of economic activities based on processes and biological resources. The strategy reveals the political concepts of sustainable development, circular economy, and bioeconomy.

2.5.3.3. The author of the strategy

In 2014, the Ministry of Agriculture, Food, and the Environment, in collaboration with the Ministry of the Economy and Competitiveness, took the first initiative for a national bioeconomy strategy. A working group, including the Secretary of State for Research, Development, and Innovation (SEIDI) and public and private experts, was set up to elaborate a first strategy blueprint. This draft underwent public consultation for public feedback. Finally, the strategy was adopted in March 2016.

A broad stakeholder consultation process was initiated in 2017 for the development of the Extremadura 2030 strategy. The document was eventually published by the government of Extremadura (BÖR 2018).

2.5.3.4. The key goals of the strategy

The national bioeconomy strategy, as well as the Extremaduran policy strategy, has two pillars. From a global perspective, they highlight the great societal challenges Spain faces, including global food security and climate change.

In the national and regional context, the strategies aim to increase competitiveness and reinforce economic growth by promoting and the internationalization of biobased companies and innovative technologies.

Moreover, Spain intends to develop a more environmentally and diversified, sustainable economy where bioeconomy will contribute to rural development and stronger territorial cohesion (BÖR 2018).

2.5.3.5. The priority areas of the strategy

The main focus of the Spanish bioeconomy is the use of biological resources to produce feed and food.

The national bioeconomy strategy primarily document identifies the transition to a sustainable bioeconomy by innovations in biosciences and digitization. Besides, the only path to obtain renewable organic materials is environmental sustainability.

Basically, the strategy emphasizes the triangle of science – economy – society. The scientific field's generated knowledge should be used to develop productive activities growing in those areas where society accepts and adopts. As a result, indirect and direct involvement of all stakeholders is required to reinforce the triangle.

On the one hand, society plays a key role as facilitators, promoters, and catalysts of the strategy through organizations representing different economic, environmental, and social groups and as consumers.

On the other hand, researchers and scientists in the science field consist of an integral part of the innovation system and Spanish science. In addition, in the economy field, companies in the productive sectors, either individually or organized into associations and clusters, comprise the main part of the activity (Laineza, et al. 2017).

The strategy especially is based on the economic importance and competency of the forestry and agri-food sectors, promoting more sustainable production and leading to bioeconomy development. In this regard, new technologies and innovation can contribute to the improvement and efficiency of organizational, logistics, and production processes. For instance, precision farming tools, sustainable intensification practices, and "omics" technologies are the key to improve cropping systems. New processing, packing, conservation, and cold chain technologies expect to reduce waste throughout the supply chain, improving the nutritional quality of new functional and traditional products at the same time. In the forestry sector, the strategy focuses on the implementation of sustainable resource management systems. The sector's productivity should be increased via knowledge in the field of genetics and genomics. As a matter of fact, the strategy encourages the development of high-tech materials (such as wood composites) to raise material efficiency and added value (BÖR 2018). Besides, another significant pillar in the strategy is the support of public-private sector cooperation in order to strengthen existing value chains and to create new ones.

The strategy document also intends to influence the primary sector towards bio-innovation in other industrial sectors positively. For instance, a set of new bioproducts and biomaterials, such as food additives, bioplastics, biolubricants, cosmetics, chemicals, and solvents, can be developed using residues and by-products from the food and agriculture industry as well as supporting biorefining projects. In addition, it is mentioned progress in the bioenergy field by using alternative

feedstocks, such as organic waste and residues, as well as developing new ways of synthesizing biofuels with the use of biochemical or thermochemical technologies.

Furthermore, the Spanish strategy aims to the development of the blue bioeconomy through marine biotechnology. A variety of pharmaceuticals, chemicals, and other bioproducts can be developed by using marine compounds, such as polymers, carbohydrates, and enzymes. Great potentiality is also allocated to biomass production from non-conventional sources, such as algae and microorganisms.

Taking into consideration that Spain is impacted by seasonal droughts and hot weather conditions, adequate water management and reuse across sectors, along with rural development, evaluated fundamental.

The Extremadura 2030 policy strategy intends to support further regional specialization in the forestry and wood processing, agri-food, green tourism, health sectors, and clean energy. It is required improved resource management through sustainable water management practices as well as reuse and recycling technologies. In order to promote green agriculture, agro-ecological practices are further considered important. In addition, the strategy expects to encourage new business models for the "4th industrial revolution" based on circular approaches and integrating physics, digital and biological technologies (BÖR 2018).

2.5.3.6 An action plan - quantitative targets

In 2016, the Spanish government published both a national bioeconomy strategy and its first Action Plan.

This provides a budget estimate for innovation and research funding from regional and general state administration funds as well as European Union funds (H2020). The available funds were ranged to EUR 230 million/USD 290 million in 2016. The total bioeconomy budget expectation is EUR 1.1 billion/USD 1.4 billion up to 2020 (BÖR 2018).

2.5.3.7 Measures - actions for promoting the strategy

Spain follows a comprehensive approach to growing regional and national bioeconomy. Initially, the Spanish strategy supports innovation through public and private research and industrial investment. Several public R&I programs are funded under Horizon2020 and RIS 3 and provide

EUR 570 million/USD 704 million. Furthermore, it defines other regional operating programs in the framework of Rural Development Programs (PDR) and new multidisciplinary alliances funded under the State Scientific and Technical Research and Innovation Plan as well as Horizon2020, providing around EUR 696 million/USD 860 million. Successful international public-private collaboration models will be analyzed to generate a database of best practices for public research projects of bioeconomy.

In addition, the government promotes clusters and open innovation platforms, building up a contemporary bioeconomy infrastructure, and enhancing networking activities among stakeholders. In this case, it is important a co-funding with the private sector.

