

Department of Political Science

Chair: Analysis and Evaluation of Public Policies

# THINK GLOBALLY, ACT LOCALLY: OPPORTUNITIES AND POLICY CHALLENGES OF THE BIOECONOMY

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# List of abbreviations

Bioeconomy
Common Agricultural Policy
Carbon dioxide
Circular Economy
Deutsches Biomasseforschungszentrum
Directorate General
European Commission
European Agricultural Fund for Rural Development
European Network for Rural Development
European Structural and Investment Funds
European Union
Food and Agriculture Organization
German Bioeconomy Council
Global Bioeconomy Summit
Green Economy
Green Growth
Greenhouse gases
International Advisory Committee on Bioeconomy
International Bioeconomy Forum
International Energy Agency
Information Technology
Indirect Land Use Change
Intergovernmental Panel on Climate Change

JBA	Japan Bioindustry Association
JRC	Joint Research Center (of the EU)
KBBE	Knowledge-Based Bio-Economy
LAC	Latin America and the Caribbean
MS	Member State
OECD	Organization for Economic Cooperation and Development
REBICAMCLI	Ibero-American Network of Bioeconomy and Climate Change
RD	Rural Development
RDPs	Rural Development Programmes
R&D	Research and Development
SD	Sustainable Development
SDGs	Sustainable Development Goals
SMEs	Small and Medium-sized Enterprises
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Convention on Climate Change
U.S.	United States
USD	United States Dollars

# Introduction

Considered as "the (green) industrial revolution of the Third Millennium"<sup>1</sup>, "an opportunity to redesign the global system of production and consumption in a manner guaranteeing a secure sustainable base in every respect"<sup>2</sup>, the development of a sustainable circular bioeconomy seems to be the response to the main global challenges of the 21<sup>st</sup> century. The idea is to put natural biological resources at the centre of a new, innovative, knowledge-based approach to the conservation, production, consumption and recycling across all economic sectors.

Strong scientific evidence and international political agreement underline the need to go beyond a linear development model based on the massive use of finite and polluting resources and aimed just at increasing economic growth. The predictions on the collapse of the global system of nature by 2100 caused by the exponential population growth, pollution, and unsustainable resources exploitation, presented in the Report of the Club of Rome The Limits to Growth<sup>3</sup> already in 1972, seem to have been confirmed so far<sup>4</sup>. The human population is continuing to rise, and the better livelihoods achieved in the emerging economies, especially China and India, will lead to a dramatically growth of the middle class. This will have a huge impact on the Planet in terms of consumptions, and, consequently, in terms of emissions, worsening the climate change phenomenon. In these regards, the last Special Report<sup>5</sup> of the Intergovernmental Panel on Climate Change (IPCC) published in 2018 stresses the need of limiting the increase of the global temperature to 1.5°C with respect to the pre-industrial levels, in order to avoid harmful effects on the ecosystem and on human activities, while ensuring a more equitable and sustainable society. Going back to the consumptions, it is important to note that the finiteness of fossil resources cannot ensure resource efficiency and energy security for everybody.

<sup>&</sup>lt;sup>1</sup> Il Bioeconomista, <u>https://ilbioeconomista.com/manifesto-english-version/</u>.

<sup>&</sup>lt;sup>2</sup> Rural 21- The International Journal for Rural Development, *Bioeconomy*, visited in February 2019, https://www.rural21.com/english/a-closer-look-at/kategorie/article/bioeconomy-00001228/

<sup>&</sup>lt;sup>3</sup> Meadows, D. H., Meadows, D. L., Randers, J., Behrens, W. (1972), *The limit to growth*, Universe Books, New York.

<sup>&</sup>lt;sup>4</sup> Giovannini, E. (2018), L'Utopia Sostenibile, Laterza Editori, Bari-Roma, p. 6.

<sup>&</sup>lt;sup>5</sup> IPCC (2018), *Special Report: Global Warming of 1.5°C,* World Meteorological Organization, Geneva, Switzerland. <u>https://www.ipcc.ch/sr15/</u>.

The International Community recognised the need for a "sustainable development", a development which "meets the needs of the present without compromising the ability of future generations to meet their own needs"<sup>6</sup>, in 1987, with the Report *Our Common Future*, also known as the Brundtland Report. The concept, and its social, economic and environmental dimensions, gained then more interest in the following years, leading to the creation of a specific dedicated section in the international law. Several global conferences have taken place in the last decades; then, in 2015, the unsustainability of the current development model was finally admitted with the adoption of the Agenda 2030. Several months later, in the context of the United Nations Framework Conference for Climate Change (UNFCC), the Paris Agreement was signed by 175 countries, in order to redesign the mechanism underlaying the fight against the global warming.

Within this framework which promotes a new, sustainable, low-carbon development model, the sustainable use of biological feedstocks (also referred to as 'biomass') for production and energy reasons, on which the bioeconomy relies, is seen by many as meeting the social, environmental and economic objectives of the sustainable development. It would allow, indeed, to go beyond the traditional trade-off between economic and environmental goals, by creating new jobs and value added, respecting the ecosystems, while increasing societal wellbeing, in alignment with the Agenda 2030 and the Paris Agreement provisions.

However, implementing a sustainable, circular bioeconomy is appearing to be not so easy. First, the shift towards a bioeconomy is not automatically environmentally friendly; an unsustainable exploitation of biomass can have, in fact, several negative effects on the ecosystems. In the second place, countries around the world are setting quite different targets and objectives in their bioeconomy strategies, on the basis of their specific national characteristics and potential. Finally, the cross-cutting nature of bioeconomy, which involves several sectors (from agriculture to rural development, forestry, fisheries, food, trade, waste management, energy, pharma and industry) poses several challenges in terms of coherence between different relevant policies.

<sup>&</sup>lt;sup>6</sup> UN, *Our Common Future*, the World Commission on Environment and Development of the United Nations (WCED), 1987.

This work, organised in three chapter, aims therefore at understanding the principal policy challenges that the implementation of a sustainable, circular bioeconomy is currently facing. The dissertation is based on the study of the main literature regarding the bioeconomy and the analysis of the bioeconomy policy strategies adopted around the world. Relevant for the scope of the work is the identification of the main characteristics of the bioeconomy policy cycle, and the interaction between the bioeconomy policy and other relevant policies. In order to assess the latter, the relationship between the mutually linked policies addressing rural development and bioeconomy in the EU and in Italy is taken into account.

The first chapter will be then devoted to the analysis of the bioeconomy as a whole, its evolution and different definitions; the external factors pushing for its conceptualisation; its potentials and links with the Sustainable Development Goals (SDGs) and the concepts of Green Growth and Green Economy; and the serious environmental challenges which it could contribute to.

In particular, the chapter will show that the emerging of bioeconomy is gaining increasing attention in both research and policy debates in recent years. Some analysis sees the use of the term increasing considerably in research and policy papers over the last decades. In addition, the growing number of initiatives undertaken by societal stakeholders, as business and research networks and NGO, reflects the dynamic development of the bioeconomy. For instance, the Global Bioeconomy Summit (GBS) is important in this context, since it has been the first bioeconomy related event on a global scale. The Summit, organized by the German Bioeconomy Council in 2015 and 2018 in Berlin, brought together, on the occasion of the second meeting, representatives from more than 70 countries from Africa, Americas, Asia and Europe, as well as international policy experts and representatives from science and industry, for a total of 700 people. The GBS also set up the International Advisory Committee on Bioeconomy (IACB), an informal platform composed of leading bioeconomy experts. However, other significant initiatives have been launched around the world, such as: the International Bioeconomy Forum (launched by the European Commission and AgriFood Canada); the World Bioeconomy Forum and the Bioeconomy Investment Summit (focusing on the potentials of the Northern Europe's bioresources); the EU Bioeconomy Stakeholders Panel; the Biobased industries Joint Undertaking; the BioEAST (a Central and Eastern European initiative) and the Ibero-American Network of Bioeconomy and Climate Change, REBICAMBLI.

Most importantly, almost 50 countries have developed a bioeconomy dedicated or related strategy so far.

The idea of bioeconomy was firstly conceptualized by scientists, referring to the application of the technology on biological sciences, which could have the potential to transform industrial production processes. In parallel, the European Commission had a central role in the promotion of the "knowledge-based bio-economy", in alignment with the goals on innovation of the Lisbon Strategy of 2000. Germany and other European Northern countries proved to be very active in pushing the EU in this direction. In parallel, other countries and international organisation developed their own approaches to the concept, such as: the Canadian think thank Pollution Probe, through the document *Towards a biobased economy – issues and challenges* published in 2002; the OECD with *Biotechnology for sustainable growth and development* and *The Bioeconomy to 2030: Designing a Policy Agenda*, published in 2009. In the wake of the increasing attention to the topic, some countries as the USA, the Russian Federation, Malaysia and South Africa developed their own bioeconomy strategies.

In spite of the momentum that the topic of bioeconomy has gained recently, a globally agreed definition has not been found so far, and there is little international consensus on what the bioeconomy actually implies. In fact, it can be said that the definition outlined by the Global Bioeconomy Summit in 2015, about a "knowledge-based production and utilization of biological resources, innovative biological processes and principle to sustainably provides goods and services across all economic sectors" is shared by many. However, three different visions can be distinguished in the process of evolution of the bioeconomy concept: the bio-technology vision, based on the importance of technology and innovation; the bio-resource vision, which puts the need for a sustainable use of biomass at the centre of the debate; and the bio-ecological vision, which highlights the effects of the environment of that kind of shift.

It is, instead, generally agreed by many that the replacement of fossil resources with biomass for energy and production use can have a huge potential, from both a social, economic and environmental point of view. For instance, it can contribute to climate change mitigation by reducing greenhouse gases (GHGs) emissions; preserving the ecosystem, by a revaluation of abandoned land and efficiently using natural recourse; boost the economy; improving public health and the quality of life. In this perspective, the bioeconomy can meet the objectives presented in the Agenda 2030 for sustainable development. In particular, the bioeconomy seems to directly contribute to ten out of 17 Sustainable Development Goals identified by the Agenda, i.e. those dedicated to the achievement of: zero hunger (SDG 2); good health and well-being (SDG 3); clean water and sanitation (SDG 6); affordable and clean energy (SDG 7); decent work and economic growth (SDG 8); sustainable cities and communities (SDG 11); responsible consumption and production (SDG 12); climate action (SDG 13); life below water (SDG 14); and life on land (SDG 15). In addition, bioeconomy can be englobed in in the broader framework of Green Economy and Green Growth concepts, both subcategories of the sustainable development and both focusing on fostering economic growth while ensuring environmental protection and societal well-being.

Also, in 2015 the GBS highlighted the importance to align the principles of a sustainable bioeconomy with those of the circular economy, which already share the aim of adding value to biological waste and residues. The notion of circular economy is, indeed, referred to an economic system in which "the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised"<sup>7</sup>. Actually, the 'cascading-use' of biomass approach, is based on the multiple re-use of biomass in the value chain, when economically and technically feasible.

The last part of the first chapter is dedicated to the environmental challenges of the bioeconomy. As a matter of fact, given the potential of the latter in terms of direct contribution to the goals of Agenda 2030, the use of biological feedstocks for production and energy purposes, if not properly managed, can have harmful effects on the ecosystems. Actually, all bioeconomy aspirations and assumptions depend on the supplies of biomass. Indeed, the competition between the exploitation of biomass for food use or for industrial one firstly emerges. If we start using land to grow biomass, will there be enough land for food growing? Additionally, an increase in the price of the food can be expected. Secondly, the use of biological resources can have geographical and geopolitical implications, mainly in terms of biomass trade. The difference between

<sup>&</sup>lt;sup>7</sup> European Commission, Closing the loop – An EU action plan for the Circular Economy, Brussels, 2015

biomass-rich countries and biomass-poor countries could exacerbate phenomena such as land grabbing or could lead to biomass exporters countries to over-exploit their natural resources, in order to respond to the demand of the biomass importers. Finally, the harvesting of crops for bioeconomy purposes, can increase GHGs emissions in the atmosphere instead of limiting it, because of the indirect land-use change phenomenon (ILUC).

The state of the bioeconomy strategies around the world and the characteristics of the bioeconomy policy cycle will be, instead, discussed in the second chapter.

Many countries have shown their strong interest in building a structured policy aiming to regulate and promote the sustainable exploitation of renewable biological resources for production and energy use recently. Others have developed policies addressed to bioeconomy-relevant sectors, such as the bioenergy, green economy and green growth, forestry, blue economy, chemistry.

Apart from South Africa, which uses a holistic approach in developing its national bioeconomy strategy in 2013, no other national dedicated bioeconomy strategies have been developed in Africa so far. A specific focus on the area of biotechnology is, instead, mainly promoted by Kenya, Tanzania and Uganda. The first, adopted a national biotechnology policy in 2006 and a policy dedicated to its rich biodiversity in 2011. Tanzania, as well, adopted a national biotechnology policy in 2010. Uganda, in turn, promotes both the sectors of biotechnology and bioenergy with the "National Biotechnology and Biosafety" in 2008 and a "Biomass Energy Strategy" in 2014. The importance of bioenergy and biofuels is also addressed by Mali, Mozambique, Nigeria and Senegal. By contrast, Mauritius adopted strategies which focus on the blue economy, especially the ocean potential and its contribution to GDP, touching marine biotechnology, food processing, aquaculture, marine pharmaceuticals and cosmetics. Finally, Namibia also developed a strategy on research and innovation. What is more, several projects have been promoted by international partners in Africa; for instance, the German Government and the Swedish Development Agency launched some initiatives in the continent.

When coming to Americas, it can be said that bioeconomy-related topics have been increasingly discussed in both North and South America in the last few years. Nevertheless, as for Africa, only the US adopted a bioeconomy dedicated national strategy in the continent in 2012. However, several countries have adopted strategies in relevant bioeconomy fields. As one of the most active Southern American countries in bioeconomy development, Argentina presented the position paper *Bioeconomia Argentina* in 2017. Relevant is also the *Plan Provincial de Bioeconomia* adopted by the province of Buenos Aires. Brazil, Mexico, Uruguay and Paraguay, in turn, have focused more on biotechnology and bioenergy, while Colombia on biodiversity. Similarly, Northern American bioeconomies are also bioresources-driven, especially focusing on agriculture and forestry. Canada, for example, have a forest-based approach to bioeconomy.

In the Asia/Pacific region, bioeconomy development in countries such as China, India, Russia, South Korea, Malaysia, Japan, Thailand and Sri Lanka is generally oriented to high-tech emerging industries and industrial innovation. In contrast, Australia and New Zealand are more focused on the growth and value-creation in their primary industries, similarly to Canada. In particular, Japan has been one of the first countries in the world to adopt a national bioeconomy strategy. Likewise, Malaysia has been one of the pioneer countries in Asia to focus on bioeconomy as a whole. Finally, in 2017 Thailand has become the third country in the continent to have a dedicated "Bioeconomy Roadmap". All the others have shown to be very proactive mainly in addressing biotechnology. Indonesia also emerges as a country addressing two bioeconomy related areas: bioenergy and agro-industry.

Finally, the development of national bioeconomy policy strategies in the European Union has been strongly influenced by the work of the European Commission in the field of biotechnology since 1982. The idea of a knowledge-based bio-economy has then led to the adoption of the European Bioeconomy Strategy in 2012, updated in 2018 after the review of an expert group conducted in 2017. The 2018 Bioeconomy Strategy is built on three main action areas: strengthen and scale up the bio-based sectors, while unlocking investments and markets; deploy local bioeconomy. Germany had a leading role in the process of bioeconomy development in the EU. It established a Bioeconomy Council in 2009 and launched a bioeconomy dedicated strategy already in 2010. Germany was followed by the Nordic Countries, Finland, Norway and the Netherlands. Besides, since 2015, Spain, France Italy, Latvia and Ireland have adopted bioeconomy dedicated

strategies. Finally, Austria, Iceland, Estonia and UK have announced the preparation of a national strategies addressing bioeconomy.

The second part of the second chapter is devoted to the analysis of the bioeconomy policy cycle and of the issue of governance. Globally, all the bioeconomy dedicated policy strategies adopted around the world vary in scope and depth, differing in terms of objectives pursued and actors addressed. At the same time, common goals and general measures are shared by many countries, such as the need to foster technological innovation, economic growth, resource efficiency and ecological sustainability.

In particular, the pre-decision phase of the bioeconomy cycle is strongly influenced by country-specific characteristics and strengths. Globally, the setting of priorities reflects the industrial and economic profile of the individual country as well as its natural resource potential, i.e. the amount of biomass which can be sustainably exploited for production and energy use. Resources-rich countries usually promote innovation in the primary sector; by contrast, the countries which lack in big amounts of natural resources but have a strong industrial structure, such as Germany and Japan, mainly focus on their industrial and technological leadership. Furthermore, this phase is normally characterised by a participatory approach. Many countries involve industry, civil society representatives and the general public to bioeconomy policy formulation, trough public consultation processes. This process is often based on the preparation of workshops, conferences or online surveys.

In addition, if top-down approaches are primarily used during the implementation phase, in particular in Finland, Germany, Japan the Netherlands, Norway and the US, a lot of countries seek to exploit existing private sector and public research initiatives to implement their bioeconomy strategies. Several local-level approaches are also developing in some regions. Two good examples are the Malaysia Community-based Bioeconomy, the Japan Biomass Town and the bioeconomy plan adopted by the province of Buenos Aires.

As regards to the last phase pf the policy cycle, an increasing number of countries is launching monitoring and evaluation processes to assess the accountability of bioeconomy development. Several dedicated advisory councils, representing public, private and civil stakeholders, have been established to provide advisory services for bioeconomy development.

Finally, the issue of good governance of the bioeconomy is further discussed in the last section of the second chapter. The cross-cutting nature of the bioeconomy requires a strong coordination among policy makers and stakeholders at different scales, but also among different relevant policies. This is what the third chapter seek to focus on. In particular, the relation between rural development policy (as a part of the Common agricultural policy) and the bioeconomy strategy is discussed.

Indeed, bioeconomy seems to have a great potential on the process of revitalisation of rural areas. The latter suffer for ageing population, gender imbalances, lack of diversity in the job market, low incomes, inadequate supply of public services and, as a consequence, low quality of life. In addition, rural communities appear to be more vulnerable to external economic and environmental shocks. Nowadays, according to the OECD, rural regions are home to one-quarter of the population and account for 75% of land area, containing then the vast majority of the land, water and natural resources. It is exactly the richness of their biodiversity which makes of these zones a great contributor to the fight against the big global challenges of humankind, especially climate change mitigation and resource security, and to the development of the bioeconomy. At the same time, the sustainable production and use of biological feedstocks, stabilised in rural areas (where the biomass grows) can offer economic diversification to these areas (through the creation of new industries), more income and better livelihoods.

The policies which address rural development and bioeconomy development are, therefore, mutually linked; each of them can foster the implementation of the other. However, in order to ensure that, a high level of coordination between the two policies has to be granted.

The last part of the third chapter focus, therefore, on the level of integration between the second pillar of the Common Agricultural Policy (CAP) – responsible for the Rural Development policy in the EU – and the Bioeconomy Strategies, both at the European and the Italian level. I will be found that the European Commission tried to englobe CAP principles in the updated Bioeconomy Strategy of 2018, also in view of the forthcoming reform of the agricultural policy. Some instruments have also been used by the European Network for Rural Development (EFRD), such as the Rural Bioeconomy

Panel and the Thematic Group on *Mainstreaming the Bioeconomy*, in order to improve the integration of bioeconomy principles in the future rural development programmes.

At the Italian level, instead, the two policies still seem to be separated. Indeed, even though several regions mention the potential of bioenergy and agro-industrial byproducts for climate actions in their rural development programmes, no specific measure is devoted to the bioeconomy as a whole. At the same time, the Italian Bioeconomy Strategy should develop a better coordination with the CAP.

At the end of this work some conclusions about the main policy challenges to the bioeconomy development and implementation, identified throughout the analysis, will be presented. In particular, the need for the creation of a global governance framework for the bioeconomy, which could set indicators and targets to ensure the respect of the Agenda 2030 and the Paris Agreement, is highlighted. At the same time, a better integration between relevant policies, and in particular between the Bioeconomy strategies and Common Agricultural Policy, at the EU and Italian level is needed. Finally, recommendations will also be provided to improve the state of the art of the Bioeconomy policy at the Italian level.

# Chapter 1

# The Bioeconomy: a big societal transition

CONTENTS: 1.1 Overview; 1.2 Definitions and birth of the concept; 1.2.1 Early use of the term; 1.2.2 Different ways to see the bioeconomy; 1.2.3 A general conceptualization; 1.3 External factors pushing for a Bioeconomy policy; 1.3.1 Changing population; 1.3.2 Energy security; 1.3.3 Climate change; 1.4. Potentials; 1.5 Bioeconomy and Sustainable Development; 1.5.1 Green Growth and Green Economy; 1.6 The Circular (Bio)Economy; 1.7. Challenges; 1.8 Conclusions.

#### **1.1 Overview**

Seen by many as a big societal transition, the emerging of bioeconomy is gaining increasing attention in both research and policy debates over the last decades. This shift would allow to go beyond the current paradigm of economic growth based on the exploitation of fossil resources – that are, by definition, finite and polluting – in favour of a new economic system built on the sustainable use of biological feedstocks (also referred to as 'biomass'). In order to do that, investments in education, research and development, innovation and technology are required.

However, the international community has not agreed on a unified definition of bioeconomy yet, and different opinions on what it actually implies have been voiced recently. In particular, three visions can be distinguished in this context: the biotechnology vision, based on the importance of technology and innovation; the bioresource vision, which puts the need for a sustainable use of biomass for economic development at the centre of the debate; and the bio-ecological vision, which highlights the effects on the environment of that kind of shift. Additionally, one can identify as a general trend the change from a technology-centric perspective of bioeconomy development to an approach that focuses more on the sustainable use of natural resources.

Finally, on the occasion of its second meeting in 2018, the Global Bioeconomy Summit described the bioeconomy as a complex field that includes a variety of sectors, actors, interests – so that it demands a long-term and global policy perspective – which is based on the production, utilization and conservation of biological resources, aiming toward a sustainable economy.

The global challenges of our time, such as the growing population, energy and food security and the climate change, also push for the creation of a structured bioeconomy policy. Indeed, bioeconomy seems to have a big potential, from both an economic, social and environmental point of view. The replacement of fossil resources with biomass for energy and production use could, in fact, reduce greenhouse gases emissions while offering new job opportunities, boosting innovation, R&D, and ensuring societal well-being.

In these terms, the bioeconomy appears to be well-integrated in the broad context of the sustainable development and its economic, social and environmental dimensions. It seems, therefore, that a clear link can be recognized between the bioeconomy aims and the Sustainable Development Goals of the Agenda 2030, adopted in 2015 by the United Nations. At the same time, the idea of that kind of transition is also close to the concepts of green growth and green economy, which foster economic and social improvement while ensuring environmental protection.

Nevertheless, an improper use of biological resources can have negative effects on both the society and the environment. It can, indeed, increase social inequalities (see the consequences of biomass trade and the phenomenon of land grabbing) and encourage natural resources depletion (such as the intensification of water scarcity and soil degradation, deforestation, biodiversity loss) with a consequent increase of greenhouse gases emissions.

In order to avoid that, as pointed out by the Global Bioeconomy Summit in 2018, the establishment of an international mechanism for knowledge exchange and coordination on global bioeconomy seems to be critical<sup>8</sup>.

#### **1.2 Definitions and birth of the concept**

Globally, the concept of bioeconomy has gained further momentum in both research and policy debates in recent years. According to a bibliometric analysis conducted by Bugge and al.<sup>9</sup>, as the shown in the graph (see Figure 1), the use of the term

<sup>&</sup>lt;sup>8</sup> GBS, Communiqué of the Global Bioeconomy Summit, Berlin, 2018.

<sup>&</sup>lt;sup>9</sup> Bugge M.M, Hansen T., Klitkou A., *What is Bioeconomy? A Review of the Literature*, 2016, Sustainability, MDPI, p 1.

has grown considerably from 2005 to 2014; indeed, it appears that researchers in several different fields are increasingly interested by the topic.



Figure 1: Number of papers per year (n=453 papers).