Regarding measures that support infrastructure and capacity building, the strategy document emphasizes new training and education programs replying to the private sector's needs.. It is also highlighted the necessity for train-the-trainer programs to obtain the professional management of research projects at universities. The strategy enhances the development of self-learning tools, such as open access platforms, fostering public awareness, and further education.

Another strategic measure is the integration of commercialization support for biobased products in the activities of the trade promotion agencies as well as in existing policies and measures of the ministries. The strategy also demonstrates a lot of success stories regarding biobased innovations and their positive effects to encourage awareness in the business community.

Moreover, another group of measures is referred to as the promotion of bioeconomy development on the demand-side. This purpose is served through the organization of an annual bioeconomy conference. It is underlined the need to design a communication strategy and create stakeholder dialogue platforms to raise awareness of the bioeconomy (BÖR 2018). The strategy also pays special attention to identifying obtainable products, public procurement policy, and labelling systems to increase demand for biobased products (Laineza, et al. 2017).

Besides, policy strategy identifies the requirement for improving the regulatory framework conditions removing barriers, and providing incentives for bioeconomy development. For example, legal and administrative hurdles should be identified and overwhelmed to bring biobased products to the market.

In order to strengthen the political, administrative, and social context of the bioeconomy, a Spanish Bioeconomy Observatory has also been created as a strategic government tool. This

includes a Bioeconomy Strategy Monitoring Group, with representatives from autonomous communities and ministries. A Strategy Management Committee, with representatives from a Technical Scientific Support Group, the Technological Networks Group, as well as the Strategy Monitoring Group, will monitor the implementation of support measures.

Finally, the government intends to further international collaboration among EU member states. The strategy highlights the importance of international monitoring activities (BÖR 2018).

2.6 Conclusions

As the dedicated bioeconomy strategy of the following Mediterranean basin's countries, France, Italy, and Spain, was analyzed in detail, several conclusions were revealed.

First of all, each country recognizes its strength points. Secondly, each country prioritizes its needs. Moreover, all of them focus on R & D, R & I as well as Industry development.

Table 2.1 Strength Points & Priority Areas of Mediterranean basin's countries

	France	Italy	Spain
Strength Points	• agricultural exporters & producers • biorefineries	• green chemistry • marine bioeconomy	Industry sectors
Priority Areas	• Innovation of Industry • sustainable resource management practices • increase of biomass resources' mobilization • utilization of residues & waste resources • conversion of produced biomass • biorefinery development	• transition to green or plant-based chemistry • agri-food, forestry, & agriculture sector • forest management • wood industry modernization • bioplastics and biofuels production • Sector's networks • Biomaterial's & bioproduct's production • biobased innovation clusters • marine bioeconomy • Mediterranean region	• use of biological resources (feed & food) • transition to a sustainable bioeconomy (innovations in biosciences & digitization) • Triangle: science – economy – society • forestry & agri-food sectors ("omics", processing, packing, conservation, & cold chain technologies) • forestry sector (implementation of sustainable resource management systems) • development of high-tech materials (wood composites) • public-private sector cooperation • bio-innovation (bioproducts & biomaterials) • blue bioeconomy - marine biotechnology • water management

This kind of approach should be taken into account for the development of the bioeconomy of Greece.

However, there is a disadvantage of bioeconomy development of Mediterranean basin's countries. Although, each country attempts to highlight and focus on innovation by many ways, it still required to develop the idea of innovation at regional level as each country is a part of a bigger region.

2.7 Summary

In this chapter, a set of principles and policy initiatives were initially presented for a country to succeed in good governance and promote a sustainable bioeconomy.

Thereafter, the European Bioeconomy Strategy by the European Commission was analyzed intending to provide a long-term balance of sustainable circular Bioeconomy across Europe.

Eventually, considering the decentralized and local dimensions of bioeconomy, the national strategies of three South's and the Mediterranean basin's countries, France, Italy, and Spain, were collocated, revealing their key goal, priorities, and measures for promoting their strategies.

CHAPTER 3

BIOECONOMY IN GREECE

3.1 Introduction

In this chapter, the main focus is given to Greece and Greece's bioeconomy perspective as a European country.

First of all, we cannot ignore the financial crisis that has erupted since 2009 and some of the consequences and problems that were revealed.

A dedicated national bioeconomy strategy constitutes an imperative need and has not developed yet. Nevertheless, in the last five years, governments have developed several bioeconomy related strategies. The following six documents are mentioned: a Holistic Growth Strategy, the first National Strategy for the Circular Economy, National Energy and Climate Plan, National Climate Change Adaptation Strategy (NCCAS), National Research and Innovation Strategy for Smart Specialization 2014-2020, the Rural Development Program (RDP). In particular, key goals, priority areas, and measures of these documents are analyzed.

Finally, some areas of focus - proposals are summarized and should be paid attention to in Greece.

3.2 Greece

A holistic growth strategy should constitute by their whole parts. Greece has never had such a strategy. As a result, its anarchic development model collapsed with the crisis, which began within 2009.

In the 1980s, as Greece entered the period of globalization, it faced deindustrialization, severe regional imbalances, and acute social inequalities as non-tariff and tariff barriers were steadily

reduced. At the same time, Greece lost its usual policy of the last solution – devaluation with entry into the euro.

Based on large infrastructural projects and cheap credit, a development model was hardly likely to reverse the above dynamic, let alone deal with the economy's long-standing productivity deficit. The balance of payments problem was undercover by capital inflows from shipping, tourism, private capital, remittances, and European structural funds. Both a large debt and rising fiscal deficits resulted from consecutive governments' attempts to blunt the consequences of a skewed development model combined with poor fiscal control and management. For all the above reasons, Greece entered the crisis with severe external and internal imbalances.