Source: Bugge et al., 2016;

The dynamic development of the bioeconomy is also reflected in the growing number of initiatives undertaken by societal stakeholders, as business and research networks and NGOs<sup>10</sup>. For instance, the Global Bioeconomy Summit (GBS) has been the first important event on a global scale. The summit, organized by the German Bioeconomy Council<sup>11</sup> in 2015 and 2018 in Berlin, set up the International Advisory Committee on Bioeconomy (IACB) in occasion of the first meeting, and brought together representatives from more than 70 countries – from Asia, Africa, Europe, South and North America – as well as international policy experts from the United Nations, the Organization for Economic Co-operation and Development (OECD) and the European Commission and representatives from science and industry – for a total of 700 people in occasion of the second, to discuss the latest developments and challenges in the global bioeconomy<sup>12</sup>.

<sup>&</sup>lt;sup>10</sup> More than 50 countries have developed a Bioeconomy dedicated or related strategy. Source: Fund C., El-Chichakli B. and Patermann C., *Bioeconomy Policy (Part III): Update Report of National Strategies around the World*, the German Bioeconomy Council, Berlin, April 2018, p.7.

<sup>&</sup>lt;sup>11</sup> The German Bioeconomy Council is an independent, voluntary advisory body to the German Federal Government composed of 17 experts on BE. Further information is available at <u>http://biooekonomierat.de/home-en.html</u>.

<sup>&</sup>lt;sup>12</sup> Office of the Bioeconomy Council, *Global Bioeconomy Summit – Conference Report: Innovation in the Global Bioeconomy for Sustainable and Inclusive Transformation and Wellbeing*, the German Bioeconomy Council, Berlin, July 2018.

On the other hand, the International Bioeconomy Forum (IBF) launched in Brussels in 2017 by the European Commission and AgriFood<sup>13</sup> Canada, saw the participation of nine extra-European countries, seven as members (Canada, United States, Argentina, South Africa, India, China and New Zealand) and two as observers (Australia and South Korea)<sup>14</sup>. On a macro-regional scale, among others, initiatives such as BioEAST (the Central and Eastern European Initiative for knowledge-based agriculture, aquaculture and forestry in the bioeconomy); the World Bioeconomy Forum and the Bioeconomy Investment Summit (WBF and BIS, focusing on the potentials of Northern Europe's bioresources); the EU Bioeconomy Stakeholders Panel (representing large and small NGOs, biomass producers, regions and accademia all over Europe<sup>15</sup>); the Bio-based industries Joint Undertaking (a public-private partnership between the EU and the Bio-Based industries Consortium<sup>16</sup>) and the Ibero-American Network of Bioeconomy and Climate Change (REBICAMCLI, between Mexico, Honduras, Nicaragua, Colombia, Cuba and Spain)<sup>17</sup> are worth mentioning. Relevant in this field is also the work of the Italian blog *Il Bioeconomista* (focusing on bioeconomy news, politics and business<sup>18</sup>) and of BioSTEP (an EU-funded project that promotes stakeholder engagement and public awareness for a participative governance of the European Bioeconomy<sup>19</sup>).

# 1.2.1 Early use of the term

The term "bioeconomics" was probably used for the first time in the 1960s by Zeman, to designate an economic order that appropriately acknowledges the biological bases of almost all economic activities<sup>20</sup>. Nevertheless, according to Birner<sup>21</sup>, "bioeconomics" is rather different from the early use of the term "bioeconomy", which referred to the use of biological knowledge for commercial and industrial purposes.

https://ec.europa.eu/research/bioeconomy/index.cfm?pg=policy&lib=ibf.

 <sup>&</sup>lt;sup>13</sup> Further information is available at <u>http://www.agr.gc.ca/eng/home/?id=1395690825741</u>.
<sup>14</sup> Further information about the IBF is available at

<sup>&</sup>lt;sup>15</sup> European Bioeconomy Stakeholders Panel, *European Bioeconomy Stakeholders Manifesto*, Brussels, 2017, p.

<sup>2,</sup>https://ec.europa.eu/research/bioeconomy/pdf/european\_bioeconomy\_stakeholders\_manifesto.pdf#view =fit&pagemode=none.

<sup>&</sup>lt;sup>16</sup> Further information about the BBI is available at <u>https://www.bbi-europe.eu/about/about-bbi</u>.

<sup>&</sup>lt;sup>17</sup> Red de Bio Economía y Cambio Climático: <u>https://rebicamcli.unanleon.edu.ni/</u>.

<sup>&</sup>lt;sup>18</sup> <u>https://ilbioeconomista.com/about/</u>.

<sup>&</sup>lt;sup>19</sup> Further information about BIoSTEP is available at <u>http://www.bio-step.eu/biostep/about-biostep/</u>.

<sup>&</sup>lt;sup>20</sup> Bonaiuti, M., *Bio-economics,* In: D'Alisa G, Dematia F., Kallis, G., (eds) *Degrowth, A vocabulary for a new era.* Toutledge/Taylor & Francis Group, Abingdon/Oxon, 2014, pp 52-55.

<sup>&</sup>lt;sup>21</sup> Birner R. (2018) *Bioeconomy Concepts*. In: Lewandowski I. (eds) Bioeconomy. Springer, Cham, p. 19.

Indeed, according to von Braun<sup>22</sup>, two geneticists, Juan Enriquez Cabot and Rodrigo Martinez, were the first scientists to refer to the term. For instance, in the paper "Genomics and the World's Economy"<sup>23</sup> published by Enriquez in 1998, it was pointed out that the application of the discoveries of genomics would have led to a restructuring in the role of companies and industries in a way that could change the world's economy. While not explicitly using the term "bioeconomy", the paper represents one of the root concepts of bioeconomy, by stating that advancements in the biological sciences and in biotechnology have the potential to transform many industrial production processes<sup>24</sup>. Actually, it seems that the industrial impacts of the biological revolution were already formulated by Glick in the early 1980s<sup>25</sup>.

While the idea of bioeconomy was firstly conceptualised by scientists, attention to the topic in the European policy framework arrived through the promotion of the latter by the European Commission. In the early 2000s, starting a debate on the bioeconomy meant for the EU policy makers to meet, at the same time, an increase on agricultural research funding – that have been decreasing during the 1990s – and to align with the EU innovation policy, committed to establish "the most competitive and dynamic, knowledge-based economy in the world"<sup>26</sup>. For this reason, a "Strategy on Life Sciences and Biotechnology" was adopted in 2002 and, in 2005, the European Commission organised a conference on "New Perspectives on the Knowledge-Based Bio-Economy (KBBE)"27. Additionally, on the occasion of a workshop held in Cologne under the German Presidency of the Council of the European Union in 2007, two dimensions of the bioeconomy were emphasised: the biotechnology innovation perspective, based on the role biotechnology as indispensable to sustainable economic growth, employment and energy supply; and the resource substitution perspective, highlighting the use of biomass as "renewable industrial feedstock to produce biofuels, biopolymers and chemicals"<sup>28</sup>. Actually, Germany had a relevant role in the process of development of the bioeconomy and it proved to be one of the most active European countries in this field. In 2010, the

<sup>&</sup>lt;sup>22</sup> von Braun, J., *Bioeconomy and sustainable development – dimensions.*, 2014, Rural 21 (2): 6-9.

<sup>&</sup>lt;sup>23</sup> Enriquez, J., Genomics and the World's Economy, 1998, Science 281(5379): 925–926.

<sup>&</sup>lt;sup>24</sup> Birner R. (2018) *Bioeconomy Concepts*. In: Lewandowski I. (eds) Bioeconomy. Springer, Cham, p. 19.

<sup>&</sup>lt;sup>25</sup> Glick, JL, *The industrial impact of the biological revolution*, Technol Soc 4(4), 1982, pp 283-289.

<sup>&</sup>lt;sup>26</sup> European Union, Lisbon European Council 23 nd 24 March 2000 – Presidency Conclusion of the European Union Lisbon, 2000,

https://www.consilium.europa.eu/ueDocs/cms\_Data/docs/pressData/en/ec/00100-r1.en0.htm. <sup>27</sup> European Commission, *New Perspectives on the knowledge-based bio-economy – conference report.* European Commission (EC), Brussels, 2005.

<sup>&</sup>lt;sup>28</sup> European Union, *En route to the knowledge-based bio-economy*, ("Cologne Paper"), German presidency of the Council of the European Union (EU), Cologne, 2007, p.4.

German Bioeconomy Council was established at the federal level, with the aim to advise the Federal Government on the implementation of the "National Research Strategy Bioeconomy 2030", adopted the same year. Finally, the EU published "Innovating for sustainable growth: A Bioeconomy Strategy for Europe" in 2012 (revised in 2018), promptly followed by The Netherlands, Sweden and Finland, in a first round and then by France, Italy, Ireland, Spain and Austria in a second<sup>29</sup>.

In parallel to the EU, other countries and international organisations developed their own approaches to the concept, influencing in a way the perspectives of the others. In 2002 Pollution Probe, a Canadian think tank, had already presented a document entitled "Towards a biobased economy - issues and challenges". Furthermore, according to Patermann and Aguilar<sup>30</sup>, it was through the OECD publication "Biotechnology for sustainable growth and development" that the original notion and definition of a biobased economy was spelled for the first time at a global level. This document was followed by the publication in 2009 of "The Bioeconomy to 2030: Designing a Policy Agenda", highlighting the potentials of biotechnology. In 2012, in the wake of the increasing attention to the topic, the Obama administration adopted the "National Bioeconomy Blueprint", an official strategy on the bioeconomy defining it as "based on the use of research and innovation in the biological sciences to create economic activity and public benefit"<sup>31</sup>. In the same year, the Russian Federation triggered the "State Coordination Program for the Development of Biotechnology in the Russian Federation until 2030". Bioeconomy-related strategies were also adopted by Malaysia and South Africa in 2013.

Nowadays, a significant number of countries has adopted - or is willing to adopt - a national bioeconomy-dedicated (or at least related) strategy to make progress in this area. However, the state of the bioeconomy policies worldwide will be analysed more in detail in the second chapter.

<sup>&</sup>lt;sup>29</sup> Patermann, C., Aguilar, A., *The origins of the bioeconomy in the European Union*, New Biotechnology 40 (2018) 20-24, p. 22.

<sup>&</sup>lt;sup>30</sup> Patermann, C., Aguilar, A., *The origins of the bioeconomy in the European Union*, New Biotechnology 40 (2018) 20-24, p. 22.

<sup>&</sup>lt;sup>31</sup> White House, *National Bioeconomy Blueprint*, Washington, DC, 2012, p. 7.

#### 1.2.2 Different ways to see the bioeconomy

Despite all the attention given to the topic, there is little international consensus on what the bioeconomy actually implies. Within this framework, one can identify at least three slightly different – but interrelated – visions of bioeconomy: the bio-technology, the bio-resource and the bio-ecology vision<sup>32</sup>.

As one may understand from its name, the *bio-technology* vision highlights the importance of biotechnology research and application and the commercialization of biotechnology in different sectors, while addressing economic growth and job creation. The environmental and sustainability aspects, while recognized, have a secondary role. The value added is created by the application of biotechnologies in several sectors and the commercialisation of research and technology. Consequently, investments in research and innovation, producing scientific knowledge, are at the core of this version of bioeconomy. This perspective has characterised the first attempts to conceptualize the exploitation of biomass for production and energy use.

Indeed, the early OECD definition of the bioeconomy stands in this group. In particular, in the publication of 2009 "The Bioeconomy to 2030: Designing a Policy Agenda" we can read that "a bioeconomy can be thought of as a world where biotechnology contributes to a significant share of economic output. The emerging bioeconomy is likely to involve three elements: the use of advanced knowledge of genes and complex cell processes to develop new processes and products, the use of renewable biomass and efficient bioprocesses to support sustainable production, and the integration of biotechnology knowledge and applications across sectors"<sup>33</sup>.

In spite of that, the Organisation has gradually moved beyond a biotechnology-centric vision over the years. Therefore, in the last report on bioeconomy published in 2018, the think tank based in Paris emphasises more the need to ensure a sustainable use of biomass, given the limited nature of the planet's resources<sup>34</sup>. This shift was probably influenced by the assumption that the use of biotechnological innovations and bio-based resources are not automatically more environmentally friendly than alternative options<sup>35</sup>. Furthermore,

<sup>&</sup>lt;sup>32</sup> Bugge M.M, Hansen T., Klitkou A., *What is Bioeconomy? A Review of the Literature,* Sustainability, MDPI, 2016, p. 1.

<sup>&</sup>lt;sup>33</sup> OECD (2009), The Bioeconomy to 2030: Designing a Policy Agenda, OECD publishing, Paris, p. 22.

<sup>&</sup>lt;sup>34</sup> OECD (2018), *Meeting Policy Challenges for a Sustainable Bioeconomy*, OECD Publishing, Paris, p. 11.

<sup>&</sup>lt;sup>35</sup> Birner R. (2018) *Bioeconomy Concepts*. In: Lewandowski I. (eds) Bioeconomy. Springer, Cham, p. 25.

a rising number of challenges started to be identified by researchers and policy makers when talking about bioeconomy: the risk of over-exploitation of natural resources and organic feedstocks, biomass use competition (between food and feed and energy use) and food security. The idea to put biological resources at the heart of the discussion lead to the emerging of the second vision.

The *bio-resource* vision is based on the concept that bio-innovations will provide economic growth and environmental sustainability; but, unlike the bio-technology vision, economic growth will follow from capitalising on bio-resources, rather than biotechnologies<sup>36</sup>. This approach represents the position of the European Commission. The executive body of the European Union, in fact, defines the bioeconomy as a wide concept that mainly refers to the production and conversion of biological resources and waste streams into value added products. More in detail, according to EU policy makers it "covers all sectors and systems that rely on biological resources (animals, plants, microorganisms and derived biomass, including organic waste) their functions and principles. It includes and interlinks: land and marine ecosystems and the services they provide; all the primary production sectors that use and produce biological resource (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services"<sup>37</sup>. Moreover, the Commission introduces the concept of *Circular Bioeconomy*: "to be successful, the European bioeconomy needs to have sustainability and circularity at its heart".

Finally, the literature on the bioeconomy also contains a third vision, the *bioecology* vision. While closely linked to the second approach, the bioecology one focuses more on the role of ecological processes in optimising the use of energy and nutrients, promoting biodiversity and avoiding monoculture and soil degradation. Important is now the potential of regionally concentrated processes and systems, rather than the central role that the previous two visions give to research and development activities in globalised systems. Therefore, the opportunities for rural and peripheral regions are underlined, with a suggestion on achieving rural growth through a focus on high-quality products with

<sup>&</sup>lt;sup>36</sup> Bugge M.M, Hansen T., Klitkou A., *What is Bioeconomy? A Review of the Literature*, 2016, Sustainability, MDPI, p. 1.

<sup>&</sup>lt;sup>37</sup> European Commission, *A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy, Directorate General for Research and Innovation, Unit F - Bioeconomy, Brussels, 2018, p. 4.* 

territorial identity. It also emphasises the use of favourable organic agro-ecological practises and of bio-ecological engineering techniques.

#### 1.2.3 A general conceptualization

While not succeeding in finding a unified definition, the Global Bioeconomy Summit clarifies in a Communiqué drafted after its first meeting in 2015, that an understanding of the bioeconomy as "the knowledge-based production and utilization of biological resources, innovative biological processes and principles to sustainably provides goods and services across all economic sectors" is shared by many<sup>38</sup>. Furthermore, in 2018, the GBS finally states that:

The bioeconomy is the production, utilization and conservation of biological resources, including related knowledge, sciences, technology, and innovation, to provide information, products, processes and services across all economic sectors aiming toward a sustainable economy. It is a dynamic and complex societal transformation process, which demands a long-term policy perspective; countries are welcome to define their bioeconomies, as any definition also has a programmatic element<sup>39</sup>.

In practical terms, it involves the transition from an energy and materials production system based on finite resources, to an economic regime built on the use of the renewables. In particular, the use of biological raw feedstocks (referred to as 'biomass'<sup>40</sup>) but also the application of research and innovation and industrial biotechnology in sectors as food, feed, paper and pulp, and biofuels production<sup>41</sup> are envisaged. Even if several renewable alternatives have already been identified in order to meet the future energy demand, such as solar energy, wind and water power, biomass seems to be the unique carbon source which can serve as a substitute for fossil fuels in chemical or material applications<sup>42</sup>. Furthermore, an additional distinction can be done between the concept of

<sup>&</sup>lt;sup>38</sup> Global Bioeconomy Summit (2015), Communiqué of the Global Bioeconomy Summit 2015: Making Bioeconomy Work for Sustainable Development, Berlin, p.4.

<sup>&</sup>lt;sup>39</sup> Global Bioeconomy Summit (2018), Communiqué of the Global Bioeconomy Summit 2018: Innovation in the Global and Inclusive Transformation and Wellbeing, Berlin, 2018, p.2.

<sup>&</sup>lt;sup>40</sup> See Box 1.

 <sup>&</sup>lt;sup>41</sup> Scarlat N., Dallemand J.F., Monforti-Ferrario F., Nita V., *The role of biomass and bioenergy in a future bioeconomy: Policies and facts*, European Commission, Joint Research Centre, ISPRA, Italy, 2014, p. 4;
<sup>42</sup> Lewandowski, I. Securing a sustainable biomass supply in a growing bioeconomy. *Glob. Food Secur.* 2015, *6*, 34–42.

bioeconomy, that includes the regular food and fee chains, and the bio-based economy that only considers the production of non-food goods (bio-based materials, chemicals and medicine/pharma, pulp and paper, wood, textiles and bioenergy)<sup>43</sup>.

#### Box 1: What is a biomass?

The International Energy Agency (IEA) defines the biomass as "any organic matter, i.e. biological material, available on a renewable basis. It includes feedstock derived from animals or plants, such as wood and agricultural crops, and organic waste from municipal and industrial sources". The Bioenergy is instead the energy that is derived from the conversion of solid, liquid and gaseous products derived from biomass.

The traditional use of biomass is probably the oldest human source of energy after the sun – people have burned wood to heat their homes and to cook their food for thousands of years. It can be defined as "the use of solid biomass with basic technologies, such as three-stone fire, often with no or poorly operating chimneys". Today, the traditional use still accounts for around 55% of the total consumption of biomass and waste, mainly due to this use in developing countries:



The traditional use of biomass can have negative impacts on health (e.g. due to indoor smoke pollution) and the environment. On the other hand, modern bioenergy is an important source of renewable energy, having a final contribution to final energy demand across all sectors five time higher than wind and solar PV combined. Recently, bioenergy for electricity and biofuels has been growing fastest, mainly due to higher levels of policy

<sup>&</sup>lt;sup>43</sup> IEA Bioenergy Task42, 2014. *National BioEconomy Strategies IEA Bioenergy Implementing Agreement Countries. BioEconomy Survey 2014.* Availabe at: <u>https://www.iea-bioenergy.task42-biorefineries.com/web/file?uuid=5168c6ab-e4ba-4356-b6cd-a9772aae032a&owner=218d4964-09e5-4dde-ab22-18845a4aba18</u>.



As mentioned above, bioeconomy is a complex field that includes a variety of sectors, actors and interests. It mainly touches: agriculture and forestry, fisheries, food, trade, waste management, energy, pharma and industry (see Figure 2 below).



### Figure 2: Sectors involved in the Bioeconomy

Source: Birner R., Bioeconomy Concepts, 2018.

Moreover, bioeconomy policies must work across different levels, from the regional to the global one (see Figure 3). In particular, the management of biomass trade as well as the prevention of its over-exploitation require a global action. At the same time, R&D funding (for example in synthetic biology, metabolic engineering, automation in biology, green chemistry and IT convergence) seems to speak more at a national scale. Finally, the local (or regional) level is also relevant, since the distributed bioeconomy manufacturing model stresses the importance to place the growing industry close to the raw materials and the produced and consumed goods and energy<sup>44</sup>. This could be, as will be discussed in the third chapter, a great opportunity for the process of regeneration of rural areas. The geographical complexity of bioeconomy, in terms of interrelation between scales and sectors, requires major efforts to build a policy coherence across the boundaries, to minimise duplication and ensure that policy remain flexible.



**Figure 3: Scales of the Bioeconomy** 

Source: redrawn from J. Philp (2018).

# **1.3 Factors pushing for a structured Bioeconomy Policy**

Several external factors influenced the process of development of bioeconomy and are nowadays pushing for stable and long-term bioeconomy policies. Most of them can also be considered as the global societal concerns of our time.

### 1.3.1 Changing population

While falling or stagnating in most OECD countries<sup>45</sup>, the world human population is continuing to rise. The current population of 7.6 billion people is expected

<sup>&</sup>lt;sup>44</sup> OECD, Meeting Policy Challenges for a Sustainable Bioeconomy, OECD Publishing, 2018, Paris, p. 18.

<sup>&</sup>lt;sup>45</sup> OECD, Meeting Policy Challenges for a Sustainable Bioeconomy, OECD Publishing, 2018, Paris, p. 15.

to reach 8.6 billion by 2030, 9.18 billion by 2050 and 11.2 billion by 2100<sup>46</sup>. 97% of population growth will occur in developing countries: China and India, with 1.4 and 1.3 billion inhabitants respectively, remain the two most populous countries of the world, accounting for over a third of the global population. World GDP is also expected to increase by 57% in 2030; nevertheless, chronic poverty will still affect more than 1.8 billion people in 2030. The increasing of global incomes will produce, especially in developing countries, a growing demand for health, food, education and services. Crucial is the subsequent growth of the middle class (particularly in Asia), that could increase to 4.9 billion in 2030. This will lead to an increase in terms of consumptions, but also in terms of emissions. According to the OECD, more income will also provide a source of corporate and personal savings, part of which are expected to be invested in R&D, having a positive effect on initiatives on bioeconomy.

On the other hand, the decline of fertility levels, especially in developed countries but also in China, will bring an increase in the number of elderly people. According to the UN, globally, compared to 2017, the number of persons aged 60 or over will more than double in 2050, rising from 962 million in 2017 to 2.1 billion in 2050. In Europe, 25% of the population is already aged 60 and the proportion is expected to reach 35% in 2050; the number of persons aged 80 or above is also projected to triple by that time.<sup>47</sup>

As a result, there will be an increase in the prevalence of disease of old age, while expanding demand for long-term healthcare. The use of biotechnology could represent, therefore, an opportunity to explore new possible treatments. Nevertheless, biopharmaceuticals and other advanced medical technology could remain unaffordable for most people in developing countries, mainly due to the high cost of these type of therapy. A global change in health care seems then to be needed.

Furthermore, consequently to the growing population, the global working-age population will also increase, mainly in developing countries, with employment concentrated in the third sector and in manufacturing, while declining in the primary sector. That shift is likely to bring an increase in energy demand. At the same time, the global workforce is also expected to become better qualified, with increasing investments in education. The existence of a better-educated workforce will be critical for the

<sup>&</sup>lt;sup>46</sup> UN, World population projected to reach 9.8 billion in 2050 and 11.2 billion in 2010, New York, 2017.

<sup>&</sup>lt;sup>47</sup> UN, World population projected to reach 9.8 billion in 2050 and 11.2 billion in 2010, New York, 2017.

expansion of the bioeconomy, in particular for R&D activities, that require a high level of knowledge and more specialized people.

Finally, the population will continue to move from the countryside to the city, since people become better educated and job opportunities in services and manufacturing grow<sup>48</sup>, worsening the phenomenon of rural abandonment.

### 1.3.2 Energy security

According to the *International Energy Outlook 2017* published by the U.S Energy Information Administration (EIA), world energy consumption will grow by 28% between 2015 and 2040<sup>49</sup>. Once again, most of this growth is expected to come from non-OECD countries, particularly Asian countries. Additionally, the increase will touch the energy consumption from all fuel sources; only the coal demand will essentially remain flat. The OECD projections in 2009 also viewed coal, oil and gas demand increasing by over 40% in 2030. In 2014, fossil fuels supplied 80% of the world's energy needs; in 2017 the latter still accounted for 81% of total energy demand, a level that has remained stable for more than 30 years. In this way, the world is expected to become more reliant on fossil resources in order to ensure higher standards of living.

Nevertheless, fossil resources are, as we know by definition, finite; actually, conventional oil reserves have been in decline since 1980<sup>50</sup>. Without any change in demand, supply reduction will eventually lead to higher prices for fossil fuels and a lower available quantity of them<sup>51</sup>. Following this trend, there will be huge implications for energy security. The term refers to, as defined by the IEA, the "uninterrupted availability of energy sources at an affordable price".

The challenge of ensuring energy security in the post-fossil world is one of the biggest concerns the International Community has to cope with. In this context, the use

 <sup>&</sup>lt;sup>48</sup> OECD, *The Bioeconomy to 2030: Designing a Policy Agenda*, OECD Publishing, 2009, Paris, p.32.
<sup>49</sup> EIA, *EIA projects 28% increase in world energy use by 2040*, September 2017,

https://www.eia.gov/todayinenergy/detail.php?id=32912.

<sup>&</sup>lt;sup>50</sup> Owen, N.A. et al., "The status of conventional world oil reserves – Hype or cause for concern?", *Energy Policy*, Vol. 38, Elsevier, Amsterdam, 2010, pp. 4743-4749.

<sup>&</sup>lt;sup>51</sup> MIT Center for Energy and Environmental Policy Research, *Fossil Fuel Spply and Energy Security*, 2016.

of biomass for energy reasons, as envisaged in the bioeconomy, represents a solution, as well as a great opportunity to create new jobs and value added. At the same time, as it will be analysed in the paragraph 1.8, bioenergy and biofuels can also pose several challenges.

#### 1.3.3 Climate change

Besides the above-mentioned problems in terms of energy security, the industrialization, the growing population and the consequent increase of emissions had – and is continuing to have – a direct impact on the climate.

There is general scientific agreement on the consistency of the causal link between anthropogenic emissions of greenhouse gases (GHGs) from energy use, and the global warming. According to the Intergovernmental Panel on Climate Change (IPCC), temperatures have been progressively increasing since 1850; from 1880 to 2012 the average combined global temperature of land and oceans increased by 0.85°C. Moreover, the period from 1983 to 2012 was "likely" the warmest period in the last 1400 years in the Northern Hemisphere. At the same time, because of economic and population growth, anthropogenic GHGs emissions have increased since the pre-industrial era, leading to unprecedented concentrations in the atmosphere of carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). After detecting the effects of these gases on the climate system, the Panel claimed that it is "extremely likely" that they are the cause of the observed warming since the mid-20th century<sup>52</sup>. Actually, CO2, the most abundant GHG in the atmosphere, accounting for around two-thirds of GHGs, is largely the product of burning fossil fuels.

From the early 1980s, the International Community started to recognize the climate change as a global concern; the first World Climate Programme (WCP) held in Geneva in 1980, emphasised the necessity to trigger an international cooperation to fight against that irreversible process. With this aim, the United Nations Framework Convention on Climate Change (UNFCCC) was finally created in 1992, on the occasion of the Earth Summit of the UN in Rio de Janeiro. From that point, twenty years of international climate negotiations and of Conferences of Parties<sup>53</sup> saw the adoption,

<sup>&</sup>lt;sup>52</sup> IPCC, 2014: Climate Change 2014: Synthesis Report. IPCC, Geneva, Switzerland, p.4.

<sup>&</sup>lt;sup>53</sup> The Conference of Parties (COP) is the body held by the UNFCCC to monitor the implementation of the Convention and to create international legal instruments to fight climate change. From 1992 to 2018, 24 COPs have been organized. The last one was held in Katowice (Polonia) in November 2018.

among others, of two important legal instruments at an international level, with binding targets of reducing emissions and the objective to mitigate the global warming: the Kyoto Protocol in 1997 and the Paris Agreement in 2015. Anyway, these tools have proved to be rather ineffective so far, since both emissions ad global temperatures are continuing to rise. For this reason, with its last Special Report published in 2018<sup>54</sup>, the IPCC highlights the need to limit the increase of temperatures to 1.5 °C rather than letting it go beyond, in order to ensure a more equitable and sustainable society and avoid harmful effects on the ecosystem and on human activities. Climate change is in fact contributing to the melting of polar ice shields and the progressive rising of seas levels. Also, extreme weather conditions are now occurring more frequently, and some regions are experiencing extreme heat waves and droughts. Furthermore, the report points out that global net human-caused emissions of CO<sub>2</sub> should fall by 45% from 2010 levels by 2030, reaching 'net zero' around 2050<sup>55</sup>.

To limit global warming to 1.5°C "rapid and far-reaching" transitions in energy, land, industry, cities and transport are needed. As will be further discussed, all that the bioeconomy implies could have positive impacts on the process of mitigation of the phenomenon. At the same time, efforts are needed to build a sustainable bioeconomy and to go beyond a 'business as usual' kind of economic growth.

## **1.4 Potentials of the Bioeconomy**

The potentials resulting from bioeconomy development in industrialized, emerging and developing countries, both on the supply and on the demand-side, have been, more or less, globally recognised<sup>56</sup>. Some evidence is available, by mainly checking the bioeconomy strategies adopted around the world, on the contribution of the bioeconomy to the economy, the environment and the society as a whole.

<sup>&</sup>lt;sup>54</sup> IPCC, 2018: *Special Report: Global Warming of 1.5* °C, World Meteorological Organization, Geneva, Switzerland.

<sup>&</sup>lt;sup>55</sup> UN, *Climate Change*, available online at <u>http://www.un.org/en/sections/issues-depth/climate-change/</u>.

<sup>&</sup>lt;sup>56</sup> Global Bioeconomy Summit (2015), Communiqué of the Global Bioeconomy Summit 2015: Making Bioeconomy Work for Sustainable Development, Berlin, p.4.

From an economic point of view, according to the EU<sup>57</sup>, the European bioeconomy is worth 2 trillion EURO in annual turnover and more than 22 million jobs, as well as accounting for 9% of the workforce. Some other estimates used by FAO<sup>58</sup> find, instead, that only the bio-based economy (e.g. excluding agriculture, forestry, fishery, food and tobacco products) generated in the EU about 3.2 million jobs in 2013 and has an annual turnover of 600 billion EURO. In the U.S., the economy based on biological feedstocks (not taking into account the sectors of food, feed, livestock, pharma and energy) represented, in the same year, about 4 million jobs and 370 billion US-Dollars, including direct, indirect and induced effects. Furthermore, the World Economic Forum (WEF) predicts that the revenue potential for new business opportunities in the biomass value chain could globally amount to about USD 295 billion by 2020; three times the amount of 2010. In order to meet labour demands in these industries, new high skilled jobs and need to be developed, with investments in research and education foreseen. Also, the dependence of rural areas on primary sectors such as agriculture and fisheries will be limited, while they could benefit from new bioeconomy value webs. Indeed, bioeconomy could bring new investment and employment in rural areas, as well as new business opportunities and it can support SMEs by foster regional development.

In terms of societal well-being, a bioeconomy could also contribute to the improvement of public health, by, for instance, adapting plants to produce pharmaceuticals, by boosting animal resistance to disease through breeding, or by developing new healthy and nutritious foods<sup>59</sup>.

Finally, concerning the environmental dimension of bioeconomy, there is scientific consensus on the contribution of an efficient and sustainable use of biomass in preserving the ecosystem, while improving the adaptation and mitigation of climate change. Indeed, according to the GBS<sup>60</sup>, the utilization of technological and social innovation can be critical for managing natural resources in a responsible, inclusive and efficient way.

Actually, the bioeconomy can contribute to reducing GHGs emissions by, first of all, substituting non-renewable resources. In particular, the employment of biomass from

<sup>&</sup>lt;sup>57</sup> European Commission, *A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy, Directorate General for Research and Innovation, Unit F - Bioeconomy, Brussels, 2018, p.11.* 

<sup>&</sup>lt;sup>58</sup> FAO (2016), How sustainability is addressed in official bioeconomy strategies at international, national and regional levels - An overview, Rome, p. 2.

<sup>&</sup>lt;sup>59</sup> EPRS (European Parliamentary Research Service), *Bioeconomy. Challenges and Opportunities*, Didier Bouruignon, Members, Research Service, European Union, 2017, p. 5.

<sup>&</sup>lt;sup>60</sup> Global Bioeconomy Forum, Final Communiqué, 2015.

energy and production use lead to a sustainable use of carbon: carbon absorbed naturally by plants is, in fact, used to produce bio-based products and is then released at the end of the production cycle (the so-called 'green carbon'), without increasing the concentration of CO<sub>2</sub> in the atmosphere. Fossil-based products, instead, use the 'black carbon', e.g. the fossil carbon stored underground, increasing consequently the atmospheric CO<sub>2</sub> concentration. Finally, industrial biotechnology can be used to replace fossil plastics and chemicals with bio-based alternatives; biomass seems to be, therefore, the only renewable carbon source for organic chemicals and the plastic industry<sup>61</sup>. According to Nova Institute<sup>62</sup>, bioeconomy can also strengthen the resiliency and adaption of farmers towards the change that the global warming is creating. The diversification in the production of crops for food, feed and industrial markets, as well as local production feedstocks, can foster the stability of rural areas.

However, as it will be further discussed, a shift towards a bioeconomy can have harmful effects on the environment, e.g. by releasing additional carbon emissions in several cases (such as the indirect land use change (ILUC); the use of forest residues (containing, in temperate regions, most of the carbon stored in forests) and an excessive use of chemical fertilizers).

## 1.5 Bioeconomy and Sustainable Development

As mentioned in the previous paragraphs, the notion of bioeconomy shifted from a technology-centric vision to a new (greener) perspective based on the sustainable use of biomass. In this way, and thanks to its potentials, bioeconomy has been gradually incorporated in the broader frameworks of the Sustainable Development, Green Growth and Green Economy.

The concepts of bioeconomy and sustainable development share the ideal to reconcile economic, social and environmental goals. The term *sustainable development* was first used in the report "Our Common Future", also known as the Brundtland Report, published in 1987. It described a sustainable development as a development that "meets the needs of the present without compromising the ability of future generations to meet

<sup>&</sup>lt;sup>61</sup> Nova Institute, *Bio-based economy and climate change – Important links, pitfalls and opportunities*, Germany, 2017, p. 2.

<sup>62</sup> Ibid.

their own needs"<sup>63</sup>. The concept gained more interest on the occasion of the Rio Earth Summit of 1992, and in particular after the adoption of the Agenda 21, a voluntary action plan for the implementation of the sustainable development at a global, national and regional level. Several years later, in 2000, during the Millennium Summit in New York, leaders of 189 countries signed the UN Millennium Declaration, which set 8 of goals ranging from providing universal primary education to avoiding child and maternal mortality to achieve by 2015, called "Millennium Development Goals". Trying to achieve what the Millennium Goals had not achieved yet, the Agenda 2030 and its 17 Sustainable Development Goals (SDGs) were adopted by the United Nations in 2015, in order to "promote prosperity while protecting the planet". According to the UN, these new goals realize human rights, achieve gender equality and balance the three dimensions of sustainable development: the economic, social and environmental. Indeed, they recognize that "ending poverty must go along with strategies that build economic growth and addresses a range of social needs including education, health, social protection, and job opportunities, while tackling climate change and environmental protection"<sup>64</sup> (see Figure 4).



*Source*: UN News (2015), <u>https://news.un.org/en/story/2015/09/509732-un-adopts-new-global-</u>goals-charting-sustainable-development-people-and-planet.

<sup>&</sup>lt;sup>63</sup> WCED (UN), *Our Common Future*, the World Commission on Environment and Development of the United Nations, 1987.

<sup>&</sup>lt;sup>64</sup> UN, *The Sustainable Development Agenda*, <u>https://www.un.org/sustainabledevelopment/development-agenda/</u>.
The link between the positive effects of a sustainable bioeconomy and the purposes of the sustainable development have been highlighted several times. In particular, the Communiqué of the Global Bioeconomy Summit 2015 emphasizes the direct contribution of an efficient and green bioeconomy to the achievement of the SDGs.

Indeed, through an sustainable and circular bioeconomy the society would be able to achieve: food security and improved nutrition, while ending hunger (SDG 2), by, for instance, increasing sustainable yield and investments in agriculture; healthy lives and well-being for all (SDG 3), by reducing air, water and soil pollution and by developing biopharma and functional foods; access to water and sanitation for all (SDG 6), by cleaning water through the use of sewage water to produce bioenergy and bio-based materials; affordable and clean energy (SDG 7), by the use of bioenergy; sustainable consumption and production (SDG 12), by rising consumer awareness and integrating the circular economy; the reduction of climate change (SDG 13), cutting GHGs emissions; a sustainable use of oceans, seas and marine resources (SDG 14); and a sustainable management of terrestrial ecosystems, forests, desertification, land degradation, and biodiversity (SDG 15)<sup>65</sup>. In the same way, the Biobased Industries Consortium, focuses on the relationship between the European bioeconomy and the SDGs, finding that the use of biological materials for energy and production purposes can also: promote inclusive and sustainable economic growth, employment and decent work for all (SDG 8) and make cities inclusive, safe, resilient and green (SDG 11), by linking rural areas and urban centres through bio-based products and bioenergy consumption for the latter<sup>66</sup>.

# 1.5.1 Green Growth and Green Economy

The concepts of green growth and green economy can be seen both as subcategories of the sustainable development. Normally the two terms are interchangeable; nevertheless, some authors believe that the two terms should be differentiated: indeed, whereas the green growth is more focused on the economic development, the green economy consider the social equity having a central role.

<sup>&</sup>lt;sup>65</sup> Global Bioeconomy Summit (2015), *Communiqué of the Global Bioeconomy Summit 2015: Making Bioeconomy Work for Sustainable Development*, Berlin, p.4.

<sup>&</sup>lt;sup>66</sup> Biobased Industries Consortium, *Bioeconomy and the UN Sustainable Development Goals*, Brussels, 2018.

The OECD defines the *Green Growth* as "fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies"<sup>67</sup>. In other words, the economic growth must go along with the sustainable use of natural resources. Indeed, the concept is based on the acceleration of investments and innovations, in a way that can underpin sustainable development and provide new economic opportunities<sup>68</sup>. At the same time, an environmentally friendly behaviour of business and consumers is encouraged, by facilitating equitable reallocation of jobs, capital and technologies and to provide support and incentive for the development of ecological innovations.

The notion of green growth emerged at the beginning of the new millennium, not as a tool to substitute the concept of sustainable development but as a way to achieve it. Actually, it was promoted as a new, low-emission model of sustainable development for fast developing Asian countries, during the Fifth Ministerial Conference on Environment and Development in Asia and the Pacific, held in 2005 in Seoul. On that occasion, green growth was adopted as "a strategy for achieving sustainable development, making 'Green' as a driver of an economic growth that fosters low-carbon, resource-efficient and socially-inclusive development"<sup>69</sup>. It was understood as the environmentally sustainable economic growth, in contrast to the conventional economic growth paradigm based on maximizing short term GDP by exploiting human and natural capital, worsening unemployment and ecological crisis.

A proper National Strategy for Green Growth was firstly adopted by South Korea in 2009, acting as the ambassador of the concept worldwide. In the meanwhile, the OECD also started a work that ended up with the publication of the Green Growth Strategy in 2011. The OECD Strategy was a first important tool for governments on how to realize green growth by supporting economic growth and development, while preserving the natural environment. The action implies to go beyond a business as usual and transforming the current modes of production and consumption across the entire economy at a global scale.

<sup>&</sup>lt;sup>67</sup> OECD, Towards Green Growth, OECD Publishing, Paris, 2011, p. 9.

 <sup>&</sup>lt;sup>68</sup> Kasztelan, A., *Green Growth, Green Economy and Sustainable Development: Terminological and Relational Discourse,* Prague Economic Papers, 2017, 26(4), 487–499, <u>https://doi.org/10.18267/j.pep.626</u>.
 <sup>69</sup> UNESCAP, *Green Growth and Green Economy,* <u>https://www.unescap.org/our-work/environment-development/green-growth-green-economy/about.</u>

Green growth is strictly connected with the idea of green economy, parallelly developed in the same years; it aims to increase the overall social welfare and social justice while ensuring environmental protection. The term was used for the first time in a report prepared by a group of environmental economists for the Government of the United Kingdom in 1989, entitled "Blueprint for a green economy"<sup>70</sup>; no definition was, however, presented in the publication.

In 2008, the concept was recalled in the context of the world financial crisis and the measures undertaken to limit its consequences. The UN Environment Programme (UNEP) triggered the Green Economy Initiative, in order to ensure political support and analyses for "green" investments but also to make conventional polluting sectors of the economy "greener". Increasing investments are, for instance, provided in sectors that create and reinforce the natural capital of the Earth, including renewable energy, lowemission transport, waste management improvement, energy-efficient building, clean technologies, sustainable agriculture, fishing and forest management.

Several years later, in 2011, the UNEP prepared the Green Economy Report, defining the green economy as "one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. It is low carbon, resource efficient and socially inclusive"<sup>71</sup>. The concept has been finally mainstreamed after the 2012 UN Conference on Sustainable Development in Rio de Janeiro (Rio+20), adopting the convention entitled "The Future We Want"<sup>72</sup>, which emphasised the need to pursue the promotion of sustainable development by focusing on the elimination of poverty and the construction of a more equitable society, and considered green economy as "one of the important tools available for achieving sustainable development"<sup>73</sup>.

The emergence and the development of the concepts of green growth and green economy was, most probably, influenced by the need to build a more integrated and comprehensive approach to incorporate environmental concerns in economic processes. Both notions are supposed to identify possible ways to boost economic improvement while considering the increasing deficiency in natural resources, through resource- and

<sup>&</sup>lt;sup>70</sup> Kasztelan, A., Green Growth, Green Economy and Sustainable Development: Terminological and Relational Discourse, p. 490.

<sup>&</sup>lt;sup>71</sup> UNEP, Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. 2011.

<sup>&</sup>lt;sup>72</sup> UN, *The future we want*. Resolution adopted by the General Assembly United Nations Sixth Session 22 September 2012 A/Res/66/288, 2012.

<sup>&</sup>lt;sup>73</sup> Ibid. p. 10.

energy-efficient technological innovations<sup>74</sup>. Following these definitions, the bioeconomy become a part of the green growth and green economy approaches, and then, as a consequence, of the sustainable development perspective (see Figure 5 below).



Figure 5: Sustainable Development, Green Growth, Green Economy and Bioeconomy

Source: redrawn from Birner R. (2018)

# 1.6 The Circular (Bio)Economy

Next to the concepts of green growth and green economy, and very close to that of bioeconomy, the idea of the circular economy was, according to Birner<sup>75</sup>, popularised in 1989 by two environmental economists: David Pearce and Kerry Tuner<sup>76</sup>; however, the concept had already been theorised in the 1960s by Boulding<sup>77</sup>.

<sup>&</sup>lt;sup>74</sup> Kasztelan, A., Green Growth, Green Economy and Sustainable Development: Terminological and Relational Discourse, p. 491.

<sup>&</sup>lt;sup>75</sup> Birner R., *Bioeconomy Concepts*. In: Lewandowski I. (eds) Bioeconomy, Springer, Cham, 2018, p.27.

<sup>&</sup>lt;sup>76</sup> Pearce DW, Turner KR (1989) Economics of natural resources and the environment. Johns Hopkins University Press, Baltimore.

<sup>&</sup>lt;sup>77</sup> Boulding KE (1966) *The economics of the coming spaceship earth – environmental quality in a growing economy*. In: Jarrent H (ed) Essays from the sixth resources for the future forum on environmental quality in a growing economy. Johns Hopkins University Press, Baltimore, pp 3–14

The notion, that has gained increasing attention in the last decades, describes an economic system in which "the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste is minimised"<sup>78</sup>, especially through reuse, recycling and remanufacture. According to the OECD, in the circular economy concept, the linear production model "take, make and dispose" is replaced by a circular model, in which the waste products that would be disposed in the linear model are kept within the system<sup>79</sup>. The ultimate goal of circular economy would be, therefore, "zero waste"<sup>80</sup>.

In 2015, the GBS highlighted the importance to align the principles of a sustainable bioeconomy with those of the circular economy, that would involve systemic approaches across sectors<sup>81</sup>. The Summit also find in minimizing losses and waste over the production, distribution and consumption cycles a crucial area for international cooperation.

Indeed, the bioeconomy and the circular economy already share the aim of adding value to biological waste and residues. A bioeconomy that uses biological residues and waste materials as feedstocks for biorefining can be called, as a consequence, a circular bioeconomy. Bio-waste is considered to be an important source of biomass. However, a clear definition of waste is still missing, and it is necessary in order to assess the quantity of the waste that could be used in biorefining<sup>82</sup>.

Furthermore, a bioeconomy meets the circular economy goals through the 'cascading-use' of biomass. On the base of this principle, biomass is used more than once, when economically and technically feasible, normally with material uses(s) as the first step and energy conversion as the last step<sup>83</sup> (see Figure 6). This leads to an increase in resource efficiency while lowering demand for fresh materials. The European Commission defines the cascading use of biological feedstocks as "the efficient utilisation

 <sup>&</sup>lt;sup>78</sup> European Commission, *Closing the loop – An EU action plan for the Circular Economy*, Brussels, 2015.
 <sup>79</sup> OECD, *Realising the Circular Bioeconomy*, OECD Publishing, 2018.

<sup>&</sup>lt;sup>80</sup> OECD, Meeting Policy Challenges for a Sustainable Bioeconomy, 2018.

<sup>&</sup>lt;sup>81</sup> Global Bioeconomy Summit (2015), Communiqué of the Global Bioeconomy Summit 2015: Making Bioeconomy Work for Sustainable Development, p.5.

<sup>&</sup>lt;sup>82</sup> EU, Revised Bioeconomy Strategy, 2018, p. 50.

<sup>&</sup>lt;sup>83</sup> EPRS, *Bioeconomy. Challenges and Opportunities*, p. 4.

of resources by using residues and recycled materials for material use to extend total biomass availability within a given system"<sup>84</sup>.

Therefore, the concepts of bioeconomy and circular economy complete each other. However, the bioeconomy and the bio-based economy are broader and include more aspects, such as innovation, functionalities and properties of products. Therefore, the "Circular Bioeconomy" can be defined just as the intersection of bioeconomy and circular economy<sup>85</sup>.



Figure 6: The cascading-use of biomass in the Bioeconomy

Source: Nova Institute, The "Circular Bioeconomy" – Concepts, Opportunities and Limitations, 2018.

<sup>&</sup>lt;sup>84</sup> European Commission, DG Growth webpage: <u>https://ec.europa.eu/growth/content/study-optimised-cascading-use-wood-0\_en</u>

<sup>&</sup>lt;sup>85</sup> Nova Institute, The "Circular Bioeconomy" – Concepts, Opportunities and Limitations, 2018, p. 8.

#### **1.7 Challenges**

Given the direct link between bioeconomy and sustainable development goals, as previously mentioned, and the environmental advantages the latter can offer, it should be said that the use biological resources for energy and production purposes is not necessarily sustainable. Actually, all bioeconomy aspirations and assumptions depend on supplies of sustainable biomass. The idea to exploit biological feedstocks for energy and production use has, in fact, also received several critics throughout the years. The transition to a bioeconomy could, indeed, also have negative socio-economic impacts.

### 1.7.1 Food vs Fuels

First of all, bioeconomy presents an intrinsic dilemma, that hinges on the competition between the exploitation of biomass for the food use or for the industrial one. A study<sup>86</sup>, mentioned by the OECD<sup>87</sup>, points out that if countries become active in world food security, especially for nations in food deficit, there will be no farmland left for industrial use. However, grassland should be still available for non-food purposes, and, also, forests, residual biomass, the potential of marine environment and waste gases are not taken into account; even if, as it will be further discussed, the use of those type of lands can have an impact on GHGs emissions.

India is the clearest representation of bioeconomy dilemma "food vs fuels". As previously mentioned, the country presents the second highest population level of the world, after China. As the population is continuing to rise, demand of electricity is consequently expected to increase; in particular, it could be five times bigger in 2030, according to the OECD. In this context, how can the country solve the problem of energy security through the exploitation of biological feedstocks, while ensuring, at the same time, food for all citizens? Several countries, especially emerging and developing economies (such as Korea, Japan and some African states) are facing the same dilemma.

Finally, the exploitation of biomass for energy use could also have an impact on the price of the food.

<sup>&</sup>lt;sup>86</sup> DBFZ (2011), *Global and Regional Spatial Distribution of Biomass Potentials*, Deutsches Biomasse Forschungszentrum, Leipzig.