Moreover, another part of the problem was Greece lacked a thinking capacity at the local, regional, and national level to respond to such challenges. Under these circumstances, there was a never coordinated attempt to reveal a growth strategy to build on Greece's highly educated human resources to mobilize both the public and private sector as well as to ensure that the high growth could be spread to all regions and social classes. In addition, the existence of a bureaucratic public sector with little capacity, a clientelistic political system, and a private sector focused on exploiting its contracts with the state than on seeking new products and markets, reorganizing production, or investing in R&D cause further effects. Simultaneously, widespread tax evasion and corruption permitted several opportunities for making profits without such initiatives (The Hellenic Republic 2018).

As far as the social pillar, the Greek people suffered a painful and deep social crisis. They addressed a steep fall in their income and living standards, high unemployment for prolonged periods of time sometimes. At the same time, a great number had to emigrate, encumbering to the country's demographic problem. Thus, poverty markedly increased, most notably among young people. During the decade of recession, income, social and regional inequalities, were widened swelling the range of assistance needs. Furthermore, poor wages and a lack of rights imply an implicit subsidy to non-innovative and poor employers and is not compatible with a productive model of growth strategy.

Consequently, it is crucial importance an integrated national strategy of bioeconomy to foster sustainable growth on strong social, economic, and environmental foundations set out in the Sustainable Development Goals (SDGs) and address all the above shortfalls.

The sacrifices of the Greek people, as well as the achievements of recent years, were tremendous. However, these difficulties have made us more determined and resilient than ever to build a strong and modern Greece (The Hellenic Republic 2018).

3.2.1 Bioeconomy-related strategy developed since 2015

Greece has not announced a specific National strategy on the bioeconomy yet. However, the government gives a high priority to resource efficiency and energy-efficient and low carbon investments (BÖR 2018). Nevertheless, there are several national bioeconomy-related strategy documents.

In 2018, the Greek Government prepared a Holistic Growth Strategy and presented it to the Eurogroup on April 27. This strategy has incorporated the results of an open and broad round of consultations held on many levels, mostly through the process of Regional Development Conferences.

In the same year, the Ministry of Environment and Energy (YPEN) launched for public consultation, the first National Strategy for the Circular Economy (Papadopoulou, et al. 2018). Furthermore, National Energy and Climate Plan was officially announced by the Ministry of Environment and Energy and presented in a specially convened Colloquium in the Bank of Greece in 2019. The document remained open for public consultation and presented ambitious goals concerning RES, decarbonization, and energy security.

Moreover, a National Climate Change Adaptation Strategy (NCCAS) had already announced in 2016.

Another relevant policy document includes National Research and Innovation Strategy for Smart Specialization 2014-2020, where part 5.4 refers to Energy as well as part 5.5 on Environment and Sustainable Development (European Commission 2018). In addition, the Rural Development Program (RDP) for Greece was adopted by the European Commission on 11 December 2015 and final modified on 16 December 2019, highlighting Greece's priorities for the period 2014-2020 (European Commission 2020).

3.2.2 The term “bioeconomy” or “biobased economy”

Bioeconomy is considered a new production system, where renewable organic sources cover the needs for fuel, food, and feed.

Bioeconomy in Greece is supported under different thematic areas within RIS3 (Smart Specialization Strategies), for instance, in energy, environment, and waste management. Regional strategies focusing on bioeconomy are being implemented actively in the region of Western Macedonia, which is one of the biggest energy producing regions in the country. Efforts on bioeconomy development focus primarily on the development of bioenergy from agricultural and forest residues. Specific actions include adopting new technology to exploit biomass resources in the co-firing mode in existing large-scale power stations, notably lignite-fired, and the enhanced deployment of interconnected medium and small-scale renewable energy generation facilities, including biogas (European Commission 2018).

3.2.3 The key goals of the strategies - plan

Regarding the Holistic Growth Strategy, its main vision is to support and develop sustainable growth, creating strong environmental and social foundations. It presents the external and domestic commitments. Their implementation can lead Greece to achieve a successful exit overcoming the era of adjustment (The Hellenic Republic 2018). Basically, it adopts a holistic way of planning and embraces the three dimensions -economic, social, and environmental- set out in the Sustainable Development Goals (SDGs). The Strategy intends to move towards a new, sustainable, fair, and inclusive productive model enhancing regional and social cohesion. The timely and effective implementation of the Strategy’s reforms and policies will strengthen Greece’s long-term growth potential, boost investments, support innovative and export-oriented entrepreneurship, create more and better jobs and contribute to the improvement of the welfare state, which is apprehended both as a factor and an indicator of development (the Ministry of Development and Investments 2018).

Moreover, the first National Strategy for the Circular Economy refers to the economy of the real product by feeding the primary and secondary sectors of the economy. In addition, it produces high value by utilizing and respecting natural and environmental resources. The document relies on the economy of knowledge and specialization. It also reduces dependence on imports, improves the trade balance, and creates jobs. Finally, it adapts to all economic sizes, improves resource and

energy productivity ratios, and is fully compatible with small and medium-sized enterprises and the social economy (The Hellenic Republic, Ministry of Environment and Energy (YPEN) 2018).

At the same time, the main goals of the National Energy and Climate Plan include a sustainable development model in all economic sectors, progress of the energy sector in accordance with environmental protection, the formation of energy policy by weighting the cost-benefit ratio with the energy transition, waste management, and circular economy, creating a Greek energy hub that will contribute to EU's energy security, the development of infrastructure and inclusion of Non Interconnected Islands (NIIs) in the national electricity grid, creation of an appealing investment environment which will support and promote energy transition, maximum utilization of state resources, extroversion and creation of jobs (IENE: Institute of Energy of South East Europe 2019).

The main objective of the Greek Adaptation Strategy to Climate Change (NASCC) is the crucial contribution of Greece's resilience against climate change impact. For this reason, it is required to create a proper financial and institutional frame by supporting private and public action for adjustment to the impact of climate change (Ministry of Environment and Energy 2016).