<sup>&</sup>lt;sup>87</sup> OECD, Meeting Policy Challenges for a Sustainable Bioeconomy, OECD Publishing, 2018, p. 28.

### 1.7.2 Biomass trade and over-exploitation

Secondly, according to the OECD<sup>88</sup>, the use of biological resources has geographical and geopolitical implications, mainly in terms of biomass trade (see Figure 7).



Figure 7: Major world biomass shipping routes in 2011

Source: OECD (2018), Meeting Policy Challenges for a Sustainable Bioeconomy<sup>89</sup>

Indeed, many countries are biomass-poor, because of a shortage of available farmland and high levels of population densities; whereas others appear to be biomassricher, such as some countries of North and South America, several African states, the Russian Federation, China and other Asian countries. Those which fall within the first category, mainly OECD countries, could become importers of natural resources feedstocks and just switch their dependence on oil exporters to biomass exporters. The latter, in order to respond to the demand of the importers, may be encouraged to exacerbate the harvesting of biomass in an unsustainable way, especially in the absence of strong governance of the harvested lands. This could lead to an over-exploitation of natural resources. In these terms, biological resources could be considered finite if their

<sup>&</sup>lt;sup>88</sup> Ibid., p.26.

<sup>&</sup>lt;sup>89</sup> Redrawn from BP-EBI (2014), Biomass in the Energy Industry. An Introduction.

sustainability is not ensured. In fact, the renewable nature of biomass depends primarily on the amount of available land and water. Unfortunately, assessing biomass availability at a global level is difficult, especially assessing its availability for energy use; indeed, the amount of biomass that can be used for bioenergy and biofuels could be influenced by population growth, diet, water availability and agricultural density<sup>90</sup>.

## 1.7.3 Indirect Land Use Change

Finally, while assuming that a switch to bioeconomy appear crucial to limit GHGs emissions, some activities can have an opposite result. In fact, the harvesting of crops for bioeconomy purposes – mainly for biofuels – has both direct and indirect effects in terms of land use change; we consider direct land use change when land use is directly changed from a previous agricultural use to the cultivation of energy crops or feedstock for bioproducts. The indirect land use change (ILUC) in contrast, occurs when the change in the land use takes place in an area that is geographically disconnected from the biomass feedstock production. In other words, the still necessary agricultural production maybe displaced to previously uncultivated areas such as grasslands and forests all over the world. Since these land types typically absorb high levels of CO<sub>2</sub>, their conversion into cropland may increase the atmospheric carbon levels. This results in carbon payback times of decades or centuries<sup>91</sup>. Additionally, ILUC can have an impact on biodiversity, e.g. by encouraging deforestation, and food production, e.g. by raising the price for food and speculation on farmland. Furthermore, some NGOs highlight the emergence the phenomenon of 'land grabbing' and the rising of the presence of large land holdings in developing countries; in 2011, the World Bank estimated that, in a year, foreign investors had shown interest in about 56 million hectares of land globally<sup>92</sup>.

The debate on the consequences of the ILUC phenomenon was opened in the EU in the context of biofuels<sup>93</sup>. The adverse effects on the environment of supporting policies for conventional biofuels, induced the Commission to present a legislative proposal to

<sup>&</sup>lt;sup>90</sup> IEA, The Availability of Biomass Resources for Energy. Summary and Conclusions from the IEA Bioenergy ExCo58 Workshop, 2008.

<sup>&</sup>lt;sup>91</sup> Nova Institute, *Bio-based economy and climate change – Important links, pitfalls and opportunities*, Germany, 2017, p. 6.

<sup>&</sup>lt;sup>92</sup> The World Bank, *Rising Global Interest in Farmland. Can It Yield Sustainable and Equitable Benefits?*, The World Bank, D.C, 2011.

<sup>&</sup>lt;sup>93</sup> Liquid fuels derived from biomass, used mainly in transport; the most common biofuels are bioethanol (a substitute for petrol) and biodiesel (a substitute for diesel). *Source*: EPRS, *EU biofuels policy*, p.2.

amend the Renewable Energy Directive and the Fuel Quality Directive, with the aim to reduce the share of conventional biofuels (also referred to as 'firs-generation', they are derived from crop which can also be used as food or feed) that can be included in the renewable energy target<sup>94</sup>, and increase, instead, the support to advanced biofuels (also referred to as 'second- or third- generation', they are typically derived from plant material which does not have an alternative use as food)<sup>95</sup>.

# **1.8 Conclusions**

In this first chapter, the main literature relating to the concept of bioeconomy, its definition, birth, potentials and challenges, was considered. For some, the bioeconomy appears to be a great opportunity for our society. It may allow, indeed, to break countries' dependence on fossil resources and, as a consequence, tackle the big "common concerns of humankind", such as – among others – climate change, natural resources depletion, energy and food security, poverty reduction.

However, in order to be effective, the bioeconomy development needs to be pursued in a sustainable way. Indeed, even though the concept meets the goals of the sustainable development by definition, there is increasing scientific evidence on the negative (direct and indirect) effects that maybe caused by an unsustainable exploitation of biological resources for production and energy use.

Assessing the sustainability of the bio- and bio-based economy is, nevertheless, quite complicated, because of the different methods of calculation that have been used so far, and their related variegated results.

Actually, an internationally agreed set of criteria for a sustainable bioeconomy and the availability of biomass still does not exist<sup>96</sup>. Anyway, the international community is working to make progress in the development of a sustainable bioeconomy, first of all by adopting strategies to implement at a national level; and secondly, establishing conferences, creating advisers and evaluation programs to foster knowledge exchange and coordination.

<sup>&</sup>lt;sup>94</sup> Ibid., p. 7.

<sup>&</sup>lt;sup>95</sup> See for further information: <u>https://www.euractiv.com/section/transport/news/parliament-rubber-stamps-eu-biofuels-reform-amid-final-controversy/.</u>

<sup>&</sup>lt;sup>96</sup> Priefer, C., et al., Pathways to Shape the Bioeconomy, in Resources Journal, 2017, 6,10.

An assessment of the building up of the bioeconomy policy around the world will be further discussed in the next chapter. Furthermore, we will also proceed with the analysis of the policy cycle and the challenges of such a policy from a global perspective.

# Chapter 2

# The building up of the Bioeconomy Policy

CONTENTS: 2.1 Overview; 2.2 Assessing the State of the Bioeconomy Policy around the world; 2.2.1 Africa; 2.2.2 Americas; 2.2.3 Asia and the Pacific; 2.2.4 Europe; 2.3 The Bioeconomy Policy Cycle; 2.3.1 Pre-decision phase: Agenda Setting and Policy Formulation; 2.3.2 Implementation: Top-down vs bottom-up approaches; 2.3.3 Results: bioeconomy evaluation programs and advisers; 2.4 Towards a good governance of the Bioeconomy; 2.5 Conclusions.

### 2.1 Overview

A lot of progress has been made in the context of bioeconomy policy development so far. This chapter, in particular, will focus on the initiatives which have been taken in this direction in the different macro-regions of the world. Almost 50 countries have adopted dedicated or related bioeconomy strategies in Africa, Americas, Asia and Europe. The latter, for instance, present the highest number of countries adopting national bioeconomy dedicated strategy. Anyway, all the other policies focus on areas that are relevant for the bioeconomy, such as bioenergy, green economy and green growth, forestry, blue economy. What is more, an analysis of the bioeconomy policy cycle differ will show that, even while recognising the global nature of the phenomenon, the setting of priorities as well as the way to implement bioeconomy depends a lot on national characteristics. But it is exactly the presence of conflicting goals and the potential risks that an unsustainable development of bioeconomy can bring to the environment and the society that requires the establishment of a globally agreed governance framework, made of mechanisms, indicators and standards to assess the progress of the use of biological feedstocks for energy and production. Further research is needed in this field.

### 2.2 Assessing the state of bioeconomy policies around the world

As mentioned in the previous chapter (see paragraph 1.2), the discussion on the bioeconomy has gained further momentum over the last decades. Actually, as can be seen from Figure 8, many countries have shown an increasing interest in building a structured policy aiming to regulate and promote the sustainable exploitation of renewable biological resources for commercial and energy use or have addressed related sectors (see Annex I for further details).



Figure 8: How the world is gravitating towards bioeconomy policy

Source: OECD 2018, Meeting Policy Challenges for a Sustainable Bioeconomy, p. 14.

# 2.2.1 Africa

Apart from South Africa, no national dedicated bioeconomy strategies have been developed in Africa so far. Nevertheless, many bioeconomy-related initiatives and political support has emerged in the continent in the last years.

As mentioned, South Africa is the only country in the African continent which has used a holistic approach in developing a dedicated bioeconomy policy. It has adopted a Bioeconomy Strategy in 2013, defining the concept as including "activities that make use of bio-innovations based on biological sources, materials and processes to generate sustainable economic, social and environmental development<sup>97</sup>". The document interprets the bioeconomy as a crucial driver of the economy of South Africa by 2030. The strategy is based on other two former initiatives: The National Biotechnology Strategy released in 2001 and the Ten-Year Innovation Plan of 2008. Policy support is mainly addressed to agriculture (considered as having the highest economic impact), health and bio-based industry. A great role is given to training and education policies.

A specific focus on the area of biotechnology is, instead, mainly promoted in Kenya, Tanzania and Uganda. In 2006 Kenya adopted the "National Biotechnology Development Policy", in order to foster R&D and the commercialization of modern biotechnological product. The idea is to transform Kenya into a knowledge-based economy. At the same time, the country's rich biodiversity has also been taken into account recently, with the "National Strategy on Bioprospecting" adopted in 2011.

Similarly, Tanzania promoted biotechnology and its application with the adoption of the "National Biotechnology Policy" in 2010. The underlying idea is to promote the economic transition from a mainly subsistence agriculture to a "semi-industrial" economy of the country. Public-private partnerships as well as business innovation, capacity building, national and international collaboration are encouraged.

For its part, Uganda promotes both the areas of biotechnology and bioenergy. Indeed, the country adopted the "National Biotechnology and Biosafety" in 2008, using biotechnology mainly to modernize the agricultural sector and promote industrial production. At the same time, a renewable energy policy had already been fostered in 2007. Then, in 2014 the "Biomass Energy Strategy" was adopted by the government. The document highlights the potential of Uganda's large amount of biomass to create added value, and thus contribute to energy security while promoting social and economic development.

Together with Uganda, the importance of bioenergy development is also mainly addressed by Mali, Mozambique, Nigeria and Senegal.

<sup>&</sup>lt;sup>97</sup> Republic of South Africa, *The Bio-Economy* Strategy, Department of Science and Technology, 2013, p.6.

In 2006, Mali adopted the "National Energy Policy", the "National Strategy for Renewable Energies" and the "National Strategy for the Development of biofuels". Furthermore, the National Agency for Bioenergy Development was created in 2009. The core aim of the country is to go beyond the use of traditional bioenergy, in order to protect the environment and advance rural electrification.

Mozambique also supported biofuels policy, by building bilateral cooperation, trade and technology transfer agreements with other countries, especially with Brazil. Furthermore, the "National Biofuel Policy and Strategy" was adopted by the Parliament in 2009, with the aim to reduce the country's dependence on imported fossil fuels while fostering energy security. At the same time, the support to biofuels is a way to encourage agricultural and industrial development as well as employment and income generation in rural areas. The need to ensure food security and reach the SDGs is also mentioned.

The necessity to substitute fossil fuels and contribute to a greener fuel sector is also underlined by the "Biofuel Policy and Incentives", released by the Nigerian government in 2007. The link between primary and energy sector is seen here as a way to promote job creation, technology transfer, agricultural and rural development.

Finally, a National Renewable Energy Policy has been defined in Senegal since 2003, and it has been regularly updated. In 2006, the country launched the "National Biofuels Strategy" to foster energy security and improve standard of living.

By contrast, Mauritius and Namibia adopted strategies which focus on areas that can be considered as related to bioeconomy. Mauritius, for instance, stresses the importance of ocean potential and its contribution to GDP, through its "Roadmap on Ocean Economy", adopted in 2013. The considered areas are fishing, marine biotechnology, food processing, aquaculture, marine pharmaceuticals and cosmetics. Concerning Namibia, it focuses more on research and innovation with the "National Programme on Research, Science, Technology and Innovation" adopted in 2015. In particular, the document points out that improvements in health, living standards, ecosystem management, food and water scarcity, skills level, economic value-added are expected. What is more, several projects have been promoted by international partners in Africa. For instance, the German Government supports the BiomassWeb initiative in Ethiopia, Ghana, Kenya and Nigeria<sup>98</sup>, and the Swedish Development Agency (Sida) encourages countries like Burundi, Ethiopia, Kenya, Rwanda, Tanzania and Uganda to develop bio-innovation policies.

### 2.2.2 Americas

Bioeconomy-related topics have been increasingly discussed in both North and South America in the last few years. In particular, in Latin America and the Caribbean (LAC) the bioeconomy is promoted as an alternative model for sustainable development and green growth, advancing Agenda 2030, by, for instance, decoupling GHGs emissions<sup>99</sup>. Furthermore, achieving development in bioeconomy is seen as a great opportunity to unlock the huge biomass potential that the continent can offer, thanks to its biodiversity. Nevertheless, no dedicated national bioeconomy strategy have been adopted yet in the LAC region, but several countries have adopted documents on relevant bioeconomy-related topics and others (such as Argentina, Brazil, Colombia, Ecuador and Costa Rica) have shown their willingness to prepare specific policies.

As one of the most active Southern American countries in bioeconomy development, Argentina presented the position paper *Bioeconomía Argentina* in 2017. Here the bioeconomy is defined as encompassing the production and use of goods and services based on biological resources, processes and principles. The main goal pursued by the paper is to tackle with the grand societal challenges, such as climate change and poverty reduction; regional and rural development are also mentioned. The Argentinian paper also links the concept of bioeconomy with the idea of circular economy. Even though no dedicated strategy has been developed at national level, the province of Buenos Aires published the "Plan Provincial de Bioeconomia", going in that direction at the regional level<sup>100</sup>.

<sup>&</sup>lt;sup>98</sup> German Bioeconomy Council, *Bioeconomy Policy (Part III): Update Report of National Strategies around the World*, Office of the Bioeconomy Council, Berlin, April 2018, p. 22.

<sup>&</sup>lt;sup>99</sup> GBS, *Bioeconomy World Regions: Latin America & Caribbean,* <u>www.gbs2018.com/workshop/bioeconomy-of-world-regions-lac/</u>.

<sup>&</sup>lt;sup>100</sup> FAO, Assessing the Contribution of Bioeconomy to Countries' Economy – A brief review of national frameworks, Rome, 2018, p. 4.

Brazil, in turn, has focused more on biotechnology and bioenergy in the last years. In 2006, the government published the revised "National Strategy for Sciences, Technology and Innovation", which identifies the bioeconomy as one of the priorities of Brazil. Furthermore, during the 22<sup>nd</sup> Conference of Parties of the UNFCCC in Marrakesh in 2016, the Brazilian government launched, together with 20 other countries and 13 international organizations, the "Biofuture Platform", which contains a broad definition of the bioeconomy. The idea is still to develop a sustainable bioeconomy in order to create innovative products based on the country's natural resources.

The economic potential of the country's biological resources has also been recognized by the government of Colombia, especially through the adoption of bioprospecting policies. For instance, the "Commercial development of Biotechnology based on the Sustainable Use of Biological Resources" was adopted in 2011. The document was based on two previous initiatives; the "National Plan on Continental and Marine Bioprospecting" adopted in 2002, and the "National Productivity and Competitiveness Policy" published in 2008. The importance of the biotechnology as an economic driver has also been highlighted by the "National Development Plan", implemented from 2006 to 2010; the "Research and Innovation Policy" of 2008; and the Technology and Innovation Policy adopted in 2009.

Mexico has instead focused more bioenergy development. With the National Bioenergy Strategy published in 2009, the country provides guidelines for developing the biofuels industry, which can contribute to food and energy security, while reducing environmental pollution. Rural development is also encouraged, together with the promotion of research and development in second generation biofuels. Finally, the Mexico's "National Strategy for Energy Transition and the Sustainable Use of Energy" was published in 2011. At the same time, a support fund (FOTEASE) with the aim to promote projects in the renewable energies sector is established. Among the initiatives stands the *Proyecto de Bioeconomia*, which aims to contribute to the sustainable use, management and conservation of biological resources and their use in primary production.

Finally, both Uruguay and Paraguay have shown their interest in developing the area of biotechnology recently, in particular related to the primary sector and forestry.

Paraguay adopted in 2011 the *Politica y Programa de biotecnologia agropecuaria y forestal*, which underlines the need to capitalize on the country's rich biodiversity, combat poverty, ensure food security and foster rural development. Besides, Uruguay stresses the priority of smart agriculture development. High-tech farming techniques are, for instance, promoted in *Uruguay Agro Inteligente 2010-2015*. Moreover, a biotechnology strategy is adopted in 2011.

Similarly, Northern American bioeconomies are also bioresources-driven (especially focusing on agriculture and forestry). In particular, Canada adopted "A Forest Bioeconomy Framework for Canada" in 2017, which defines the bioeconomy as a set of economic activities that use forest-based resources not only to produce traditional forest products, but also to create new high value products and services. Furthermore, the circular, innovative, knowledge-based and competitive character of the bioeconomy is recognised. Nevertheless, the main goal pursued by the strategy is economic: the government try to improve the Canadian forestry sector especially in terms of competitiveness. At the same time, the document stresses the contribution of bioeconomy to foster rural development, create jobs and include indigenous people. Again, the global societal challenges are mentioned, together with the need to promote a low-carbon future.

Concerning the US, the Obama administration had already adopted the National Bioeconomy Strategy Blueprint in 2012. The document contained a holistic approach to bioeconomy, defining it as the use of research and innovation in the biological sciences in order to create economic value added. Later, in 2015, the US government renewed the federal Strategy for American Innovation, which highlighted the need to invest in new technologies. Finally, in December 2006, the "Strategic Plan for a Thriving and Sustainable Bioeconomy was adopted, which provides a framework for biomass-derived product development in the country, enshrining the shift from a holistic perspective of bioeconomy to a more agricultural and bio-resources-based vision. The bioeconomy is now defined as the sustainable utilization of domestic biomass in order to ensure energy supply. What is more, the plan also presents a set of indicators for measuring progress on the activities.

#### 2.2.3 Asia and the Pacific

Following the great technological innovation that several emerging countries are experiencing in Asia, bioeconomy development in countries like China, India, Russia, South Korea, Japan, Malaysia, Thailand and Sri Lanka, is generally oriented to high-tech, emerging industries and industrial innovation. In contrast, Australia and New Zealand, are more focused on the growth and value-creation in their primary industries, similarly to Northern American countries.

Japan has been one of the first countries in the world promoting a national dedicated bioeconomy strategy. From the beginning, the main focus has been the production and the industrial utilization of biomass. Indeed, the "Biomass Nippon Strategy" - the first biomass strategy - was adopted in 2002, aiming at generating a sustainable economy through the efficient use of biological feedstocks. Then, the law "Basic Act for the Promotion of Biomass Utilization", which passed in 2009, appointed the National Biomass Policy Council, and provided specified government responsibilities, the political stakeholders and the political funding measures<sup>101</sup>. As a consequence, the "National Plan for the Promotion of Biomass Utilization" was adopted in 2010, setting quantitative targets to 2020, as well as policy guidelines on national, prefectural and district level. It was followed in 2012 by the Biomass Industrialization Strategy. Achieving autonomous and decentralized energy production is identified by the Plan as the main goal. Relevant for the scope of bioeconomy development are also the "Comprehensive Science and Technology Strategy", adopted in 2013, and the National Strategy and Action Plan for Biodiversity (from 2012 to 2020). What the Japanese want to achieve is the maintenance of the ecosystem, ensuring its resiliency and efficiency; the revitalization of rural areas, through the intensification of resources exchange between rural and urban areas; the building of a clean energy system; and the whole revitalization of national and regional economy.

Together with Japan, Malaysia has been one of the pioneer countries in Asia to develop a holistic policy approach to the bioeconomy development. The country, in particular, firstly focused on the biotechnological side of the bioeconomy. In 2005, the Malaysian government had already launched the "National Biotechnology Policy", which

<sup>&</sup>lt;sup>101</sup> German Bioeconomy Council, *Bioeconomy Policy (Part I): Synopsis and Analysis of Strategies in the G7*, Office of the Bioeconomy Council, Berlin, January 2015, p.39.

encouraged capacity building, R&D and internationalization<sup>102</sup>. Furthermore, the "Bioeconomy Transformation Programme" is adopted in 2012, with the aim to foster the commercialization of biotechnology; and in 2013 the "National Biomass Strategy 2020" is updated, stressing the importance of exploring the development of higher value-added from the biological feedstocks of the country, but especially from residues. Here the bioeconomy is considered as the production of renewable feedstocks and their conversion into food, feed, chemicals, energy and healthcare products, through the application of biotechnology and the combination of innovative technologies<sup>103</sup>.

In 2017, Thailand has become the third country in Asia to have a dedicated "Bioeconomy Roadmap". The roadmap identifies the bioeconomy as covering bioenergy, biochemicals, biopharmaceuticals, food and feed. At the same time, bioeconomy development in the country has been influenced by related policy strategies, such as the "Thailand 4.0 program", adopted in 2015, which encourages the transition to a technology-driven economy and substantial innovation in several sectors (food and agriculture among them) to further improve their production and efficiency. Both the Thailand 4.0 document and the Roadmap present a series of quantitative targets to reach. The Alternative Energy Development Plan (AEDP) also played a relevant role.

By contrast, China, India and Russia are characterized by their political promotion of biotechnology development.

China, began to encourage biotechnology innovation since the 1980s, making the country one of the leading biotechnology players in the world<sup>104</sup>. Biotechnology had a central role in both the 11<sup>th</sup> and the 12<sup>th</sup> Five-Year Plan (FYP) for Economic and Social Development. In 2013, for the 13<sup>th</sup> FYP, biotechnology is also highlighted as an important tool for sustainable development. In addition, the related sub-plans of the FYP further promote the development of the bioindustry, considered as the most influential industry of the 21<sup>st</sup> century, covering the health sector, agriculture, manufacturing, bioenergy, environmental technology and R&D. However, innovation in agriculture and food production remains the core area of intervention.

<sup>&</sup>lt;sup>102</sup> FAO, Assessing the Contribution of Bioeconomy to Countries' Economy – A brief review of national frameworks, Rome, 2018, p.16.

<sup>&</sup>lt;sup>103</sup> German Bioeconomy Council, *Bioeconomy Policy (Part II): Synopsis of National Strategies around the World*, Office of the Bioeconomy Council, Berlin, January 2015, p. 68.

<sup>&</sup>lt;sup>104</sup> German Bioeconomy Council, *Bioeconomy Policy (Part III): Update Report of National Strategies around the World*, Office of the Bioeconomy Council, Berlin, April 2018, p. 56.

Similarly, the Indian government endorsed the "Biotechnology Development and Innovation Strategy" in 2007, and released, after a public consultation, an updated "Biotechnology Strategy II" in 2014. Bioeconomy is here seen as the translation of life sciences knowledge into products that are eco-friendly and competitive. As for other countries, the strategy is built to promote innovation and interdisciplinary projects, modernize the scientific landscape and, especially, take advantage from the potential of a large, well-educated population in this field. The focus is on pharmaceutical biotechnology, bioenergy and biobased environmental technologies.

Russia, for its part, adopted a "Comprehensive Program for the Development of Biotechnology – BIO2020" in 2012, and an implementation roadmap a year later. The term "bioeconomics" is used in the document and is considered as the basis for the creation of post-industrial economics. Bioeconomy should be used to foster the industrial added value of the country's huge biological resources (especially forest-based biomass). Moreover, the program seeks to make Russian industry more competitive and to reduce the import dependence on foreign biotech products, while improving the country's selfsufficiency in food and medicines. Rural development, job creation and sustainability are also considered as consequences of the industrial innovation.