The vision leading the National Research & Innovation Strategy for Smart Specialization (RIS3) regards the whole country by prioritizing people and society via respect for cultural heritage and creativity, low environmental footprint, and a high level of quality of life (GSRT: General Secretariat for Research and Technology 2015).

With regards to the Rural Development Program, it aims to rural growth, which is the second pillar of the common agricultural policy (European Commission 2020).

3.2.4 The priority areas of the strategies

The holistic growth strategy focuses on Greece's deindustrialization as well as restores productivity growth and competitiveness, supported by recent reforms.

This strategy is especially based on high value-added and innovative tradable sectors developing a strong culture of environmentally and socially responsible entrepreneurship. Simultaneously, the Greek skilled workforce is reinforced to increase the potentiality of sectors of the county's economy: circular economy, pharmaceutical sector, health and environment, agri-food, manufacturing, shipping, transport and logistics, energy, tourism, and culture. By fostering the development of clusters, Greece can take advantage of its comparative advantage and advocate its

firms grow to allow the economy to expand the domestic market and securing larger shares in international markets, attracting significant foreign investment at the same time. It also intends to mobilize the economy's cooperative and social sectors of the economy by supporting sustainable production and consumption patterns. Basically, not only Greek manufacturing but also agriculture consists of a substantial number of smaller units that can benefit from cooperative firms in distribution, production, and marketing.

Another element of the strategy is the increase in the size of Greece's SMEs as well as the plan for a digital era. The economy can grow by upgrading transports, digital, and energy infrastructure while taking advantage of Greece's strategic geographic position and large European funding. Greece also provides an impressive high-skilled but underutilized human resource. This fact can attract investments that will pave the way for a sustainable growth path, as knowledge consists of one of the growth drivers.

Finally, it is mentioned the legal framework focusing on reform of the judicial system, the public administration, as well as the business environment (The Hellenic Republic 2018).

On the other hand, the priorities of the first National Strategy for the Circular Economy underlines the following three pillars: sustainable resource management, strengthening circular entrepreneurship as well as circular consumption.

In particular, the document highlights several long-term priorities of Greece by 2030.

Regarding the production of products, the main goal concerns integrating ecodesign criteria and product life cycle analysis, avoiding the introduction of hazardous substances in their production, and facilitating repairability and extending the service life. The use of non-hazardous substances also improves the quality of waste during the production process, reducing the impact on the environment. Moreover, reuse and recycling can be encouraged as well as the prevention of generation can be promoted by effective implementation of the waste management hierarchy. Eventually, it mentions the development and promotion of guidelines in order to improve energy efficiency in production processes.

Besides, the strategy document points out the promotion of an innovative way of consumption, such as using services instead of buying products or using computers and digital platforms. It also emphasizes the promotion of a rational consumption model, supporting by the transparency of information on the characteristics of services and goods, their lifespan, and their energy efficiency.

In order to create synergies compatible with the transition to the circular model, it is required the facilitation and creation of appropriate channels for the exchange of information and coordination among administrations, the scientific community, and the economic and social sectors. Furthermore, by advocating the transition from a linear to a circular economy, transparency in processes, developing citizen information, training, and raising public awareness are promoted. Finally, transparent and feasible indicators for monitoring the transition's implementation are necessary (The Hellenic Republic, Ministry of Environment and Energy (YPEN) 2018).

The main targets set out in the National Energy and Climate Plan concern a reduction of greenhouse gas emissions and an increase of renewable energy sources in domestic energy consumption managing energy savings in final energy consumption and enhancing the security of energy supply. Another aim is the protection of consumers by reinforcing their role in the energy system. Lastly, it highlights the importance of a competitive domestic energy market as well as an increase of competitiveness of the Greek economy, increasing the domestic added value in the energy sector and creating new jobs (Ministry of Environment and Energy 2019).

As far as, key objectives of the Greek Adaptation Strategy to Climate Change (NASCC), it is underlined the necessity to set up decision-making procedure regarding adaptation issues of climate change as well as to coordinate adaptation and the promotion of a sustainable growth model by implementing local and regional action plans. In addition, it is required to promote adaptation policies in all sectors within the Greek economy, focusing on the most vulnerable ones and creating a monitoring and evaluation mechanism for them at the same time. Last but not least, public awareness and adaptation capacity consist of a prerequisite (Ministry of Environment and Energy 2016).

With regards to National Research and Innovation Strategy for Smart Specialization 2014-2020 (RIS3), eight priority fields are emphasized, which are the following: agri food, energy, materials and construction, information and communication technologies, Biosciences and health, transport and logistics, environment and sustainable development as well as tourism and culture (GSRT: General Secretariat for Research and Technology 2015).

Finally, the document entitled “Rural Development Program” indicates six priorities and focus areas. Firstly, it supports knowledge transfer and innovation in forestry, agriculture, and rural areas, as well as promotes agricultural products focusing on processing, marketing, and risk management

in the agriculture field. It also promotes resource efficiency and supports the shift towards climate resilient economy in the food, agriculture, and forestry sectors. Another target is the enhancement of competitiveness and farm viability in agriculture as well as the achievement of sustainable management of forests and the use of innovative farm technologies. Lastly, the main goal is a restorative and preserving ecosystem related to agriculture and forestry, as well as a poverty reduction and economic development in rural areas (European Commission 2020).

3.2.5 An action plan - quantitative targets

The European Regional Development Fund (ERDF) sponsors a total amount of EUR 935 million for National Operational Programmes (OPs), which concern 87% of funds and the rest are attributed to all 13 Regional Operational Programmes (ROPs) (GSRT: General Secretariat for Research and Technology 2015).

In particular, the Rural Development Programme (RDP) outlines Greece's priorities for the period 2014-2020, using the EUR 5.93 billion of public money, of whose EUR 4.7 billion come from the EU budget and EUR 1.23 billion of national co-funding (European Commission 2020). Consequently, the six biggest segmentation of funds is the following:

- EUR 1 409 million for Investments in physical assets
- EUR 1 345 million for Areas facing natural or other specific constraints
- EUR 768 million for Organic farming
- EUR 452 million for Farm and business development
- EUR 446 million to support for LEADER local development / CLLD
- EUR 440 million for Agri-environment and climate measures

3.2.6 Measures - actions for promoting the strategies

The implementation of the Holistic Growth Strategy and their policies intend to be evaluated by a High-Level political committee, under the charge of the Prime Minister. Moreover, the General Secretariat is responsible for coordination at the technical level via continuous communication with relevant Ministries about the progress on the timelines and action plan and suggesting actions to

be taken. These Ministries should report progress to the high-level political committee on a bimonthly basis.

A Development Council of experts supports the High-Level Political Committee as well as a public research institute elaborates relevant policy decisions (The Hellenic Republic 2018).

Regarding the first National Strategy for the Circular Economy, the main measures are related to monitoring and coordinating action plan and planning. Especially, a great task is the mapping of stakeholders and mapping their positions through consultation procedures and elaborating proposals for the integration of actions of the Circular Economy in the existing institutional framework, legislation, and provisions. Besides, it is required formulation of proposals for incentives for financing investment projects and encouragement of industrial coexistence as well as monitoring of measurable indicators of integration of the Circular Economy in investment plans and the real economy. The document also formulates proposals for strengthening the market of secondary materials and facilitates industrial coexistence as well as conditions and measures to produce secondary fuels and alternative raw materials. Furthermore, it promotes Green Procurement. It intends country participation in international forums and representations as well as the formulation of special operational programs for the priority areas, the critical raw materials, as well as a special strategy for the Greek islands. Finally, the establishment of a product quality supervision body and control of the application of the relevant standards of their production and construction is another aim, as well as strengthen the supervision of the correct implementation of the recycling and waste management procedures based on the existing and planned institutional provisions, especially in industrial areas (The Hellenic Republic, Ministry of Environment and Energy (YPEN) 2018).

In the context of the National Energy and Climate Plan, measures for the horizontal support policies include the following three parameters. Firstly, the establishment of a control mechanism and monitoring to increase synergies among research, energy, and competitiveness policies. Besides, it takes measures about regulatory for a more efficient and useful implementation of pilot projects or research by all market players, aiming to benefit final consumers. It also takes measures to promote partnerships among stakeholders by advocating advisory and networking actions with a goal to maximize the synergies and transfer of know-how (IENE: Institute of Energy of South East Europe 2019).

3.3 Developments in Greek bioeconomy policy – Greek Proposals

Primarily, the great challenge is to develop and promote the bioeconomy in Greece where no dedicated or specific Bioeconomy Strategy exists at neither national nor regional level. Secondly, Greece has to rescue from a major economic crisis, which has cost about a lot of its national output.

The Greek Strategy should identify and include specific areas of focus.

1. Areas of traditional strength such as tourism, shipping, and energy.

It is generally accepted that sea-based tourism contributes to the Greek economy's significant part driven by foreign visitors. One of the main priorities should be not only summer tourism of islands and Athens but also agro- and ecotourism. Basically, ecotourism includes travels to natural areas that conserves the environment, sustains the local people's well-being, and involves interpretation and education. Thus, it is necessary to design new emerging business models for connecting tourism to the ecosystem to be recreated activities and urbanization strengthening interactions with remote coastal and rural regions. Besides, tourism should be combined with the Silver Economy, which is consisted of 50 plus generation and is a major economic growth factor. Moreover, considering the fact that we have a lot of physicians, a favorable environment, and low cost services, medical tourism through surgeries or medical examinations as well as therapeutic tourism should promote wellness, health, beauty, and well-being and be a value added for the country.
Finally, religious tourism should be taken into account as islands are full of small churches which are unexploited. This kind of biotourism should be promoted as it does not have a negative impact on society and environment and at the same time there is the possibility of following the paths of our tradition.

The Greek bioeconomy should be about a green transition. It must include the replacement of fossil-based and unsustainable resources through the use of waste, solar and wind energy and upgrading of side streams, and creating circular and sustainable local solutions.

2. Areas of recent successes in terms of on-going activities such as pharmaceutical companies, engineering and, energy.

The entire health system can be strengthened Pharmaceutical companies play a significant role in the private sector. Apart from Greek pharmaceutical companies, there are several international ones contributed a lot by investing in Greece. At this point, the essential challenge is the proper management of such funds. For instance, clinical trials conducted in Greece provide a lot of money to hospitals that can make them sustainable.

As far as Greece, it is a country of origin of democracy and medicine. Greek traditional medicine should be promoted and our tradition on health field can be transmitted to a platform, in which Greek people can develop the traditional knowledge and this can be redeemable.

3. Areas of major national interest such as archaeology, culture, energy, biomedicine, and food production. These areas of high added value are able to deliver major economic profits and employment prospects.

For example, the Greek climate is ideal for growing herbs, which are found in abundance, flourishing on mountainsides, where they grow naturally. The herbs found in Greece today are the same herbs gathered thousands of years ago in Ancient Greece, and their uses have remained unchanged, not only to flavor delicious Greek cuisine but also for medicinal purposes. Greek pharmaceutical companies should focus on the production and export of Greek herbs.

Moreover, we can provide a lot of varieties of aromatic plants such as sage and oregano because of Mediterranean climate. These kind of plans and herbs can be considered as delicatessen. In addition, we have small quantities of food of high nutritional value, especially in our local flora. For instance, functional food such as Cichorium spinosum, mastiha, caper, a variety of mushrooms can be considered as delicatessen. In combination with the new cultivation model, the urban farming, which is more efficient than other Mediterranean countries, due to the factors of sun, good temperature and low costs of farming, these kind of delicatessen products can be export as well.