South Korea and Sri Lanka have also shown their interest in biotechnology in the last decade. Actually, South Korea had already developed the document"2<sup>nd</sup> Framework plan for the Promotion of Biotechnology" ("Bio-Vision 2016") in 2006, with targets to foster the biotech industry, revised in 2012 as the "Strategy for promotion of industrial biotechnology". In parallel, the "Low Carbon, Green Growth Strategy" was published in 2008, focusing on the reduction of GHGs emissions and the advancement of green innovation and technologies, as one of the first countries in Asia. Furthermore, the country appears to be a leader in marine biotechnology policy, issuing in 2008 the "Blu-Bio 2016 Plan.

Inspired by the biotechnology advancement occurring in South and South-East Asia, Sri Lanka developed the "National Biotechnology Policy" in 2010. The document represents the first effort of the Sri Lankan government to encourage innovation and cross-sectorial application of biotechnology. The main goal for the country is to use biotechnology in a way to enhance the quality of life of the citizens, especially in terms of food security, health, clean environment and socio-economic development. The strategy takes into account all types of biotechnology that increase the added value from natural feedstocks, with a special focus on agricultural biotechnology.

In context of bioeconomy development in Asia, policy advancement in Indonesia is also worth mentioning. In particular, the country mainly focuses on two bioeconomy-related areas: bioenergy and agro-industry. Indeed, the "National Energy Policy" adopted in 2014, highlights the potential of bioenergy as an important renewable energy source. Progress in the agro-industry sector is, instead, promoted through the "Grand Strategy of Agricultural Development 2015-2045". The main goal of both documents is to ensure energy autonomy, food security, economic growth, improved health and ecological sustainability. What is more, the country is seeking to make a shift from primary agriculture, which still employs 30 percent of the country total workforce, to an integrated agricultural bioindustry based on local resources, small-scale sustainable agriculture and bio-business favourable infrastructure<sup>105</sup>.

Finally, Australia and New Zealand also resulted to be active in the process of political support to bioeconomy development. Indeed, while not developing a holistic national bioeconomy strategy, Australia is encouraging regional bioeconomy-related initiatives. As an example, the Federal State of Queensland adopted the "Queensland Biofutures 10-Year-Roadmap and Action Plan" in 2016, promoting advanced manufacturing, biomedical science, industrial biotechnology and biobased product sector, with the aim to increase economic growth and create jobs, especially in rural areas. The idea is also to greening the economy of the State and achieve environmental and climate-protection goals. In this context, primary role in the short term is given to the development of biofuels from agricultural resources.

New Zealand, instead, used a more national approach, by adopting in 2017 the bioeconomy research strategy entitled "Primary Sector Science Roadmap – Te Ao Turoa", based in turn on the "National Statement of Science Investment 2015-2025. The bioeconomy is defined in the strategy as the "set of economic activities relating to the

<sup>&</sup>lt;sup>105</sup> German Bioeconomy Council, *Bioeconomy Policy (Part II): Synopsis of National Strategies around the World*, Office of the Bioeconomy Council, Berlin, January 2015, p. 67.

invention, development, production and use of biological products and processes<sup>106</sup>", recalling the OECD definition<sup>107</sup>. As all the others biomass-rich countries, the focus of New Zealand is on the innovation of the primary sector (including agriculture, forestry, fisheries and aquaculture) and natural resources. Indigenous people and their knowledge have a central role in the promotion of the bioeconomy. The need for increased research in social sciences, especially in terms of understanding of consumer behaviour, is also highlighted.

### 2.2.4 Europe

The development of national bioeconomy policy strategies in the European Union has been strongly influenced by the work of the European Commission (EC) in the field of biotechnology. Indeed, the EC has been in charge of preparing, managing and implementing the "EU Framework Programmes in Biotechnology and Life Sciences" since 1982<sup>108</sup>. The research programmes changed over the years in terms of budget, participation and ambitions. Relevant for the scope of this work is, in particular, the 5<sup>th</sup> EU Framework Programme, which lasted from 1998 to 2002, and created the so-called "Key Actions", focusing on socio-economic targets and policy objectives that the Community needed to reach. Among them it can be identified the "Cell Factory" Key Action, which interpreted the cell as a factory, aiming at developing new type of biobased products. Towards the end of the Cell Factory, the "Strategy on Life Sciences and Biotechnology" was adopted in 2002. Several years later, in 2007, on the occasion of the strategy's review, it was pointed out that greater efforts should be made in order to promote R&D for biotechnology and life sciences applications; foster competitiveness; encourage societal debates on the topic; ensure a sustainable contribution of biotechnology to the primary sector; and improve the policy implementation. Furthermore, the idea to reach a competitive and sustainable Knowledge Based Bio-Economy in the European Union, as already presented in a conference in 2005 by the Commissioner for Research, Science and Innovation Janez Potocnik, was recalled. Finally, thirty years later the adoption of the first EU research programme on biotechnology, the Strategy "Innovating for sustainable growth: A Bioeconomy for

<sup>&</sup>lt;sup>106</sup> German Bioeconomy Council, *Bioeconomy Policy (Part III): Update Report of National Strategies around the World*, Office of the Bioeconomy Council, Berlin, April 2018, p. 63.

<sup>&</sup>lt;sup>107</sup> OECD, The Bioeconomy to 2030: Designing a Policy Agenda, OECD Publishing, Paris, 2009.

<sup>&</sup>lt;sup>108</sup> Patermann, C., Aguilar, A., *The origins of the bioeconomy in the European Union*, New Biotechnology 40, Elsevier B.V., 2018, 20-24, p. 20.

Europe" was launched in 2012. The document highlights the need to build "a more innovative, resource efficient and competitive society that reconciles food security with the sustainable use of biotic renewable resources for industrial purposes, while ensuring environmental protection<sup>109</sup>". In particular, five main objectives are identified in the document: ensuring food security; managing natural resources sustainably; reducing dependence on non-renewable resources; mitigating and adapting to climate change; and creating jobs and maintaining EU competitiveness<sup>110</sup>. On 22 October 2018, the Council launched a review of the strategy, now called "A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment". The updated strategy changes a bit the focus of the EU actions in the context of bioeconomy, underlining the importance of regional bioeconomy strategies, rural renaissance and of sustainable management of natural resources. The 2018 Bioeconomy Strategy is built on three main action areas: strengthen and scale up the bio-based sectors, while unlocking investments and markets; deploy local bio-economies across the whole Europe; and understand the ecological boundaries of the bio-economy<sup>111</sup>. Furthermore, the update of the strategy highlights the need to accelerate the deployment of a sustainable circular bioeconomy in Europe in order to maximise its contribution to 2030 Agenda and its SDGs, as well as the targets imposed by the Paris Agreement. In addition, the Horizon 2020 had a significant role in providing the basis for further development of innovation strategies and national research in Europe<sup>112</sup>.

In this context, Germany had a great role in the development of a bioeconomy policy in the European Union. Indeed, during the German Presidency of the EU Council in 2007, Germany the importance of the use of biological resources as primary feedstock and significant role of biorefineries as production facilities had already been stressed. Furthermore, the German Bioeconomy Council (an independent expert committee to advise the Federal Government in bioeconomy policy questions) was established in 2009. Then in 2010, a bioeconomy dedicated national research strategy was published by the German government, three year before the implementation of a final dedicated

<sup>&</sup>lt;sup>109</sup> European Commission (2012), *Innovating for Sustainable Growth. A Bioeconomy for Europe*, European Union, Brussels.

<sup>&</sup>lt;sup>110</sup> Interreg Europe, *Important Update on the EU Bio-Economy Strategy*, Policy Learning Platform, 20 November 2018, <u>https://www.interregeurope.eu/policylearning/news/4395/important-update-on-the-eu-bioeconomy-strategy/</u>.

<sup>111</sup> Ibidem.

<sup>&</sup>lt;sup>112</sup> German Bioeconomy Council, *Bioeconomy Policy (Part II): Synopsis of National Strategies around the World*, Office of the Bioeconomy Council, Berlin, January 2015, p. 84.

Bioeconomy Policy Strategy. The documents consider the sustainable production of renewable resources and advances in biotechnology as key drivers of the bioeconomy; in particular, the Strategy identifies five core action areas: sustainable agriculture production, global food security, healthy and safe nutrition, industrial use of renewable resources and improving the use of bioenergy<sup>113</sup>. The importance of collaboration and transparency is also highlighted.

Together with Germany, Finland has been one of the first countries to develop a bioeconomy dedicated strategy in Europe. The sustainable and innovative use of biological resources was already promoted in the Natural Resource Strategy, adopted in 2009. Additionally, the sustainable replacement of fossil resources to tackle with the climate change and the depletion of the ecosystem is also pursued by the document "Distributed Bio-based Economy – Driving Sustainable Growth" and the report "Sustainable Bio-economy: Potential Changes and Opportunities for Finland" of 2011. Finally, the first comprehensive policy strategy on bioeconomy was published by the Finnish government in 2014, with the title "The Finnish Bioeconomy Strategy – Sustainable growth from bioeconomy". The Finnish definition of bioeconomy refers to the use of renewable natural resource to produce food, energy products and services. Also, one of the core elements of the strategy is the forest industry.

In 2014, The Nordic Council of Ministers<sup>114</sup> also announced the publication of a macro-regional bioeconomy strategy for the West Nordic countries (Iceland, Greenland and the Faroe Islands), which was called "Future Opportunities for Bioeconomy in West Nordic Countries". Since the economy of these countries is mainly based on fisheries, marine bioresources, representing the countries' competitive advantage, have a central role. Moreover, a common Nordic bioeconomy strategy (including also Denmark, Finland, Norway and Sweden) seems to be in development. Also, cooperation and dialogue are fostered in the Baltic Sea Region by the Baltic Sea Region Bioeconomy Council<sup>115</sup>.

<sup>&</sup>lt;sup>113</sup> German Bioeconomy Council, *Bioeconomy Policy (Part I): Synopsis and Analysis of Strategies in the G7*, Office of the Bioeconomy Council, Berlin, January 2015, p. 26.

<sup>&</sup>lt;sup>114</sup> The Nordic Council is an official body and cooperation forum composed of government representatives from Denmark, Finland, Iceland, Norway and Sweden. The West Nordic Council, instead, only includes representatives from Iceland, Faroe Islands and Greenland.

<sup>&</sup>lt;sup>115</sup> German Bioeconomy Council, *Bioeconomy Policy (Part III): Update Report of National Strategies around the World*, Office of the Bioeconomy Council, Berlin, April 2018, p. 1.

In this context, Norway finally adopted the national bioeconomy strategy entitled "Familiar resources – undreamt possibilities" in 2016, after a consultative, multi stakeholder process based on a national conference, a series of workshops and regional meeting.

Besides, several other European countries have announced the adoption of a dedicated bioeconomy policy strategies since 2015: Spain, France, Italy, Latvia and Ireland (in a chronological order)

Indeed, the Spanish government adopted their first bioeconomy dedicated strategy, entitled "Horizon 2030", in 2016. The document highlights the importance of innovations in the biosciences and digitalization, as fundamental drivers for the transition to a sustainable bioeconomy. New technology and innovation in the agri-food and forestry sectors are therefore critical in this context. At the same time, spill-over effects from the primary sector to bio-innovation in other industrial sectors are encouraged by "Horizon 2030"<sup>116</sup>. In addition, bioeconomy development is also promoted at the regional level, with the initiatives of Andalusia and Extremadura.

France, for its part, published "A Bioeconomy Strategy for France" in 2017, as the base for a policy for long-term bioeconomy development. After a stakeholder consultation, the dedicated action plan is also released in 2018. This was not, nevertheless, the first French effort towards the building up of a bioeconomy policy. The country, as one of the largest European agricultural producers and exporters and hosting among the world's biggest biorefineries, could, indeed, already boast a number of initiatives in terms of political support of the bioeconomy. Anyway, the final strategy defines the bioeconomy as "the whole range of activities linked to the production, use and processing of bioresources", and stresses the concepts of sustainability and circular economy. The French government primarily seeks to foster food security, rural development and independence from fossil fuels imports, through the sustainable development of bioenergy. Innovation in the primary sector is also at the core of the strategy.

In Italy, the Italian Agency for Territorial Cohesion had already presented the draft of a dedicated bioeconomy strategy on its website in 2016, in order to call for a public

<sup>&</sup>lt;sup>116</sup> Ibid., p. 96.

consultation. Bioeconomy development in the country has, indeed, been strongly influenced by private actions of companies in green chemistry or regional clusters. In April 2017, the national strategy was officially adopted by the Italian government. Furthermore, a position paper on bioeconomy has also been developed by the Italian Conference of Regions and Autonomous Provinces at regional level. As for other countries, bioeconomy development in the Italian context focuses on the need of innovation in the primary sector. Similarly, to France and anticipating the EU guidelines, the strategy gives a preponderant role to the concept of circular bioeconomy. Ensure food security while limiting climate change are the key global issues that the strategy addresses. From a domestic point of view, the need to reduce dependence on fossil resources as well as rural and coastal development, the prevention of biodiversity loss and fostering Italy's competitiveness, through a sustainable circular bioeconomy, are highlighted.

At the end of 2017, another European state published its own national bioeconomy strategy: Latvia. The government, indeed, adopted the dedicated bioeconomy strategy 2030 (LI-BRA), in compliance with the Latvian Sustainable Development Strategy 2030 and the National Development Plan 2014-2020. The definition of bioeconomy that can be found in the strategy is aligned to the one of the European Commission of 2012, and clearly stresses the link with Agenda 2030 and its SDGs. As many others, the Latvian bioeconomy strategy concentrates on the sustainable use and production of natural resources.

The last country of the EU having adopted a dedicated bioeconomy strategy – at the timing of writing this thesis – has been Ireland. The Irish government, indeed, published in February 2018 a "National Policy Statement on the Bioeconomy", interpreting the concept as extending "from farming to the agri-food businesses, marinebased industries, forestry, waste management, energy suppliers, and pharma and biotechnology products"<sup>117</sup>. It highlights the need to promote coherence between the many sectors of the bioeconomy; to grow bio-based markets; leverage private investment. Furthermore, the strategy mentions the sustainability, cascading, precautionary<sup>118</sup> and

<sup>&</sup>lt;sup>117</sup> Government of Ireland, National Policy Statement on the Bioeconomy, February 2018, p. 2.

<sup>&</sup>lt;sup>118</sup> The principle reflects a risk management approach in order to prevent policies or actions which can cause harmful effects to the public and the environment. *Source*: Government of Ireland (2018).

"food first" principles as guidelines to translate the bioeconomy vision into coordinated actions.

To conclude, other countries in the Europe, such as Austria, Iceland, Estonia and the UK, have announced the preparation of national dedicated bioeconomy policies. All of them have, however, already developed a series of documents and policy support in several bioeconomy-related areas (R&D, Blue Economy, Green Economy, High-Tech, Bioenergy, Circular Economy and Bioenergy), as can be seen from the Annex 1. Lithuania, The Netherlands and Portugal join also the group. Belgium, instead, has developed a holistic bioeconomy strategy but with a regional approach, through the adoption of the "Bioeconomy in Flanders" by the Flemish government in 2014, a first memo describing the Flemish vision for a sustainable transition to bioeconomy in their region.

# 2.3. A comparative analysis of the Bioeconomy Policy Cycle

As can be seen from the previous section, all the bioeconomy (dedicated or related) policy strategies adopted around the world vary in scope and depth and differ in terms of objectives pursued and actors addressed. At the same time, common goals and general measures are shared by many countries, such as the need to foster technological innovation, economic growth, resource efficiency and ecological sustainability. Furthermore, the idea of shifting from just promoting biotechnology and bioenergy as a stand-alone solution to the idea of fostering the value-added, cascading use of biological resources can be considered as a general trend<sup>119</sup>.

## 2.3.1 Pre-decision phase: agenda setting and policy formulation

Globally, the motivations underlying bioeconomy strategies range from the desire to secure access to raw materials to the comprehensive regeneration of the innovation system and the ecological transformation of the economy<sup>120</sup>. Nevertheless, as already mentioned, the setting of priorities can present great variation between countries. This stage of the policy cycle is in fact influenced by country-specific characteristics or

<sup>&</sup>lt;sup>119</sup> BioSTEP, *Review of Bioeconomy Strategies at Regional and National levels*, Brussels, January 2016. <sup>120</sup> Ibid., p. 16.

strengths. The industrial and economic profile of the individual countries as well as their natural resources potential, e.g. the amount of natural resources which can be sustainably exploited for commercial and energy use, influence a lot the aims that a strategy should pursue in the context of bioeconomy development. Indeed, resources-rich countries usually promote innovation in the primary production sector and see the bioeconomy as an opportunity to capitalize this strength. Many regions of Canada, for instance, focus more on the forestry sector due to the high potential of their forest resources; whereas the West Nordic Countries (e.g. Iceland) promote the use of oceans and marine ecosystems<sup>121</sup>. The US, Finland, the Netherlands and Norway also follow this scheme. On the other hand, countries which lack in big amounts of natural resources but have a strong industrial structure, such as Germany, Japan, France and Italy, mainly focus on their industrial and technological leadership. The UK, for example, is seeking to develop high-value industries, pursuing a "reindustrialization strategy", Which consists of fostering extensive production capability. Similarly, France developed the "Green Chemicals and Biofuels" initiative to modernise industrial facilities for biofuels<sup>122</sup>. In addition, Germany, Japan and UK also underline the importance to establish international technology and resource partnerships with emerging countries, which have a big supply of biomass, in order to secure access to raw materials.

Furthermore, according to the German Bioeconomy Council<sup>123</sup>, industry, civil society representatives and the public in general have been included in the first stage of the bioeconomy policy development globally. Many countries adopted, indeed, a participatory approach of bioeconomy policy formulation, launching public consultation processes in order to take into account the voice of the stakeholders in a way that could create a shared vision of bioeconomy. This process is often based on the preparation of workshops, conferences or even online surveys, aiming at integrating public feedback into a final strategy document. Additionally, multi-stakeholder dialogue is seen as a crucial part of the bioeconomy policy development since it ensures mutual learning and inclusive participation. Some countries, such as Argentina, Australia, Ireland, Italy, the UK and the United States, have commissioned a foresight report to identify country-specific opportunities and challenges in bioeconomy. The preparation of five workshops,

<sup>&</sup>lt;sup>121</sup> Priefer, C., et al., Pathways to Shape the Bioeconomy, in Resources Journal, 2017, 6,10, p. 3.

<sup>&</sup>lt;sup>122</sup> BioSTEP, *Review of Bioeconomy Strategies at Regional and National levels*, Brussels, January 2016, p.16.

<sup>&</sup>lt;sup>123</sup> German Bioeconomy Council, *Bieconomy Policy (Part III): Update Report of National Strategies around the World*, the German Bioeconomy Council, Berlin, April 2018, p. 19.

three regional forums and sectoral consultations also paved the way for the adoption of the Finnish strategy, which can be considered a good example of stakeholder consultation. Spain and Italy also included the inputs of science experts, social organizations and private sector, as well as a public consultation. Finally, the European Commission also carried out a public consultation in 2011, before the publication of the European Bioeconomy Strategy in 2012.

### 2.3.2 Implementation: Top-down vs bottom-up approaches

In many of the considered countries, the development of bioeconomy is principally driven by central government policy that develops visions, strategies and action plans to promote and shape the important societal shift that the bioeconomy represents. In particular, the top-down kind of approach has been used by Finland, Germany, Japan, the Netherlands, Norway and the US.

However, many private stakeholders have progressively become active in bioeconomy policy in the last years, and the industry-driven initiatives have also increased. In Japan, for instance, the Japan Bioindustry Association (JBA) developed a Vision Document for the Japanese bio-based industry. The latter includes the medical sector, environmental technologies, agriculture, fisheries and food processing. The JBA estimates that future bioeconomy will contribute JPY 15 to 25 billion (around USD 142-237 billion)<sup>124</sup>. As another example, bioindustry associations in India are also promoting developments in bioeconomy and all the related sectors. Indeed, the Association of Biotechnology-Led Enterprises (ABLE) presented in 2016 a report highlighting the economic growth potential of the Indian biotechnology industry and organised the first Indian bioeconomy conference.

Actually, countries like Italy, Belgium, France or Canada, seek to exploit existing private sector and public research initiatives, primarily relying on regional led or industrial funded actions, consequently adopting a bottom-up approach to the implementation of the bioeconomy policy. For example, in Belgium, the Government of

<sup>&</sup>lt;sup>124</sup> German Bioeconomy Council, *Bieconomy Policy (Part III): Update Report of National Strategies around the World*, the German Bioeconomy Council, Berlin, April 2018, p. 15.

Flanders developed a strategy with the aim of incentivising existing and future stakeholders within the bioeconomy to detect and seize opportunities themselves<sup>125</sup>.

Falling in the categories of the bottom-up kind of approaches, the local-level approach to bioeconomy implementation is developing in some regions. Two good examples are the Malaysia community-based bioeconomy and the 'Japan Biomass Town'<sup>126</sup>. The Argentinian strategy also presents territorial planning because of the different types of biomass produced in each region and the specific features of the industry value chains that each region embraces to optimize their natural resources. Another important reason for the use of local approach to bioeconomy implementation is the difficulty of biomass logistics. For instance, the majority of ethanol and by—products plants are located in hinterlands, far from the ports<sup>127</sup>. As it will be further discussed (see chapter 3), the necessity of this kind of approach could represent a great opportunity for the regeneration of rural areas.

Finally, according to FAO<sup>128</sup>, some countries (such as Denmark, Japan, UK and Germany) combine the top-down and bottom-up approaches.

### 2.3.3 Results: bioeconomy evaluation programs and advisors

The evaluation of policy strategies is also promoted by some countries to assess the accountability of bioeconomy development<sup>129</sup>. For instance, Finland launched the evaluation process of its strategy in 2016, led by the Ministry of Employment and the Finnish Bioeconomy Panel. In Germany, a series of workshops accompanied the revision of the bioeconomy research strategy, and an evaluation of the strategy was commissioned by the Ministry of Education and Research (BMBF), which resulted in a report published in 2017. The German Bioeconomy Council and the Ministry of Food and Agriculture have also a critical role in the monitoring of the German bioeconomy policy. The

<sup>&</sup>lt;sup>125</sup> BioSTEP, *Review of Bioeconomy Strategies at Regional and National levels*, Brussels, January 2016, p. 16.

<sup>&</sup>lt;sup>126</sup> The Japanese "Biomass Town Concept" is based on the creation of a comprehensive biomass utilization system – concerning thus the generation, conversion, distribution and use of biological feedstocks – carried out by several stakeholders, which are linked through institutional arrangements (e.g. cooperatives and regional clusters). The system is adapted to local conditions and results to be appropriate to the community. *Source:* FAO (2018).

<sup>&</sup>lt;sup>127</sup> FAO, How sustainability is addressed in official bioeconomy strategies at international, national and regional levels - An overview, Rome, 2016, p.15.

<sup>&</sup>lt;sup>128</sup> Ibid., p.15.

<sup>&</sup>lt;sup>129</sup> German Bioeconomy Council, *Bieconomy Policy (Part III): Update Report of National Strategies around the World*, the German Bioeconomy Council, Berlin, April 2018, p. 17.

European Union and Malaysia have shown their willingness as well in carrying out evaluation efforts. In Malaysia, the progress report on the country's Bioeconomy Transformation Program (adopted in 2012) has been published by the Bioeconomy Corporation (the public agency responsible for implementation of the bioeconomy strategy) in 2017. The report shows key achievements in the area of industrial, agricultural and medical/pharmaceutical biotechnology, and quantifies the bioeconomy's contribution to gross national income, investments and job opportunities<sup>130</sup>. In the European Union, several activities have been launched by the European Commission in order to monitor bioeconomy development in its territory. These actions fall under the wider project called "Bioeconomy Observatory", led by the Joint Research Center (JRC) of the EU. In 2015, the JRC estimated that bio-based economy turnover was about 2.4 billion EURO, with almost 22 million persons employed<sup>131</sup>. In 2017, the European Commission presented an expert review of the European bioeconomy strategy; in 2018 it announced the publication of an updated strategy and a revised action plan.