Beekeeping should be considered while it is disappearing as a profession. Although it does not have much support, beekeeping products like pollen and propolis apart from honey are of high added value as well as functional due to Greek flora.

Besides, Greece has a history of great potential regarding wine. This is based on a simple but unpredictable recipe of Greek wines, which bring the signature of the most prominent personality from a vineyard or a place, and also have a dynamic advantage of the aromatic purity of the fruit

and the mineral fineness of the vine, and a high gastronomic value. The new taste sensitivity of wine seeks this peculiarity as an inexhaustible source of inspiration and a journey to the world's tastes. History and nature have given our country invaluable treasures such as self rooted vineyards and hundreds of grape varieties.

Consequently, Greece can become known throughout the world, enhancing enotourism.

3.4 Summary

This chapter deals with Greece's bioeconomy strategy through several related documents since 2015 as there is no dedicated one yet. Moreover, it is mentioned in the Greek financial crisis and its impact on Greek society. Eventually, some proposals are identified which can support bioeconomy and strengthen Greece generally.

CHAPTER 4

BIBLIOGRAPHY

Bevan, Michael W, and Maurice C R Franssen. 2006. "Investing in green and white biotech." *Nature Biotechnology.* doi: 10.1038/nbt0706-765.

Davies, Sara, Laura Griestop, Heidi Vironen, John Bachtler, Viktoriya Dozhdeva, and Rona Michie. 2016. "Promoting stakeholder engagement and public awareness for a participative governance of the European bioeconomy: Case studies of national bioeconomy strategies in Finland and Germany." *BioSTEP.* http://www.bio-step.eu/fileadmin/BioSTEP/Bio_documents/BioSTEP_D3.1_Case_studies_of_national_strategies.pdf [07.11.17].

Laineza, Manuel, José Manuel Gonzálezb, Alfredo Aguilarc, and Carmen Velad. 2017. *Spanish strategy on bioeconomy: Towards a knowledge based sustainable innovation.* Elsevier B.V., New Biotechnology 40 (2018) 87–95. Accessed May 21 , 2017. http://dx.doi.org/10.1016/j.nbt.2017.05.006.

Matyushenko, Igor, Iryna Sviatukha, and Larysa Grigorova-Berenda. 2016. "Modern Approaches to Classification of Biotechnology as a Part of NBIC-Technologies for Bioeconomy." *British Journal of Economics, Management & Trade.*

Antikainen, Riina, Carl Dalhammar, Mikael Hildén, Jáchym Judl, Tiina Jääskeläinen, Petrus Kautto, Sirkka Koskela, et al. 2017. *Renewal of forest based manufacturing towards a sustainable circular bioeconomy.* Finland: Finnish Environment Institute. http://hdl.handle.net/10138/186080.

BBI JU. 2018. *Bio-based Industries Joint Undertaking.* https://www.bbi-europe.eu/about/about-bbi [19.02.18].

Belyazid, Salim , and Therese Bennich. 2017. "The Route to Sustainability—Prospects and Challenges of the Bio-Based Economy." (Sustainability).

Bioeconomy Congress EBCL. 2016. "Lodz Declaration of Bioregions." http://www.sureaqua.no/Sureaqua/library/Lodz%20Declaration%20of%20Bioregions,%202016.pdf [07.11.17].

Bioeconomy Summit. 2015. *making bioeconomy work for sustainable development.* Berlin: Communique´ of the global Bioeconomy Summit.

Birner, R., F. Isermeyer, Ch. Lang, W. Treffenfeldt, and H. Zinke. 2014. *Die Wettbewerbsfähigkeit der Bioökonomie in Deutschland nachhaltig stärken.* Berlin: German Bioeconomy Council.

Bonaccorso, M. 2017b. "In Italy starts the first edition of the first Master in Bioeconomy in the Circular economy." https://ilbioeconomista.com/2017/01/24/in-italy-starts-the-first-edition-of-the-first-master-in-bioeconomy-in-the-circular-economy/ [24.01.17].

Bonaccorso, M. 2017a. "Industrial Renaissance. Renewable Matter." http://www.renewablematter.eu/art/291/Industrial_Renaissance [20.02.17].

Bonaretti, P. et al. 2017. "Bioeconomy in Italy: A unique opportunity to reconnect economy, society and environment."

http://www.agenziacoesione.gov.it/opencms/export/sites/dps/it/documentazione/S3/Bioeconomy/BIT_v4_ENG_LUGLIO_2017.pdf[27.11.17].

BÖR. 2010. *bio-economy innovation.* Bio-economy council report 2010, Berlin: German Bioeconomy Council, p.1 5.

BÖR. 2017. *Bioeconomy policies and strategies established by 2017.* Berlin: The German Bioeconomy Council.

BÖR. 2018. *Bioeconomy Policy (Part III): Update Report of National Strategies around the World.* German Bioeconomy Council.

Bracco, Stefania, Ozgul Calicioglu, Marta Gomez San Juan, and Alessandro Flammini. 2018. "Assessing the Contribution of Bioeconomy to the Total Economy: A Review of National Frameworks." *sustainability.*

Carus , Michael , and Lara Dammer. 2018. *The "Circular Bioeconomy" –Concepts, Opportunities and Limitations.* nova-Institut. www.bio-based.eu/nova-papers.

CEBB. 2017. "Qui sommes nous." http://cebb-innovation.eu.

CESE. 2017. *Vers une bioéconomie durable.* Economic, Social and Environmental Council. http://www.lecese.fr/travaux-publies/vers-une-bioeconomie-durable [22.02.18].

Conference of the Italian Autonomous Regions. 2016. "Documento delle regioni e delle province autonome di posizionamento sulla bioeconomia in attuazione della strategia nazionale di specializzazione intelligente (SNSI)." at http://www.regioni.it/download/conferenze/485361/[27.11.17].

Devaney, L., M. Henchion, and Á. Regan. 2017. "Governance in the Bioeconomy." *EuroChoices* p. 41–46.

Diaz-Chavez, Rocio. 2015. *The Biomass Assessment Handbook: Energy for a sustainable environment.* 2nd Edition. Edited by Peter de Groot, Sarah L. Hemstock, Jeremy Woods Frank Rosillo-Calle. London: Earthscan, Routledge. https://doi.org/10.4324/9781315723273.

European Bioeconomy Stakeholder Panel. 2017. *European Bioeconomy Stakeholders MANIFESTO.* European Bioeconomy Stakeholder Panel. http://ec.europa.eu/research/bioeconomy/pdf/european_bioeconomy_stakeholders_manifesto.pdf[13.12.17].

European Commission. 2017. http://s3platform.jrc.ec.europa.eu [06.11.17].

European Commission. 2012. "Commission adopts its Strategy for a sustainable bioeconomy to ensure smart green growth in Europe." Brussels. https://ec.europa.eu/commission/presscorner/detail/en/MEMO_12_97.

—. 2018. *European Commission: Boeconomy.* https://ec.europa.eu/knowledge4policy/bioeconomy/topic/policy_en#bioeconomy.

European Commission. 2020. *Factsheet on 2014-2020 Rural Development Programme for Greece.* European Commission.

European Commission. 2016. "Mapping of EU Member States'/regions'. Research and Innovation Plans & Strategies for Smart Specialisation (RIS3) on Bioeconomy."

European Commission. 2016. *Policy: The Bioeconomy Stakeholder Panel.* European Commission. http://ec.europa.eu/research/bioeconomy/index.cfm?pg=policy&lib=panel [09.11.17].

European Commission. 2017. "Review of the 2012 European Bioeconomy Strategy." https://ec.europa.eu/research/bioeconomy/pdf/review_of_2012_eu_bes.pdf [13.12.17].

European Commission. 2018. "Roadmap: Update of the 2012 Bioeconomy Strategy." https://ec.europa.eu/info/law/better-regulation/initiatives/ares-2018-975361_en [02.03.18].

27 2017. "Exchange rate of November (1 USD = 0,83760 EUR)."

Frazzetto, G. 2003. "White biotechnology." *EMBO Reports.* doi:10.1038/sj.embor.embor928.

French National Research Agency. 2018. "Investments for the Future." http://www.agence-nationale-recherche.fr/en/about-anr/investments-for-the-future/ [22.02.18].

Fund, Christin, Christian Patermann, and Beate El-Chichakli. 2018. *Bioeconomy Policy (Part III) Update Report of National Strategies around the World.* Berlin: the Office of the Bioeconomy Council. https://biooekonomierat.de/fileadmin/Publikationen/berichte/GBS_2018_Bioeconomy-Strategies-around-the_World_Part-III.pdf.

German Bioeconomy Council. 2015. "Bioeconomy Policy (Part I) – Synopsis and Analysis of Strategies in the G7." http://biooekonomierat.de/fileadmin/Publikationen/berichte/BOER_Laenderstudie_1_.pdf[15.02.17].

Government of Andalucía. 2018. "The Andalucia Bioeconomy Strategy." http://www.juntadeandalucia.es/organismos/agriculturapescaydesarrollorural/areas/politica-agraria-comun/desarrollorural/paginas/the-andalusia-bioeconomy-strategy.html [16.02.18].

GSRT: General Secretariat for Research and Technology. 2015. "National Research and Innovation Strategy For Smart Specialization 2014-2020."

Hellenic Republic. 2018. "Greece: A Growth Strategy for the Future." http://www.mindev.gov.gr/greece-a-growth-strategy-for-the-future/.

Hellenic Republic, Ministry of Environment and Energy (YPEN). 2018. "Circular Economy."

Hetemäki, Lauri, Marc Hanewinkel, Bart Muys, Markku Ollikainen, Marc Palahí, and Antoni Trasobares. 2017. *Leading the way to a European circular bioeconomy strategy, From Science to Policy 5.* European Forest Institute's Forum. https://doi.org/10.36333/fs05.

IENE: Institute of Energy of South East Europe. 2019. *IENE.* https://www.iene.eu/new-national-energy-and-climate-plan-announced-by-greek-energy-ministry-p5413.html.

INRA. 2018. "INRA Metaprogrammes." http://metaprogrammes.inra.fr/en [22.02.18].

Jegannathan , KR, and PH. Nielsen . 2012. "Environmental assessment of enzyme use in industrial production– a literature review." *Elsevier.* https://doi.org/10.1016/j.jclepro.2012.11.005.

Joint Research Center. 2016. "JRC Science for Policy Report: Bioeconomy Report 2016." http://publications.jrc.ec.europa.eu/repository/bitstream/JRC103138/kjna28468enn.pdf [09.03.18].

Junta de Extremadura. 2017. "Marco Regional de Impulso a la Economía Verdey y Circular en Extremadura." http://extremadura2030.com/wpcontent/uploads/2017/03/marco_070617_v.f_sin-anexos.pdf [21.08.17].

Kirk, Ole, Torben Vedel Borchert, and Claus Crone Fug. 2002. "Industrial enzyme applications." *Current Opinon Biotechnology.* doi:10.1016/s0958-1669(02)00328-2.

Laínez , Manuel , and María Jesús Periago. 2019. *The Bioeconomy: An Opportunity for the Spanish Economy.* intechopen. doi:DOI: http://dx.doi.org/10.5772/intechopen.84917.

Lainez, M. 2016. "La estrategia espanola de bioeconomia. Paper presented at Curso de Bioeconomia: Gestión y Financiación de Proyectos de Bioeconomia." http://agripa.org/download-file/63823-105857[04.04.17].

Lamers, Patrick, Erin Searcy, Richard J. Hess, and Heinz Stichnothe. 2016. *DEVELOPING THE GLOBAL BIOECONOMY: TECHNICAL, MARKET, AND ENVIRONMENTAL LESSONS FROM BIOENERGY.* Elsevier.