Finally, an increasing number of countries is also establishing dedicated advisory councils, representing public, private and civil society stakeholders, to provide advisory services for bioeconomy policy development<sup>132</sup>. For instance, the Nordic Bioeconomy Panel and the Baltic Sea Region Bioeconomy Council were established in 2015. In the same year, a national Bioeconomy Panel was created in Finland, together with a Bioeconomy Forum, set up by the Technical Research Centre of Finland (VTT). In 2016, the European Commission launched the Bioeconomy Panel, which published its own Manifesto<sup>133</sup> in 2017. In parallel, a Bioeconomy Council was set up in Denmark and a "Bioeconomy Federation" was formed in the Netherlands. Also, a national bioeconomy panel was formed in the Czech Republic in 2016; nevertheless, according to the GBC, the panel has not been officially institutionalized.

<sup>&</sup>lt;sup>130</sup> Ibidem.

<sup>&</sup>lt;sup>131</sup> Scarlat N., Dallemand J.F., Monforti-Ferrario F., Nita V., *The role of biomass and bioenergy in a future bioeconomy: Policies and facts*, European Commission, Joint Research Centre, ISPRA, Italy, 2014, p. 13.

<sup>&</sup>lt;sup>132</sup> German Bioeconomy Council, *Bieconomy Policy (Part III): Update Report of National Strategies around the World*, the German Bioeconomy Council, Berlin, April 2018, p. 18.

<sup>&</sup>lt;sup>133</sup> European Bioeconomy Stakeholders Panel, *European Bioeconomy Stakeholders Manifesto*, Brussels, 2017, available at:

https://ec.europa.eu/research/bioeconomy/pdf/european\_bioeconomy\_stakeholders\_manifesto.pdf#view=fit&pagemode=none.

Globally, there is general consensus about the need to foster cooperation among different actors and sectors in order to ensure the bioeconomy policy to be coherent and effective. In particular, inter-ministerial collaboration and federal-state cooperation is mainly promoted. The strategies of Argentina, Australia, Italy, Spain, Thailand and the US, for example, propose to establish inter-governmental working groups and to provide some exchanges of personnel and memoranda of understanding among governmental authorities<sup>134</sup>. Moreover, in Austria, a sub-working group on bioeconomy has been created as part of the inter-ministerial working group on climate change<sup>135</sup>. Some evidence about the inter-ministerial collaboration on the topic of bioeconomy has also been found in Ireland and Germany. Furthermore, the importance of inter-regional coordination and best-practices is also underlined: for instance, some countries organize regular regional bioeconomy events. To name an example, FAO reported that the Baltic Sea Region strategy established the "Baltic Sea Region (BSR) Bioeconomy Policy Dialogue Forum", which organize meetings twice a year, in order to assess the policy strategy, fund opportunities and adopt a detailed cooperation framework<sup>136</sup>.

Besides, during its last meeting in 2018, the GBS reiterated the need to foster international collaboration and dialogue. Actually, after the creation of the IACB in 2015, that is mainly working as an informal platform composed of leading bioeconomy experts, the GBS2018 re-emphasized the urgency to make it more structured, or even to institutionalize it. During the Summit, indeed, it was recommended to explore options for the design and the creation of an international mechanism for knowledge exchange and coordination on global bioeconomy<sup>137</sup>. As discussed in the first chapter (see section 1.2.3), the global management of the bioeconomy is critical in terms of transfer of technology, trade in biomass and prevention of the over-exploitation of natural resources. Nevertheless, while often mentioned, international collaboration in the bioeconomy has hardly been addressed in most policy strategies so far<sup>138</sup>.

 <sup>&</sup>lt;sup>134</sup> German Bioeconomy Council, *Bieconomy Policy (Part III): Update Report of National Strategies around the World*, the German Bioeconomy Council, Berlin, April 2018, p. 19.
 <sup>135</sup> Ibidem.

<sup>&</sup>lt;sup>136</sup> FAO, *How sustainability is addressed in official bioeconomy strategies at international, national and regional levels - An overview,* Rome, 2016, p.16.

<sup>&</sup>lt;sup>137</sup> Global Bioeconomy Summit (2018), *Communiqué of the Global Bioeconomy Summit 2018: Innovation in the Global and Inclusive Transformation and Wellbeing*, Berlin, p.3.

<sup>&</sup>lt;sup>138</sup> German Bioeconomy Council, *Bieconomy Policy (Part III): Update Report of National Strategies around the World*, the German Bioeconomy Council, Berlin, April 2018, p. 20.

### 2.4 Towards a better governance of the Bioeconomy

The need to ensure a good governance of bioeconomy has become a big issue recently. This urgency derives, according to Von Braun<sup>139</sup>, from five factors which the bioeconomy policy has to deal with: the high level of complexity of the system; the interconnectedness of policy domains; conflicting goals of the individual countries; market failures (externalities); and the delivery of public goods. The bioeconomy is, indeed, considered as a hot topic in research and a very complex area, involving, as also showed by the above-mentioned policy strategies, a multitude of competing interests, scopes and definitions. For instance, among the most developed countries, such as the EU, Japan and the US, the idea is to promote bioeconomy development as a way to reindustrialize and create wealth; China and India, instead, as emerging economies, focus on biotechnology as a part of innovation, in which they can quickly compete<sup>140</sup>; and, finally, resources rich countries, such as Brazil, Australia, Malaysia, South Africa, Russia, are investing to better exploit and add value to their vast biological resources. Moreover, it seems that developed countries focus more on ecological sustainability, while developing countries give more attention to inclusive and equitable rural development. It becomes clear that the conflicting nature of national priorities makes it hard to build a sustainable bioeconomy which could operate at a global scale, and to align bioeconomy policy to meet the targets of Agenda 2030 and its SDGs. Indeed, as shown in the chapter 1, unsustainable bioeconomy development could lead to negative collateral effects, such us land use change, inequitable biomass trade, food insecurity. However, these indirect effects and trade-offs cannot be addressed or taken into account without agreed global priorities and assessment methods<sup>141</sup>.

In this context, good governance could seek to co-ordinate collective action amongst different stakeholders at different scales (from local to global) with the aim to pursue social, environmental and economic goals. Applying principles such as accountability, transparency, effectiveness, participation and fairness at national level can be a starting point for the building up of a good governance of the bioeconomy. At the

<sup>&</sup>lt;sup>139</sup> Von Braun, J. (2017), *Governance of the Bioeconomy*, European Workshop on Bioeconomy, [Power Point Slides] Paris. Retrieved from <u>http://biooekonomierat.de/fileadmin/Veranstaltungsdokumente/JvB\_Good\_Bioeconomy\_Governance\_Par</u> is\_formatiert.pdf.

<sup>&</sup>lt;sup>140</sup> El-Chichakli, B., von Braun, J., Lang, C., Barben, D. and Philp, J. (2016), *Policy: Five Cornerstones of a Global Bioeconomy*, Nature, 535(7611): 221-223.

<sup>&</sup>lt;sup>141</sup> Ibidem.

same time, national bioeconomies needs a globally coordinated governance framework which would set a series of priorities and targets to be reached for a sustainable bioeconomy. Indeed, while a great number of countries showed their interest in promoting bioeconomy development through comprehensive political support, only few of them present in their strategies the political management of conflicting goals and potential risks. Additionally, those policies often provide only soft political tools and approaches to manage the negative consequences of bioeconomy for sustainable development<sup>142</sup>.

More research is therefore required to identify the ingredients of such a framework. For now, the GBS 2018 gave some recommendations about the types of actions to be used to improve governance, that can be summarized as follows: leading an international policy and stakeholder dialogue; promoting societal participation; and establishing linkages with sustainable development policy<sup>143</sup>.

## 2.5 Conclusions

According to the German Bioeconomy Council<sup>144</sup>, almost 50 countries have adopted strategies related to bioeconomy development in the world. Among them, only fifteen countries, including the European Union and the West Nordic Countries, have developed dedicated strategy, following a holistic approach to bioeconomy development, understanding therefore the bioeconomy as a broad societal transition that involves a variety of sectors, actors and interests. As shown in Table 1, Argentina, Finland, France, Germany, Ireland, Italy, Japan, Latvia, Malaysia, Norway, South Africa, Thailand and the United States fall in this group. All other countries have adopted strategies which present a – more or less strong – link to the bioeconomy. In particular, these normally refer to the promotion of R&D and innovation; the development of high-tech infrastructures; capacity building and education; or are more focused on particular sectors, such as: bioenergy, biotechnology, Green and Blue Economy, agriculture and forestry. Canada, for example, defined the concept of "forest-based bioeconomy"; the UK and New Zealand (but also the US) highlight instead the importance of synthetic biology and high-tech innovation.

<sup>&</sup>lt;sup>142</sup> Dietz, T., Börner, J., Förster, J.J., von Braun, J. (2018), *Governance of the Bioeconomy: A Global Comparative Study of National Bioeconomy Strategies*, in Sustainability, MDP, Basel, Switzerland, p.2.

<sup>&</sup>lt;sup>143</sup> Global Bioeconomy Summit (2018), Communiqué of the Global Bioeconomy Summit 2018: Innovation in the Global and Inclusive Transformation and Wellbeing, Berlin.

<sup>&</sup>lt;sup>144</sup> German Bioeconomy Council, *Bieconomy Policy (Part III): Update Report of National Strategies around the World*, the German Bioeconomy Council, Berlin, April 2018, p. 13.

Furthermore, taking into account the date of publication of the strategies, Germany and Japan can be considered as pioneer countries which support the expansion of the bioeconomy in the world. In particular, the role of Germany was critical for the creation of special strategies and action plans at the EU level. Finland and the Benelux countries have also been very active in preparing policies and implementing activities to foster bioeconomy development<sup>145</sup>.

Country	Title	Year
Germany	"National Research Strategy BioEconomy 2030"	2010
	"National Policy Strategy on Bioeconomy"	2013
Japan	"National Plan for the Promotion of Biomass Utilization"	2010
	"Biomass Industrialization Strategy"	2012
EU	"Innovating for Sustainable Growth – A Bioeconomy for Europe"	2012
	"A sustainable Bioeconomy for Europe: strengthening connection between economy, society and the environment" – Updated Strategy	2018
USA	"National Bioeconomy Blueprint"	2012
Malaysia	"Bioeconomy Transformation Programme"	2012
	"National Biomass Strategy"	2013
South Africa	"The Bio-economy Strategy"	2013
Finland	"The Finnish Bioeconomy Strategy"	2014
West Nordic Countries	"Future opportunities for bioeconomy in the West Nordic countries"	2014
Norway	"Familiar resources – undreamt possibilities"	2016
Argentina	"Bioeconomia Argentina"	2017
France	"A bioeconomy Strategy for France"	2017
Italy	"Bioeconomy in Italy: A unique opportunity to reconnect economy, society and environment"	2017
Latvia	"Latvian Bioeconomy Strategy 2030"	2017
Thailand	"Bioeconomy Roadmap"	2017
Ireland	"National Policy Statement on the Bioeconomy"	2018

 

 Table 1: Bioeconomy-dedicated strategies following a holistic approach in chronological order by date of appearance

*Source*: redrawn from Priefer (2017: p. 2), based on data published by the German Bioeconomy Council (2018).

<sup>&</sup>lt;sup>145</sup> Patermann, C., Aguilar, A., *The origins of the bioeconomy in the European Union*, New Biotechnology 40 (2018) 20-24.
Nevertheless, while sharing several common goals, the strategies adopted worldwide are distinct from one another. Each stage of the policy cycle presents, indeed, special characteristics on the basis of the adopting countries. Generally, biomass-rich countries try to leverage their huge natural potential, with envisaged innovation in the agro-food and forestry sector. Biomass-poor but industrialized countries (such as the EU), as well as emerging powers (China and India), give much more importance to the development of their biotechnology sectors and to foster education and training investments.

Furthermore, the two typical kind of approaches have been identified for the implementation of the bioeconomy policy: the top-down approach (used in Finland and Germany for example); and the bottom-up approach, which seeks to exploit the presence of private initiatives at a regional and local level. Some countries have also launched activities and established some bodies in charge of assessing and evaluating the impact of the bioeconomy policies adopted. An increasing number of bioeconomy advisory councils or panel can be identified. However, in spite of the political support to bioeconomy development that the countries are showing, and because of the great variety of the bioeconomy policy in terms of definitions and scope, the creation of a globally agreed governance framework is needed to achieve their goals and to align with the aims of Agenda 2030 and the Paris Agreement. Even though there is a general agreement on the urgency to create such a framework, further research will be needed in order to establish sustainable indicators and targets recognized at a global scale.

After introducing the concept of bioeconomy and the steps towards the building of a sustainable bioeconomy policy which have been done so far, the next chapter will be devoted to one special side of its huge potential: rural regeneration. The issue of policy coherence between the Bioeconomy Strategy and the Common Agricultural Policy (which include the Rural Development policy) will be therefore discussed, both at the European and the Italian level.

### Chapter 3

## Making bioeconomy work for rural revitalization in the European and Italian contexts

CONTENTS: 3.1 Overview; 3.2 The Bioeconomy as a driver for rural renaissance; 3.3 Bioeconomy and rural areas: the EU policy context; 3.3.1 The EU rural development policy; 3.3.2 Integrating CAP principles in the EU Bioeconomy strategies; 3.3.3 The Rural Bioeconomy Portal and its Thematic Group; 3.4 Bioeconomy and rural areas: the Italian policy context; 3.4.1 The Italian Bioeconomy strategy; 3.4.2 The integration between Bioeconomy Strategy and Rural Development programmes in Italy; 3.4 Conclusions.

#### **3.1 Overview**

The revitalization of rural areas is one of the several opportunities which the development of a sustainable bioeconomy can bring to the society. Globally, rural regions are suffering of land abandonment, ageing population, lack of economic diversification and gender imbalances. At the same time, thanks the richness of their ecosystems, rural communities can benefit of a competitive advantage in the context of a system which relies on the use of biological feedstocks for production and energy reasons. In fact, central for the bioeconomy are the biorefineries, which are usually settled down where the biomass grows. However, in order to make bioeconomy work for rural renaissance, coordination has to be ensured between the policies which deal with the two issues. Several countries have already incorporated rural development principles into their bioeconomy policies (and are using local approaches to implement it) in the world. When it comes to the context of the European Union, the relationship between the European Bioeconomy Strategy and the Common Agricultural Policy (CAP) is gaining increasing attention. Indeed, after the recommendations of an Expert Group presented in the review of the 2012 Bioeconomy Strategy for increased cooperation between the EU policies relevant to the bioeconomy, the Commission has dedicated a specific action to support the discussion the incorporation of bioeconomy principles in the present and future

national/regional rural development programmes. Italy, instead, has to work more in this direction.

#### 3.2 The Bioeconomy as a driver for rural renaissance

There is no globally agreed definition of rural areas, which instead varies by region and economic concepts<sup>146</sup>. However, in general and simplest terms, a rural area can be identified as a geographical region with a very low share of population density, and that is located outside of urban centres. According to statistical trends, the majority of the countries boasting the highest number of people residing in rural areas are in developing economies in Africa and Asia<sup>147</sup>. In OECD countries, rural regions are home to one-quarter of the population and account for about 75% of the land area, containing, therefore, the vast majority of land, water and other natural resources<sup>148</sup>. Three dimensions differentiate rural or low-density economies from urban economies. The first takes into account physical distance from markets and the costs it imposes in terms of transport and connectivity. The second approach focus on the issue of competitiveness in regions where the home markets is small, the economy is highly specialised in the production of commodities and transport costs are absorbed by local firms. Generally, the distance of the farmer from the market has critical consequences on his earnings from the sale of his products, the value of his land and thus the aggregate income in the region. The third dimension instead, highlights the way in which the specific natural capability creates economic opportunities, the so-called "first-nature geography"<sup>149</sup>.

Scientific evidence can be found on the potential contribution of rural areas to tackle the main global challenges of the 21<sup>st</sup> century. Actually, they can provide valuable eco-system services which could contribute to mitigate and adapt to climate change, such as the purification of air and water, biodiversity and GHGs mitigation. Moreover, new energy sources, productivity and innovation in food production will be needed for a

<sup>&</sup>lt;sup>146</sup> To name an example, the OECD classifies regions as "predominantly urban", if the share of population living in rural local units (defined as local units where the population density is below 150 inhabitants per square kilometre) is below 15%; "intermediate", if this value is between 15% and 50%; and "predominantly rural", if this value is higher than 50%. However, a region classified as predominantly rural becomes intermediate if it contains an urban centre of more than 200 000 inhabitants; and an intermediate region becomes predominantly urban if it contains an urban centre of more than 500 000 inhabitants, representing at least 25% of the regional population. For further information see: OECD (2011), *Regional Typology*, p.3. <sup>147</sup> See: https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS.

<sup>&</sup>lt;sup>148</sup> OECD (2018), Rural 3.0. A Framework for rural development, OECD Publishing, Paris, p. 7.

<sup>&</sup>lt;sup>149</sup> Ibid., p. 11.

growing global middle class (see chapter 1). Raw materials from these areas will then be needed to enable the next production revolution.

However, rural communities are facing structural challenges in the last decades, especially a combination of population loss and population ageing, making it hard to maintain public services and quality of life. Additionally, rural remote regions seem to be more vulnerable to external economic and environmental shocks; according to the OECD<sup>150</sup>, the share of remote regions in the top 10% of productive regions declined from 21% before the crisis to 9% afterwards. Also, they are significantly affected by the effects of climate change.

It becomes clear that to reach the Sustainable Development Goals, and especially the principle "no one is left behind", the implementation of place-based rural development policies will be critical. The development of a sustainable bioeconomy could be a great opportunity in this direction.

Among the most common visions of the bioeconomy that have been developed so far, the one dedicated to agricultural innovation and the impact of this change of the production system on rural development is gaining increasing momentum. Actually, it is based on the idea that diversifying, revitalising and modernising agriculture, forestry and biomass production can make land more productive and farmers more connected to markets. At the same time, this kind of approach could provide more attractive agricultural and bioresource processing jobs while improving livelihoods, in a way that rural regeneration and revitalization can be finally achieved<sup>151</sup>. At basis of this prospective stands the idea that a sustainable bioeconomic production should rely, therefore, on local processing, reefing and transforming of biomass. Indeed, in the framework of the bioeconomy, supply and value chains<sup>152</sup> have the opportunity to be developed in the place where the biomass grows, instead of originating at the sources of

<sup>&</sup>lt;sup>150</sup> OECD (2018), Rural 3.0. A Framework for rural development, OECD Publishing, Paris, p. 10.

<sup>&</sup>lt;sup>151</sup> Hoff, H., Johnson, F.X., Allen, B., Biber-Freudenberger, L., Förster, J.J. (2018), *Sustainable bioresource pathways towards a fossil-free world: the European bioeconomy in a global development context*, Policy Paper produced for the IEEP Think2030 conference, Brussels, p. 2.

<sup>&</sup>lt;sup>152</sup> Supply chains describe the flows of goods and services between different actors (as an example, the production of wheat, its collection, processing, the manufacturing of pasta and eventual sale). The term "value chains", instead, takes into account the flow of value between different actors in a supply chain and may include a broader set of actors than in supply chains. Value can be referred to different concepts: economic, where the value chains describe the flow of profit or income between actors in the supply chain; environmental or climatic, when value chains are referred to the flow of benefits to given environmental or climate objectives; and social, where value chains describe the flow of benefits to people and communities. *Source:* European Network for Rural Development (2018), *Mainstreaming the Bioeconomy*, Thematic Group Scoping Paper, p. 17. Available at <a href="https://enrd.ec.europa.eu/enrd-thematic-work/greening-rural-economy/bioeconomy\_en">https://enrd.ec.europa.eu/enrd-thematic-work/greening-rural-economy/bioeconomy\_en</a>.

fossil feedstocks<sup>153</sup>. This could have positive environmental, social and economic effects, since the resources transportation costs across oceans are limited and more jobs would be created much closer to the feedstocks.

Rural regions seem then to be key actors to structural change the direction of a bioeconomy. As a matter of fact, they are, on the one hand, critically important in terms of biomass growing, especially in the perspective of food and energy security, i.e. to provide sufficient biological resources to supply the population with food and renewable raw materials. On the other hand, rural areas can benefit from bioeconomy development, since the latter can offer them opportunities to establish new industries, new income and stabilized food market<sup>154</sup>.

In particular, small-scale biorefineries (see Box 2 below) are at the core of the process.



biorefineries must rely on environmental, social and economic sustainability.

*Source*: IEA (2009), *Biorefineries: adding value to the sustainable utilization of biomass*, IEA Bioenergy: T42: 2009: 01.

<sup>&</sup>lt;sup>153</sup> OECD (2018), Realising the Circular Bioeconomy, OECD Publishing, Paris, p.7.

<sup>&</sup>lt;sup>154</sup> Van Liempt, H. (2014), *Research: Global co-operation for locally optimised solutions*, in Research 21 – The International Journal for Rural Development. Available at: <u>https://www.rural21.com/english/a-closer-look-at/detail/article/research-global-co-operation-for-locally-optimised-solutions-00001223/</u>.

Several studies claim that the presence of biorefineries in rural communities can boost rural economies and reduce the rate of migration from rural areas. For instance, a study<sup>155</sup> conducted by the Hungarian Academy of Sciences at the *Pannonia Ethanol* biorefinery at Dunafoldvar in Hungary, found that the establishment and operation of the plant has increased the city's revenues from business tax, giving to the town's budget more room for manoeuvre. In this way, the latter has managed to improve the standard of public services and develop its transport infrastructure, while improving the quality of life of the citizens.

However, opportunities come always along with challenges. Indeed, the development of value chains in rural areas creates the need for a new generation of RD and production companies in these regions. A lot should be done in terms of new skills development and investments on training to form a new, better-educated workforce. Indeed, a higher number of bio-based experts seems to be expected in the future.

As already discussed in chapter 2, several countries are focusing on the importance of bioeconomy to create wellness in rural areas, mentioning the issue in their dedicated (or related) bioeconomy strategies. Indeed, rural development seems to be a critical issue in the strategies of Malaysia, South Africa, China, Argentina, Finland, Russia and United States. Furthermore, different kind of decentralised approach to bioeconomy implementation have been developed so far, with the aim to revitalise rural areas. The already mentioned case of the Japanese "Biomass Town" (see section 2.3.3), is a clear example of regional implementation model which promote local management of the value chains which rely on local conditions and is appropriate to the community.

The Malaysian Bioeconomy Community Development Programme, component of the country's Bioeconomy Transformation Programme also create local jobs and improve the skills of the farmers. The Bioeconomy Corp (the Malaysian bioeconomy implementing agency) give soft loans to company and cooperatives in order to fund the necessary farming purchases for their contracted farmers. In this way, sustainable biomass

<sup>&</sup>lt;sup>155</sup> For further information see: <u>https://biofuels-</u> news.com/display\_news/12288/biorefineries\_boost\_rural\_economies/.

supply can be guaranteed to companies, and farmers get a guaranteed income, a locked demand and the opportunity to develop their bio-entrepreneurship skills<sup>156</sup>.

The establishment of public-private partnerships has also become a way to promote decentralised production and processing. To name an example, the Russian Development Plan of Regional Biotechnology Programmes and Bio-clusters provides the implementation of individual regional programmes for the development of biotechnology and bio-product.

#### 3.3 Bioeconomy and rural areas: the EU policy context

According to an assessment of the rural development policy for the period 2007-2013 conducted by the Directorate-General for Agriculture and Rural Development (DG Agri) in 2013<sup>157</sup>, predominantly rural regions in the EU accounted for around 52% of the territory and 20% of the population. In 2010, 16% of the total GVA and 21% of the employment was generated by rural areas. Moreover, statistics<sup>158</sup> also show that there are significantly differences between the EU Member States (MS) as regard of their regional typologies in 2016 (see Figure 9 below). Indeed, some Member States such as Ireland (more than half of the population was living in a predominantly rural region), Finland, Sweden, Romania and Slovenia, appear to be very rural in terms of share of population living there. Others, such as the Benelux countries and Malta, present a high degree of urbanisation. Consequently, from an aggregate point of view, following the European regional classification<sup>159</sup>, more than half of the EU's population was living in intermediate (36.0%) or predominantly rural (19.2%) regions in 2016.

<sup>&</sup>lt;sup>156</sup> FAO (2016), How sustainability is addressed in official bioeconomy strategies at international, national and regional levels - An overview, Rome, p.15.

<sup>&</sup>lt;sup>157</sup> European Commission (2013), *Rural Development in the European Union. Statistical and Economic Information – Report 2013*, DG Agriculture and Rural Development, Brussels. Available at: https://ec.europa.eu/agriculture/sites/agriculture/files/statistics/rural-development/2013/full-text\_en.pdf.

<sup>&</sup>lt;sup>158</sup> Eurostat, *Eurostat Regional outlook*, accessed in January 2019: <u>https://ec.europa.eu/eurostat/statistics-</u> explained/index.php?title=Regional\_policies\_and\_European\_Commission\_prorities#Rural\_development\_ in\_the\_EU.

<sup>&</sup>lt;sup>159</sup> On the basis of the OECD definitions, Eurostat classification for NUTS level 3 (territorial units for statistics used to establish the urban-rural typology) identifies as: predominantly urban regions, the NUTS 3 where at least 80% of the population live in urban clusters; intermediate regions, the NUTS 3 where between 50% and 80% of the population live in urban clusters; and predominantly rural regions, the NUTS 3 where at least 50% of the population live in rural grid cells.



Figure 9: Population distribution by regional typology in the EU in 2016

Source: Eurostat (2018)

#### 3.3.1 The EU rural development policy

Formally introduced as the second pillar of the Common Agricultural Policy (CAP) on the occasion of the Agenda 2000 reform<sup>160</sup>, the European Rural Development Policy was designed to help rural areas of the EU to meet economic, social and environmental challenges. However, the need to foster the economies of rural areas, while improving the livelihoods of rural communities and ensuring more cohesion between European regions was already highlighted in the early 1960's, with the adoption of the Common Agricultural Policy and in the middle of the European integration process.

The CAP, the first common policy of the EU, was launched in 1962 as a way to revitalise the economies of the Western Europe, strongly damaged by the Second World War, and, most importantly, to support the creation of an internal single market in agriculture, while insulating the agriculture sector from the international competition.

<sup>&</sup>lt;sup>160</sup> Eurostat, *Regional policies and European Commission priorities*, Statistics Explained, 2018. Available at: <u>https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Regional\_policies\_and\_European\_Commission\_priorities#Rural\_development</u> in the EU.

According some authors, the CAP was basically an anti-market policy: the price of agricultural products were, in fact, not established by the market through a balance of demand and supply but, instead, depended on political decisions. The idea underlaying the policy was that of guaranteeing even small-scale farmers a lifestyle compatible with general standards. Farmers were protected against the effects of the over-production (essentially the Community used to buy the surpluses that were not absorbed by the market) and the import competition was counterbalanced through export subsidies. In this context, the basic orientation of farmers became rent-seeking instead of profit-making. With the time, this kind of protectionism resulted in exacerbating intra-sectorial inequalities. Indeed, the price-support system benefited more large farmers than small farmers and encouraged large-scale industrial methods. This started to have a negative impact on both the traditional life of farmers and the environment. In addition, it became clear that this kind of sectoral support was not useful to stop the decline of many rural areas.

However, limited assistance to farm restructuring accompanied the CAP market measures between 1972 and 1994, through the European Agricultural Guidance and Guarantee Funds (EAGGF) and the European Regional Development Fund. Indeed, even if intrinsically linked to agriculture, rural development measures have been mainly considered as part of the EU's regional development policy until the 1990's<sup>161</sup>. In these years, actually, the evolution of the Cohesion Policy sharply influenced the approach of the EU towards rural development. Already in 1988, with the document entitled "The Future of Rural Society", the European Commission recognised that the overall potential of rural areas had to be taken into account in the EU rural development policy. The document underlined the idea to create a policy for the revitalisation of rural areas decoupled from the agriculture and rural areas, the Commission recognised that at the time, out of 166 regions of the Community, only in 10 regions (mainly in Greece, Italy and Spain) the share of agricultural employment account for 30% of the total employment; while in 118 other regions the share decreases to 10% of the total<sup>162</sup>.

<sup>&</sup>lt;sup>161</sup> FAO (2009), *The Evolution and Impact of EU Regional and Rural Policy*, FAO/Word Bank working paper, Rome, p.3.

<sup>&</sup>lt;sup>162</sup> European Commission (1988), *The future of rural society*, Commission communication transmitted to the Council and the European Parliament, Luxembourg, p. 5-6.

With the MacSharry Reform of 1992, environmental protection and the diversification of rural areas economies took a primary role in the framework of the CAP. In addition to change the nature of the EU's agricultural policy, the reforms also created the basis for a strong rural development policy<sup>163</sup>. Parallelly, LEADER, a pilot programme for rural development, was launched by the Commission.

After 2000, EU rural development policy underwent a major thematic reorientation, with the development of the "endogenous growth" concept, based on the idea to focus on the endogenous potential of rural areas in different sectors, not only in the agricultural one. The policy started to see in the building of a knowledge-based economy at the regional and rural level as an opportunity to foster labour productivity, in alignment with the EU's Lisbon and Europe 2020 strategies. Innovation start to be at the core of policy interventions, in order to enhance the creation of an environment for self-sustaining endogenous development<sup>164</sup>.

A further strengthening of the EU rural policy was one of the key elements of the ambitious reform of the CAP launched by the Commission in 2003. Indeed, together with decoupling direct payments from production and introducing single farm payments, as well as cross-compliance, the reform envisaged a new rural policy to implement from 2007 onwards. The EAGGF was replaced by the European Agricultural Guarantee Fund (EAGF) for market measures and direct income support, and the European Fund for Rural Development addressing initiatives rural revitalization. Four main areas were identified: the improvement of agricultural and forestry sectors competitiveness; the improvement of the environment and the countryside; the improvement of the quality of life in rural areas and rural economy diversification; and LEADER projects. The latter represented a bottom-up approach to rural development. It envisages the collaboration of a development policy adapted to their region.

The last development of the EU rural policy took place in the framework of the CAP reform of 2013. The debate on the future of the CAP after 2013 was launched in 2010; the main objective of the legal proposal published by the Commission was to make

<sup>&</sup>lt;sup>163</sup> Ibid., p. 7.

<sup>&</sup>lt;sup>164</sup> FAO (2009), *The Evolution and Impact of EU Regional and Rural Policy*, FAO/Word Bank working paper, Rome, p.5.

agriculture more competitive and sustainable in the rural areas. In particular, three longterm strategic objectives had been identified for the period 2014-2020: improving the competitiveness of agriculture; safeguarding the sustainable management of natural resources and climate action; and ensuring that the territorial development of rural areas is balanced<sup>165</sup>. At the same time, in order to provide a basis for the implementation of the policy, six priority areas underline the promotion of:

- knowledge and innovation in agriculture and forestry;
- the viability and competitiveness of all types of agriculture and support sustainable management;
- the organisation of the food production chain, animal welfare and risk management in farming;
- the restoration, preservation and enhancement of agricultural and forest ecosystems;
- the efficient use of natural resources and support the transition to a low-carbon economy;
- and social inclusion, poverty reduction and economic development areas.

From 2014 onwards, each MS and regions draft coordinated Rural Development Programmes (RDPs), which are subject to negotiations with the Commission and should cover the priorities set by the EU. 118 different programmes have been established in the EU28 (20 national and 98 regional programmes<sup>166</sup>) for the period 2014-2020, and are financed by the EAFRD, which has a budget of almost EUR 100 billion. In each RDP, quantified targets, measures and funding envisaged to reach the targets have to be set. For the last programming period, measures for the environment and climate change must account at least for 30% of funding; 5% must be, instead, dedicated to LEADER.

The EU rural development policy should also take into account the goals of the Europe 2020 strategy for smart, sustainable and inclusive growth and contribute to reach them. The broad framework in which the RD policy operates is shown in the Figure 10.

<sup>&</sup>lt;sup>165</sup> ERND, *Rural Development Policy Framework:* https://enrd.ec.europa.eu/policy-in-action/policy-framework\_en.

<sup>&</sup>lt;sup>166</sup> 8 Member States decided to have two or more regional programmes in addition to the national programmes for the period 2014-2020.

#### Figure 10: The current EU Rural Development policy framework



Source: ENRD, https://enrd.ec.europa.eu/policy-in-action/policy-framework\_en.

As can be seen from Figure 10, support to rural areas is not only provided by the EAFRD in the context of the rural development policy. Actually, the same objectives are pursued by other European funds, namely: the European Rural Development Fund (ERDF), the European Social Fund (ESF), the Cohesion Fund, and the European Maritime and Fisheries Fund (EMFF)<sup>167</sup>.

<sup>&</sup>lt;sup>167</sup> The management of these funds, which together form the European Structural and Investment Funds (ESIF) is defined in the Common Provisions Regulation, a set of basic legal rules which guide the funds' use. Additionally, the funds are guided and coordinated under a Common Strategic Framework and are finally managed nationally by each EU MS on the basis of Partnership Agreements. *Source:* ENRD, https://enrd.ec.europa.eu/policy-in-action/policy-framework\_en.

The legislative proposals for a reform of the CAP beyond 2020 was presented by the European Commission on 1 June 2018. The aim of the Commission is to make the CAP more adapted to the global challenges such as climate change and ageing population, while still supporting European farmers and ensuring the agricultural sector to be sustainable and competitive. Not surprisingly, influenced by the effects of the Brexit, a budget reduction is also envisaged by the legal proposals, which plan to reduce the funding for the CAP by around 5% (a total budget of EUR 365 billion is proposed for the period 2021-2027).

The implementation of the future policy will also rely on the use a new delivery model: the emphasis will be shifted from compliance to results and performance, and will reflect, according to the Commission, the territorial and sectorial specificities of EU Member States. In particular, a set of objectives and of result indicators will be agreed at the EU level and the MSs are responsible to design the specific measures and interventions it considers meeting the specific needs of their communities. The latter, together with a proposition on how they want to use the CAP funding from both 'pillars', and with which tools, will be presented by MSs in a CAP (national) Strategic Plan. The Strategic Plan should be then approved by the Commission, to ensure it is consistent with the EU-wide objectives. What is more, a performance report will be submitted by countries each year on the basis of specific indicators, in order to show the achieved progress towards the envisaged targets.

The future CAP will be based on nine new objectives, namely: to ensure fair income to farmers; to increase competitiveness; to rebalance power in food chain; climate change action; environmental care; to preserve landscapes and biodiversity; to support generational renewal; to build vibrant rural areas; and to protect food and health quality<sup>168</sup>. Thus, concerning the rural development policy, the future CAP envisages to boost rural economies and improve the livelihood of rural communities by: supporting the knowledge transfer between different generations, helping new generations of farmers to join the profession; encouraging EU Member States to do more at national level, with the new delivery model; and strengthen food safety and quality requirements on farmers (see Figure 11).

<sup>&</sup>lt;sup>168</sup> European Commission (2018), *EU Budget: The Cap after 2020*, Brussels. Available at: <u>https://ec.europa.eu/commission/sites/beta-political/files/budget-may2018-modernising-cap\_en.pdf</u>.



#### Figure 11: The new objectives of the CAP post 2020

Source: DG Agri

For the first time the Bioeconomy is mentioned in the proposals, which highlight the opportunity to foster link the EU Research and Innovation policy and the agricultural policy by "introducing bioeconomy as a priority of the CAP"<sup>169</sup>. In fact, a complementary publication of the Commission on the socio-economic challenges facing EU agriculture and rural areas<sup>170</sup>, underlines the role of the cultivation and sourcing of biomass in the process of diversification of the European rural economies. In particular, it focuses on the potential of bioenergy in agriculture and forestry, as a key driver for green jobs creation in rural areas. The future CAP post 2020 will also benefit from a specific budget of EUR 10 billion established by the Horizon Europe<sup>171</sup> for research and innovation in food agriculture, rural development and the bioeconomy in the period 2021-2027. The role of

<sup>&</sup>lt;sup>169</sup> European Commission (2018), *Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the financing, management and monitoring of the common agricultural policy and repealing Regulation (EU) No 1306/2013*, COM/2018/393 final – 2018/0217 (COD), Brussels, section 1.4.4.

<sup>&</sup>lt;sup>170</sup> European Commission (2018), *Modernising and Simplifying the CAP – Socio-Economic challenges facing EU agriculture and rural areas*, Brussels, p. 20.

<sup>&</sup>lt;sup>171</sup> Horizon Europe is the programme proposed by the Commission for the period 2021-2027, to replace Horizon 2020. The proposed budget is of EUR 100 billion in Research and Innovation, overcoming the previous programme that, at the time, was considered the biggest Research and Innovation programme ever with a budget of EUR 80 billion.

the European Innovation Partnership (EIP-AGRI) is also highlighted as a way to foster competitive and sustainable farming. and forestry.

# 3.3.2 Integrating the CAP principles in the EU Bioeconomy strategies and vice versa

In parallel to the development of the EU Rural Development policy, the EU adopted the first Bioeconomy strategy and its related action plan in 2012 (see paragraph 2.2.4 of the previous chapter). According to the European Commission, the bioeconomy is central to three of the ten key priorities for the European Union identified by President Juncker in his Agenda for Jobs, Growth, Fairness and Democratic Change<sup>172</sup>. In particular, the development of a sustainable bioeconomy in Europe can contribute to boost new jobs (especially in rural and coastal areas), growth (for instance of new markets in bio-fuels, food and bio-based products) and investments (in research and innovation). Also, it can foster a resilient energy union, helping to diversify European sources of energy and ensure a low-carbon economy, while combating climate change. Finally, the bioeconomy can strengthen the industrial base of a deeper and fairer internal market, creating a circular, resource-efficient economy. What is more, the bioeconomy fits also in the strategic priorities "Open Innovation, Open Science, Open to the World"<sup>173</sup> identified by the Commissioner for Research, Science and Innovation, Carlos Moedas, in the context of the research funding programme Horizon 2020. Indeed, the bioeconomy requires an innovation approach to tackle the grand societal challenges of the 21<sup>st</sup> century (open innovation); promotes research across different disciplines and borders (open science); and promotes research and cooperation across the EU and at a global scale (open to the world).

In fact, the overall objectives presented in the 2012 Bioeconomy Strategy were: ensuring food security; managing natural resources sustainably; reducing dependence on non-renewable resources; mitigating and adapting to climate change; and creating jobs while maintaining EU competitiveness. The action towards these goals were built around three core areas, namely: investing in research, innovation and skills; reinforcing policy

<sup>&</sup>lt;sup>172</sup> The guidelines for the next European Commission that Jean-Claude Juncker presented the for its election as Commission President. For further information: <u>http://europa.eu/rapid/press-release\_SPEECH-14-546\_en.htm</u>.

<sup>&</sup>lt;sup>173</sup> See: <u>http://europa.eu/rapid/press-release SPEECH-15-5243 en.htm.</u>

interaction and stakeholder engagement; enhancing the markets and competitiveness in bioeconomy.

The Strategy, among other things, recognised the potential of the new system envisaged by the building of a bioeconomy for the revitalisation of rural and coastal areas. Indeed, both demand and supply actions can be promoted at the regional level, such as the creation of supply chains for residues and waste as feedstock for bio-based industries, developing infrastructures for aquaculture and setting up a network of small-scale local biorefineries. At the same time, technological advances require the development of new skills: to benefit of the potential of bioeconomy, rural and coastal communities should be able adapt to the new uses of biological materials in the primary sector. New skilled agricultural and fishery workers will be then required in the future (the strategy forecasted that 2.2 million workers would be required by 2015). The aim to limit climate change and foster social innovation is also considered as vital for rural renaissance. In this context, the EU rural development policy is considered having a crucial role, since the funds and the goals of the policy could be utilised for the building up of new infrastructures and instruments, required by the bioeconomy, that is to foster the development of sustainable supply chains and facilities.

It becomes clear that strategic discussion with the authorities responsible for rural and coastal development has to be supported, in order to maximise the impact of existing research and innovation activities and funding mechanisms<sup>174</sup>. Furthermore, the results of the public consultation on the bioeconomy held before the adoption of the strategy, push also in this direction. In fact, 73% of the total participants to the consultation (around 200 stakeholders) perceived the insufficient links between policies related to the bioeconomy as one of the main barriers at both EU and national levels to the development of a European bioeconomy. Additionally, 78% considered necessary to provide a coordination mechanism for the set of all relevant policies related to the bioeconomy, and 80% underlined the need to strengthen the link between existing funding instruments for the promotion of the bioeconomy<sup>175</sup>.

<sup>&</sup>lt;sup>174</sup> European Commission (2012), *Innovating for Sustainable Growth. A Bioeconomy for Europe*, European Union, Brussels, p.15.

<sup>175</sup> Ibid., p. 20.

In line with these recommendations, the EU bioeconomy strategy of 2012 underlined the need to ensure a more coherent policy framework for the bioeconomy development, calling for "more informed dialogue and better interaction between existing bioeconomy-supporting policies at EU and Member States level. This will provide stakeholders with a better integration between EU policies and encourage private investment<sup>176</sup>. In particular, the synergy with other EU policies will be ensured, according to the strategy, by a Bioeconomy Panel that will provide a discussion platform and will be composed of: the relevant services of the European Commission which cover the main bioeconomy-related policies and sectors; different Member States representatives from the ministries which manage bioeconomy-relevant topics; and representatives of relevant stakeholders groups (environmental NGOs, associations from the industrial sector, research and scientific organisations, universities, farmers, foresters and fishermen). Furthermore, the opportunity for an informal dialogue between the participants of the Bioeconomy Panel and policy makers and members of the civil society will be provided by a Bioeconomy Stakeholders Conference, to be organised regularly. The creation of a European Bioeconomy Information System (Bioeconomy Observatory) is also envisaged as a research forum monitoring the various areas related to the bioeconomy.

Despite the efforts, the "Review of the Bioeconomy Strategy and its Action Plan"<sup>177</sup>, conducted in 2017 by an expert group, considered necessary a refocusing of the document. Globally, the review found that "significant achievements were made during the implementation and addressing major societal challenges"<sup>178</sup>, particularly in research and innovation, thanks also to the involvement of Horizon 2020. In addition, the 2012 strategy seems to have encouraged national and regional policy-makers to adopt bioeconomy-dedicated policy (the number of national/regional dedicated policies has in fact increased since 2012). However, relevant for the scope of this thesis, is the opinion of the expert group on the need for policy integration between the bioeconomy strategy and other EU relevant policies related to it, and, in particular, the CAP. In fact, increased coherence among relevant EU policies and increased involvement of Member States, regions and cities is still required according to the experts. The review especially recommends the inclusion of a specific link to the various relevant policies.

<sup>&</sup>lt;sup>176</sup> Ibid., p.11.

<sup>&</sup>lt;sup>177</sup> European Commission (2017), *The Review of the Bioeconomy Strategy and its Action Plan*, Brussels. Available at:

https://ec.europa.eu/research/bioeconomy/pdf/publications/bioeconomy\_expert\_group\_report.pdf. <sup>178</sup> Ibid., p.4

In alignment with the recommendations of the Review, the European Commission has adopted a new bioeconomy strategy in October 2018. The updated document, entitled "A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and environment"<sup>179</sup>, after giving a definition of the bioeconomy and focusing on its potentials, presents the three core action areas, namely:

- 1. strengthening and scaling-up of the bio-based sectors, unlocking investments and markets;
- 2. deploying local bioeconomies rapidly across Europe;
- 3. understanding the ecological boundaries of the bioeconomy.

The second action area, which support the adoption of local bioeconomies in the EU, is of particular interest for the scope of this thesis. Indeed, the European Commission encourages here Member States to adopt and update national and regional bioeconomy strategies throughout Europe while ensuring coherence and consistency between the different EU policies and goals. At the same time, coastal, rural and urban areas are supported in exploiting bioeconomy opportunities. One of the actions included in this section, envisages the creation, together with Member States, of a Strategic Deployment Agenda for sustainable food and farming systems, forestry and bio-based production in a circular bioeconomy<sup>180</sup> by 2021, to provide a more coherent framework and to optimize synergies between the CAP, the Common Fisheries Policy, and other financial instruments such as the EMFF, Horizon 2020 and the proposed Horizon Europe, the EAFRD and other European Structural and Investment Funds in the framework of the bioeconomy. In this context, links with other policies and instruments, as well as possible interactions and complementarities will be discussed. This action is expected to be built on existing platforms and initiatives such as the agricultural European Innovation Partnership (EIP-AGRI)<sup>181</sup> and, therefore, bring together different actors (primary

<sup>&</sup>lt;sup>179</sup> European Commission (2018), *A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy*, European Union, Brussels. Available at: <u>https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A393%3AFIN</u>.

<sup>&</sup>lt;sup>180</sup> Ibid., p. 72.

<sup>&</sup>lt;sup>181</sup> Contributing to the European Union's strategy 'Europe 2020' for smart sustainable and inclusive growth, EIP-AGRI is a partnership programme launched in 2012 under the initiative 'Innovation Union', created to help all EU Members States grant to their citizens a more competitive economy, more and better jobs and quality of life. Its aim is to foster a competitive and sustainable agriculture and forestry sector, and it is based on an interactive innovation model which brings together different actors in the so called 'Operational Groups' to find solution for specific issues. Some workshops on the bioeconomy have been organised under the EIP-AGRI.

producers, citizens, policy-makers and national authorities, scientists and innovators, educators, SMEs) to define together needs and long-term approaches to support bioeconomy development. Deployment pathways combining the appropriate means and instruments will be proposed, and guidelines and advisory services will be provided, for instance, to primary producers and SMEs.

What is more, this section of the action plan dedicates a specific action on the integration of the bioeconomy in the CAP, supporting the use of the European Rural Development Fund as a way to deploy inclusive bioeconomies in rural areas<sup>182</sup>. In fact, workshops, seminars and meetings with the EU countries and relevant public and private stakeholders will be organised in order to facilitate awareness raising, capacity building and the share of best practices. Mentioning the on-going reform of the CAP, which, as discussed above, will provide Member States more flexibility in designing their own rural development programmes, the Commission is willing to encourage the incorporation of the bioeconomy in future CAP national plans. The streamlining of good and best practices in this field can help Members States – now free to choose the type of policy interventions they consider appropriate for their local situations – to include bioeconomy in their future strategic plans. The link between bioeconomy strategies and national CAP strategic plans can ensure, therefore, policy coherence.

#### 3.3.3 The Rural Bioeconomy Portal and its Thematic Group

In November 2018, exactly two weeks after the publication of the Updated Bioeconomy Strategy, the Rural Bioeconomy Portal was created in the European Network for Rural Development (ENRD<sup>183</sup>).

The ENRD was established in 2008 by the European Commission (DG Agri), with the aim of exchanging practical information on the work of Rural Development policy, programmes, projects and other initiatives. It engages different stakeholders, which are interested in and committed to rural development in Europe, but is governed by formal structures, namely the European Rural Networks' Assembly and Steering Group. The ENRD has identified four objectives for the programming period 2014-2020: increase the

<sup>&</sup>lt;sup>182</sup> European Commission (2018), A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy, European Union, Brussels, p.74.

<sup>&</sup>lt;sup>183</sup> See: <u>https://enrd.ec.europa.eu/sites/enrd/files/publi-enrd-booklet-2016-en.pdf</u>.

involvement of stakeholders in rural development; improve the quality of RDPs; better inform on the benefits of Rural Development policy; and support the evaluation of RDPs.

In the 2014-2020 programming period, one of the themes of the ENRD is 'Greening the Rural Economy'. The latter is directly linked to two of the EU RD policy priorities, namely: restoring, preserving and enhancing agriculture and forestry ecosystems; and promoting resource efficiency and the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors. One of the sub-themes of this thematic work of the ENRD is 'Mainstreaming Bioeconomy', on which a Thematic Group (TG) is currently working. The TG, in particular aims to "understand how a more structured approach to the use of the RDPs can be adopted for delivering the bioeconomy in a way that balances the objectives of viable food production, sustainable management of natural resources and balanced territorial development"<sup>184</sup>. Globally, the development of sustainable bioeconomy value chains in rural areas are encouraged, in order to endorse economic growth and employment, while preserving the environment. The TG will then proceed first by analysing national and regional bioeconomy strategies and investigating existing relevant initiatives in EU countries. Then, opportunities for the development of bio-based business models in rural areas will be explored and networking will be promoted. Finally, after identifying good practice examples, some recommendations will be formulated on how to support the development of sustainable bioeconomy under the EU's RD policy, both for the current programming period 2014.2020 and for the future CAP strategic plans. During the last meeting of the group, held on 17 January 2019 in Brussels, the need to reflect local-level needs and priorities in bioeconomy strategies and to increase awareness of bioeconomy opportunities, as well as the potential of bottom-up approaches were discussed<sup>185</sup>.