Lewandowski, Iris. 2018. *Bioeconomy: Shaping the Transition to a Sustainable, Biobased Economy.* Springer International Publishing AG.

McCormick, K, and N. Kautto. 2013. "The bioeconomy in Europe: an overview." *Sustainability* 2589–608.

Ministry of Environment and Energy. 2016. "National Climate Change Adaptation Strategy (NCCAS)." https://ec.europa.eu/knowledge4policy/visualisation/bioeconomy-different-countries_en.

Ministry of Environment and Energy. 2019. "National Energy and Climate Plan."

NEA. 2014. *Setting up international biobased commodity trade chains. A guide and 5 in Ukraine.* Netherlands: Netherlands Enterprise Agency. Accessed August 04, 2014. https://english.rvo.nl/sites/default/files/2014/06/Setting%20up%20international%20biobased%20commodity%20trade%20chains%20-%20May%202014.pdf.

Netz, B., O. R. Davidson, P. R. Bosch, R. Dave, and L. A. Meyer. 2007. *Climate change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Summary for Policymakers.* Geneva, Switzerland: Intergovernmental Panel on Climate Change (IPCC) . http://www.ipcc.ch/.../ar4-wg3-spm.pdf .

OECD. 2008. *Sustainable Development Studies, OECD.* Paris, France: Organisation for Economic Co-operation and Development.

OECD. 2009. *The Bioeconomy to 2030: Designing a policy agenda.* Paris, France: Organisation for Economic Co-operation and Development. http://www.oecd.org/futures/long-termtechnologicalsocietalchallenges/thebioeconomyto2030designingapolicyagenda.

OECD. 2010. *Towards the Development of OECD: Best Practices for Assessing the Sustainability of Bio-Based Products.* Paris, France: Organisation for Economic Co-operation and Development.

Papadopoulou, Electra, Konstantinos Vaitsas, Ioannis Fallas, Giorgos Tsipas, Konstantinos Chrissafis, Dimitrios Bikiaris, Constantina Kottaridi, and Konstantinos E. Vorgias. 2018. *Bio-economy in Greece: Current trends and the road ahead.* The EuroBiotech Journal. doi:10.2478/ebtj-2018-0018.

Polívka, Ľudovít, and Eva Ürgeová. 2007. "BIOECONOMY AND WHITE BIOTECHNOLOGY AS A BASIC PILLAR OF THE LISBON STRATEGY." *Nova Biotechnologica VII-I, University of SS. Cyril and Methodius* 69-76.

Priefer, Carmen, Juliane Jörissen, and Oliver Frör. 2017. "Pathways to Shape the Bioeconomy." *Resources 6(10):1-23.* doi:10.3390/resources6010010.

Regina Birner. 2018. *Bioeconomy: Shaping the Transition to a Sustainable, Biobased Economy.* Edited by Iris Lewandowski. Gewerbestrasse 11, 6330 Cham, Switzerland: Springer International Publishing AG. https://doi.org/10.1007/978-3-319-68152-8.

Republic of France. 2017. "A Bioeconomy Strategy for France: Goals, issues and forward vision." http://agriculture.gouv.fr/telecharger/88386?token=d7ce1762548787efcf4c17968b81895e [01.02.18].

République Française. 2018. "A Stratégie Bioéconomie pour la France: Plan d'action 2018-2020." http://agriculture.gouv.fr/une-strategie-bioeconomie-bioeconomie-pour-la-france-plan-daction-2018-2020 [01.03.18].

Research Institute of Agricultural Economics. 2018. *BIOEAST Vision Paper.* http://bioeast.eu/article/bioeastvisionpaper23022018[01.03.18].

Scarlat, Nicolae , Jean Francois Dallemand, Fabio Monforti, and Viorel Nita. 2015. "The Role of Biomass and Bioenergy in a Future Bioeconomy: Policies and Facts." *Environmental Development.* doi:10.1016/j.envdev.2015.03.006.

Sillanpää, Mika, and Chaker Ncibi. 2017. *A Sustainable Bioeconomy: The Green Industrial Revolution.* Gewerbestrasse 11, 6330 Cham, Switzerland: Springer International Publishing AG.

Socaciu, Carmen. 2014. "Bioeconomy and green economy: European strategies, action plans and impact on life quality." *Bulletin UASVM Food Science and Technology.*

Spanish Ministry of Economy, Industry and Competitiveness. 2015. "The Spanish Bioeconomy Strategy: Horizon 2030." http://bioeconomia.agripa.org/download-doc/102159 [04.04.17].

Székács, András. 2017. "Environmental and Ecological Aspects in the Overall Assessment of Bioeconomy." *Springer.* Accessed January 27, 2017. https://link.springer.com/article/10.1007/s10806-017-9651-1#Sec2.

the Ministry of Develpment and Investments. 2018. *mindev.gov.gr.* http://www.mindev.gov.gr/greece-a-growth-strategy-for-the-future/.

University of Hohenheim. 2013. *Concept for the Development of an M.Sc. Program "Bioeconomy".* University of Hohenheim.

Von Braun, J. 2017. "Governance of the Bioeconomy." *The European Workshop on Bioeconomy, Paris, France.*

WCED. 1987. *Our Common Future.* Oxford University, Oxford, UK: World Commission on Environment and Development (WCED).

Zsarnoczky , Martin. 2016. "INNOVATION CHALLENGES OF THE SILVER ECONOMY." *Vadyba Journal of Management.* https://www.researchgate.net/profile/Martin_Zsarnoczky/publication/312369239_INNOVATION_CHALLENGES_OF_THE_SILVER_ECONOMY/links/587b9ad308ae4445c06423a6/INNOVATION-CHALLENGES-OF-THE-SILVER-ECONOMY.pdf?origin=publication_detail.