In this framework, the online platform Rural Bioeconomy Portal collects all relevant sources related to bioeconomy (documents, projects, organisations, initiatives), with the aim to focus on opportunities and challenges for bioeconomy in EU's rural areas.

<sup>&</sup>lt;sup>184</sup> European Network for Rural Development (2018), *Mainstreaming the Bioeconomy*, Thematic Group Scoping Paper, Brussels, p.15.

<sup>&</sup>lt;sup>185</sup> See: <u>https://enrd.ec.europa.eu/news-events/events/2nd-meeting-thematic-group-mainstreaming-bioeconomy\_en</u>.

#### 3.4 Bioeconomy and Rural Areas: the Italian context

Italy covers an area of 302 069 km<sup>2</sup> of which around 90% is rural<sup>186</sup>. Also, over 20% of the total population (nearly 60 million) live in rural areas. The total allocation of the CAP funds (Direct Payments and Rural Development) in Italy accounts for around EUR 37.5 billion for the programming period 2014-2012<sup>187</sup>. Rural development policy alone, has a budget of EUR 10.4 billion and is implemented through 23 RDPs: 22 at regional level and two at national level, the Italian National Rural Development Programme and a National Programme on risk and water management and agricultural biodiversity. More broadly, 46% of the EAFRD in Italy is allocated to smart growth (4% to research and innovation, 3% to information and communication technologies, 39% to competitiveness of SMEs); 41 % to sustainable growth (8% to low-carbon economy, 15% to combating climate change, 18% to environment & resource efficiency, sustainable transport); and 11% to inclusive growth (employment and mobility, social inclusion, better education)<sup>188</sup>.

Even though different priorities can be identified for the different regions, most of the Italian RDPs aim at supporting the competitiveness of agricultural production systems and of agro-industry enterprises; ensuring economic diversification and better quality of life in rural areas; promoting investments in sustainable energy as well as climate change adaptation and the protection of the environment. In particular, the Italian National Rural Development Programme (NRDP), allocates around 73% of its budget (EUR 2 billion) to the promotion of food chain organisation (processing and marketing of agricultural products, animal welfare and risk management); around 10% to restoring, preserving and enhancing ecosystems related to agriculture and forestry; and around 14% to the promotion of resource efficiency and the support of the shift towards a low carbon and climate resilient economy in agriculture food and forestry sector<sup>189</sup>. The updated version

<sup>&</sup>lt;sup>186</sup> OECD classification of urban areas applied. Source: European Commission, <u>https://ec.europa.eu/agriculture/sites/agriculture/files/rural-development-2014-2020/country-files/it/factsheet-national\_en.pdf</u>.

<sup>&</sup>lt;sup>187</sup> European Commission (2016), *CAP in your country*, https://ec.europa.eu/agriculture/sites/agriculture/files/cap-in-your-country/pdf/it en.pdf.

 <sup>&</sup>lt;sup>188</sup> ENRD (2015), Partnership Agreement 2014-2020: Key facts & figures – Italy, https://enrd.ec.europa.eu/sites/enrd/files/it pa fiche final web.pdf.

<sup>&</sup>lt;sup>189</sup> The remaining 3% is dedicated to technical assistance. *Source:* DG Agri, <u>https://ec.europa.eu/agriculture/sites/agriculture/files/rural-development-2014-2020/country-files/it/factsheet-national\_en.pdf</u>.

of the Italian NRDP published in 2018<sup>190</sup>, does not dedicate any measures to the common objective "facilitating the supply and use of renewable energy sources, of by-products, waste, residues and other non-food raw material, for the purposes of the bioeconomy".

#### 3.4.1 The Italian Bioeconomy Strategy

Italy has adopted its own national bioeconomy strategy in April 2017. Following the definition of the European Commission, the bioeconomy is view as a set of interrelated sectors based on the invention, development, production and use of biological products. In terms of impact, the document highlights that, on the basis of the National Accounts, the bioeconomy as a whole (including then agriculture, forestry, fisheries, food and beverages production, paper, pulp and tobacco industries textiles from natural fibbers, leather, bio-pharmaceuticals, green chemistry, biochemicals and bioenergy) can be considered as accounting for a total turnover of EUR 254 billion in 2015 with around 1.6 million employees.

In the first part of the strategy, four macro-sectors are identified as the most relevant for the bioeconomy: agri-food, forestry, marine bioeconomy and bio- based industry. The latter, after incorporating forestry in the agri-food sector, appear also to be the three pillars on which the Italian bioeconomy is based.

#### The agri-food pillar

Contributing to Gross Value Added for about EUR 31 billion (2.3%) and with 910,000 people employed, agriculture turns out to be a relevant economic sector in Italy. Only 12.9 million hectares are in use of the total 17.1 million hectares of agricultural area in the country. Rural development is mentioned as having a critical role; different challenges linked to the need to diversify rural economy, ensure a better lifestyle to rural communities, as well as granting big data availability, sustainability and new business models, are emerging in several Italian regions. Quite a lot of marginal areas do not have access to the same public services as towns and cities.

Accounting for approximately 37% of the total territory, forests in Italy cover instead 11 million hectares of surface. The management of the latter needs to be improved, and the integration between the primary production and the wood processing industry seem also necessary. However, great potential is identified in the agricultural and forestry sectors in

<sup>&</sup>lt;sup>190</sup> The document is available at: <u>http://www.reterurale.it/downloads/PSRN\_6\_0.zip</u>.

Italy in the context of biobased and circular economy. In 2015, agriculture forestry and fisheries accounted for 22,8% (EUR 57.773 million) of the total bioeconomy turnover (EUR 253.815 million) and 57,2% of the total people employed.

In addition, thanks to the variety of its territory and biodiversity richness, Italy boasts a unique variety in food tradition, which represents one of the strengths of the agrifood sector. The Italian food industry is the second largest manufacturing sectors in the country and the third in Europe, behind the German and French industries. In fact, 385,000 people are employed in the sector, and 54,400 businesses work for it, with a total turnover of EUR 132 billion in 2015. Globally, this industry sector is characterised by the presence of very small SMEs. However, a great opportunity can be seen in the Italian food industry sector for the development of a sustainable bioeconomy, especially in terms of innovation and growth. Critical in this context is the role of the National Agrifood Technology Cluster "C.L.A.N.", which, working as a multi-stakeholder network of the key national players of the agri-food chains, encourage the identification of challenges and priorities for the food industry concerning the reuse of by-products<sup>191</sup>.

#### *The marine bioeconomy*

Thanks to its 8000 km of coastline (40% under water), Italy boasts a notable amount of sea-based resources (food, energy, landscape, materials, microbes). In this context, according to the strategy, bioeconomy related activities (including fishery, aquaculture, the exploitation of marine algae, microbes, enzymes, and by-products, processing of bio-waste from fishery and aquaculture products, biomonitoring and bioremediation of marine water/sediment systems)<sup>192</sup> account for 20% of the total turnover and job opportunities of the present Italian blue economy. It is important to consider that Italy is the second biggest European fish producer and the fourth in terms of aquaculture; the potential of the bioeconomy in this sector is to be taken more into account.

<sup>&</sup>lt;sup>191</sup> In particular, launching the Sustainability of Agri-food supply chain ("So.Fi.A.") the National Agri-food Technology Cluster ("C.L.A.N") aims to reduce waste and valorise sub-products, as well as their use for other food and non-food applications, while reducing the impact of the agri-food industry from the production to the end user. The project especially works on: the valorisation of dairy by-products, especially residues of ricotta cheese (scotta) and cheese whey for recovery of their bio-molecules; strategies for the reutilization and valorisation on beef processing by-products and cheese; and new solutions for the efficiency of processes in the fresh-cut vegetables. For further information see The Italian Bioeconomy Strategy, available at: <a href="http://www.assobioplastiche.org/assets/documenti/BIT\_v4\_IT.PDF">http://www.assobioplastiche.org/assets/documenti/BIT\_v4\_IT.PDF</a>.

<sup>&</sup>lt;sup>192</sup> Italian Bioeconomy Strategy (2017), p. 20.

#### The bio-based industry

Finally, the bio-based industry appears to be the bioeconomy related sector in which Italy has been working the most recently. It is characterised by the interaction of large, medium and small-sized companies which work together for an efficient and sustainable use of biomass, to increase the added value of agricultural production while respecting the ecosystems and the biodiversity of rural areas. Indeed, the country seems to have a leading role in producing and processing renewable biological resources through innovative industrial processes. With 1,924 installed plants and an energy production of 19,400 GWh, Italy ranks second in the EU (after Germany) for the production of biogas and bio-methane. The bio-based chemistry, in particular, is the sector which received the largest amount of private investments, resulting in several important projects based on the reconversion of industrial sites affected by the crisis into biorefineries. For instance, the re-industrialisation of decommissioned or no longer competitive national relevant sites and the construction of four flagships plans have received a financing of over a billion euros. The "Green Chemistry" Cluster SPRING<sup>193</sup>, a national networking platform, have a relevant role in the development of the Italian bio-based chemistry. From farmers to private associations, the cluster brings together over 100 of the main stakeholders of the value chain.

Besides the three main pillars on which the Italian bioeconomy relies, the strategy also underlines the critical role of the implementation of a circular bioeconomy, created by the integration of the bioeconomy with the circular economy models, aiming at making businesses more economically viable and sustainable in the long term. In order to achieve this goal, local resources and facilities have to be involved in the process, as well as private and public stakeholders, and the economic sectors and policies concerned need to be better integrated. This local perspective gains the attention of Italian regions, especially in terms of rural regeneration. Actually, as previously mentioned, the richness of Italian landscapes and the biodiversity of ecosystems represents a great potential for the development of the bioeconomy while ensuring rural renaissance. Italian regions have, in fact, shown their willingness in keeping total economies alive by supporting agro-

<sup>&</sup>lt;sup>193</sup> Based on the discussion with regional, national and European institutions, SPRING aims to: achieve a near-to-zero waste country by reusing biowaste as bio-char, biogases and biobased products; reconvert disused industrial sites into next generation biorefineries; maintain and reinforce Italian excellence in R&D in a global context "facing more and more aggressive policies developed by the major countries and the growing interest of the most important chemical companies. *Source:* the Italian Bioeconomy Strategy (2017), p. 16. Further information on SPRING available on its official website: http://www.clusterspring.it/home/.

industrial local projects with the idea to use bio-resources in a more innovative and efficient way. Importance is thus given to interregional cooperation, which also emerged from the Position Paper on Bioeconomy developed by the Conference of the Italian Regions<sup>194</sup>. Several regional initiatives have been launched in Italy in the last few years<sup>195</sup>.

The second part of the strategy is instead dedicated to the opportunities of biowaste and on the impact that the bioeconomy can have on the environment. In particular, in order to avoid the harmful effects to the ecosystems, innovative and sustainable bioeconomy sectors should: determine which are the most suitable species and biomass at local level to be exploited for production and energy reasons; identify and then use marginal and/or contaminated lands, in line with international environmental policies (on climate change, biodiversity, sustainable intensification) and in synergy with regional and local policies; promote an efficient use of the biomass, using a cascading approach; build up new supply chains integrated with agriculture, forestry and the industrial sectors; and rely on eco-labelled, certified forest products, especially from local chains<sup>196</sup>.

What is more, the social awareness and dialogue are described as being critical for the development of an efficient, sustainable bioeconomy in Italy. The understanding of the challenges and opportunities of the bioeconomy and greater knowledge on what is being consumed can have a huge influence on the demand for new products and services. On one hand, companies working on bioeconomy should support sustainable business models based on the involvement of costumers, workers, users and stakeholders affected by their activities (especially citizens). On the other hand, the government should adopt a participatory approach, which supports the interactions between institutions and people.

The last parts of the strategy identify the legislative framework, the available funding programmes and the market pull measures for a sustainable bioeconomy in the European and Italian contexts. After that, an action plan, together with a set of measure and priorities are presented. The overall objective of the strategy is "to increase the current

<sup>194</sup> The paper monitored the strategic position of the regions with respect to the three pillars of the bioeconomy: Agri-food, marine bioeconomy and bio-based industry. Source: The Italian Bioeconomy Strategy (2017). The document is available at: <u>http://www.regioni.it/download/conferenze/485361/</u>.

<sup>&</sup>lt;sup>195</sup> See: The Italian Bioeconomy Strategy (2017), p. 23.

<sup>&</sup>lt;sup>196</sup> Ibid., p. 26.

Italian turnover and jobs by 20% by 2030, while increasing the level of circularity in the economy"<sup>197</sup>.

# 3.4.2 Integration between Bioeconomy Strategy and Rural Development programmes in Italy

Although mentioning the issue of the rural development several times, the Bioeconomy Strategy adopted by the Italian Council of Ministers in 2017 does not identify any measures aimed at integrating the two policies. In fact, one of the objectives of the vision presented before the action plan is concentred on the "valorisation of marine and rural biodiversity through the creation of new value chains implementing sustainable and circular models, through the reconversion of abandoned lands and industrial sites, or the identification and exploitation of bio-wastes, effluents and civil wastewater"<sup>198</sup>. One of the challenges of the country, identified by the strategy, is the abandoning of rural areas, which are increasingly characterized by unsatisfactory living conditions and logistic services. In this context, the development of the Italian bioeconomy sectors is seen as a great potential for the revalorisation of rural areas, local biodiversity and ecosystems, diversification of rural economies with a consequent empowerment of local communities. Furthermore, the strategy supports - in theory - the alignment of EU, national, regional policies, regulations, funding and the coordination of local stakeholders. Policy coordination among public authorities is considered as critical in order to unlock the innovation potential of the Italian bioeconomy. According to the strategy, several projects have also been launched at the regional level, and the creation of important clusters promotes the involvement of regional and local institutions and stakeholders in the bioeconomy related processes.

However, the EU Rural Development policy is "informally" cited in the document through a mention to the EAFRD as a possible fund which can support bioeconomy related activities in the agricultural sector<sup>199</sup>. No specific measures are envisaged to ensure a better coordination between the bioeconomy and rural development policies. Actually, it should be mentioned that the strategy envisaged the preparation of a detailed

<sup>&</sup>lt;sup>197</sup> The Italian Bioeconomy Strategy (2017), p. 47.

<sup>&</sup>lt;sup>198</sup> Ibid., p. 48.

<sup>&</sup>lt;sup>199</sup> Ibid., p. 39.

implementation plan with timetables for the measures provided as well as the the setting up of a bioeconomy panel. No detailed action plan has been published yet.

At the same time, regarding to the Rural Development policy, the Italian National Rural Development Programme, as previously mentioned, does not dedicate any specific action to the incorporation of bioeconomy principles in the RDPs. In spite of this, several Italian regions have indicated some interest to the potential of the bioeconomy in their regional plans for rural development, in particular related to the priority of ensuring resource efficiency and climate change mitigation. For instance, the development of bioenergy and the use of agricultural and agro-industrial by-products are considered critical in this context for Basilicata, Campania, Emilia-Romagna, Molise, Piemonte, Valle d'Aosta and Veneto<sup>200</sup>. Furthermore, the region of Piemonte promotes "the support to groups operating in the European Innovation Partnership (EIP) and to supply chain cooperation actions for a sustainable supply of forest biomass used for energy production and industrial processes<sup>201</sup>. Globally, the regions with a limited share of renewable energy coming from biomass do not include a section dedicated to the topic in their programmes.

It becomes clear that a better incorporation of the bioeconomy in the national and regional RDPs is required in order to make bioeconomy work for rural development goals.

#### **3.5 Conclusions**

The phenomena of urbanisation, land abandonment, ageing population, lack of diversity in the job market and gender imbalances have a huge impact on the supply of public services and, as a consequence, on the quality of life in rural areas. Furthermore, rural communities appears to be more vulnerable to external economic and environmental shocks, such as financial crisis and the climate change. Nowadays, according to the OECD, rural regions are home to one-quarter of the population and account for 75% of land area, cointaining the vast majority of land, water and natural resources. The goal of

<sup>&</sup>lt;sup>200</sup> The analysis is conducted on the summaries of rural development programmes related to the programming period 2014-2020 of the Italian regions, published by the European Commission in 2015 and available on the official website of the ENRD : <u>https://enrd.ec.europa.eu/policy-in-action/rural-development-policy-figures/rdp-summaries\_en</u>.

<sup>&</sup>lt;sup>201</sup> European Commission (2015), *Factsheet on 2014-2020 Rural Development Programme for Piemonte*, Brussels, p. 3.

the Agenda 2030 to not leave no one behind requires a significant action in the direction of rural regeneration.

In this context, the bioeconomy and rural areas can benefit one from another. In fact, the richness of rural areas' biodiversity makes of these zones a great contributor to the fight against the big societal challenge of the 21<sup>st</sup> century, especially climate change mitigation and resources efficiency. At the same time, the development of a sustainable bioeconomy in rural regions can offer economic diversification, through the creation of new industries (especially biorefineries), more income and better livelihoods.

Several countries have focused on the importance of bioeconomy to create wellness in rural areas. However, to be effective, the mutual relationship between bioeconomy and rural areas development should rely on great investments on education, research and innovation and more policy coherence. This third chapter has analysed the level of integration between the Bioeconomy strategies and the Rural Development policy at the European and Italian contexts. It has been found that, as regards to the EU, progress has been made towards reconciling the needs of the two policies. In particular, following the recommendations of the Expert Group which conducted a review of the 2012 Bioeconomy Strategy in 2017, the European Commission has introduced a specific action dedicated to the need to better incorporate the objectives and principles of the bioeconomy in the national and rural development programmes (operating under the second pillar of the CAP) in the revised version of the strategy, published in 2018. In the meanwhile, a Rural Bioeconomy Panel and a Thematic Group have been created under the guidance of the European Network for Rural Development, to further discuss about the approach that can be used by the RDPs for delivering a sustainable bioeconomy. In fact, the legal proposals for the CAP post 2020, which consider the bioeconomy as a priority, envisage a new system in which the Member States have more flexibility in designing their own rural development programmes that can ecnourage the incorporation of the bioeconomy in future CAP plans.

When coming to the Italian situation, more should be done to ensure coherence between the two policies. Indeed, even tough several regions mention the potential of bioenergy and agro-industrial by-products for climate actions in their rural development programmes, no specific measures is devoted to the development of a sustainable bioeconomy as a whole. At the same time, the Italian Bioeconomy Strategy does not provide any mesure aimed at ensuring a better coordination with the CAP. In the perspective of the creation a detailed implementation plan with timetables for the Bioeconomy strategy, still not published, and the reform of the CAP after 2020, the issue of the policy coherence between bioeconomy and rural development seems to be worth consideration for additional work.

### Conclusions

The Bioeconomy is considered as "the production, utilization and conservation of biological resources, including related knowledge, sciences, technology, and innovation, to provide information, products, processes and services across all economic sectors aiming toward a sustainable bioeconomy"<sup>202</sup>. This is just one of the several definitions of bioeconomy which have been developed in the last decades. The topic has gained further momentum recently, both in research and policy debates; a growing number of initiatives undertaken by societal stakeholders, business and research networks and NGO can be identified, and almost 50 countries have adopted bioeconomy-dedicated or related strategies in the world. Globally, the concept has evolved from a biotechnology-centric vision, which put biotechnology and innovation at the centre of the discussion, to an approach that focuses more on the sustainable use of natural resources.

Based on the replacement of fossil (finite and polluting) resources with biological (and renewable) feedstocks, the development of the bioeconomy seems to be a way to change the current paradigm of economic development in favour of a new economic system aimed at achieving the Sustainable Development Goals presented in the Agenda 2030. A sustainable bioeconomy can boost the economy, creating new jobs; contribute to climate change mitigation, preserving the ecosystem; improve public health and ensure a better quality of life.

In view of this, as anticipated in the introduction, the study proposed here aimed at understanding the principal policy challenges for the implementation of the bioeconomy. It has been found that, the creation of a global governance framework for the bioeconomy and a better coordination of relevant policies are necessary in order to make of this idea a veritable societal shift able to respond to the main challenge of the 21<sup>st</sup> century.

Concerning the challenge of governance, this is strongly linked to the need of assessing bioeconomy sustainability. Indeed, the first chapter has shown that, in spite of the envisaged potentials in terms of social, economic and environmental wellbeing, the use of biomass for consumption and energy purposes is not automatically environmentally friendly. By contrast, the improper management of the bioeconomy can have harmful effects on the ecosystem and the society as a whole. In fact, the harvesting of crops for bioeconomy purposes can increase social inequalities in the context of

<sup>&</sup>lt;sup>202</sup> The Global Bioeconomy Summit, 2018.

biomass trade, as a consequence of the disparity between countries in terms of biomass availability. Indeed, biomass reach countries could over-exploit their natural resources in order to respond to the demand of the biomass importers. At the same time, private investors in biomass poor countries could exacerbate the phenomenon of 'land grabbing' in developing countries. In addition, the use of land for bioeconomy reasons poses the challenge of leaving available land for food harvesting (the so-called food vs fuels dilemma). This could also increase the price of the food. The change in the use of the land can also have an impact on the amount of GHGs emissions (the so-called ILUC phenomenon). When the agricultural production is displaced to previously uncultivated areas, such as grasslands and forests, their conversion into cropland may increase the atmospheric carbon levels.

Unfortunately, assessing the sustainability of the bioeconomy has resulted to be quite complicated; no internationally agreed set of indicators and criteria have been fixed so far. Anyway, many countries have shown their strong interest in building a structured policy aiming to regulate and promote the sustainable exploitation of biological resources. A lot of progress has been made in all continents in terms of bioeconomy strategies, even if still too few countries (only fifteen at the present) have drawn a specific bioeconomydedicated strategy following a holistic approach. Argentina, Finland, France, Germany, Ireland, Italy, Japan, Latvia, Malaysia, Norway, South Africa, Thailand and the United States fall in this group. All other countries have adopted strategies which present a – more or less strong - link to the bioeconomy. In particular, these normally refer to the promotion of R&D and innovation; the development of high-tech infrastructures; capacity building and education; or are more focused on particular sectors, such as: bioenergy, biotechnology, Green and Blue Economy, agriculture and forestry. However, while a great number of countries showed their interest in promoting bioeconomy development through comprehensive political support, only few of them present in their strategies the political management of conflicting goals and potential risks. Furthermore, all the strategies vary in scope and depth, differing in term of objectives pursued and actions addressed on the basis of the characteristics of the individual countries. It becomes clear that the conflicting nature of national priorities makes it hard to build a sustainable bioeconomy which could operate on a global scale.

In this context, the creation of a global governance framework, which could identify indicators and specific targets at a global level, to ensure the respect of the objectives presented in the Agenda 2030 and in the Paris Agreement in the implementation of the bioeconomy, seems necessary.

Coming to the second challenge identified by the present dissertation, the crosscutting nature of the bioeconomy, which involves several sectors from agriculture to rural development, forestry, fisheries, food, trade, waste management, energy, pharma and industry, requires a strong action in order to ensure coordination between relevant policies. Given the significance of the local scale for the bioeconomy – the biomass is usually processed in small-scale biorefineries in rural locations – the interaction between bioeconomy and rural development policy has been taken into account. In particular, bioeconomy seems to have a great potential in the process of revitalization of rural areas, in terms of economic diversifications, new jobs, more income for the communities, better public services and higher quality of life. At the same time, rural areas account for 75% of land area, containing then the vast majority of the land, water and natural resources. The richness of their biodiversity makes of these zones some great contributors to climate change mitigation and resource efficiency, and to the development of the bioeconomy. It becomes clear that the policies which address rural development and bioeconomy development are mutually linked: each of them can promote the goals of the other. However, in order to ensure that, a high level of coordination between the two has to be granted.

The analysis of the EU Bioeconomy Strategy and the Common Agricultural Policy (responsible for rural development in Europe) has shown that progress has been made in this direction in the Union. In particular, following the recommendations of the Expert Group which conducted a review of the 2012 Bioeconomy Strategy in 2017, the European Commission has introduced a specific action dedicated to the need to better incorporate the objectives and principles of the bioeconomy in the national and rural development programmes (operating under the second pillar of the CAP) in the updated version of the strategy, published in 2018. The document, indeed, now supports the incorporation of the bioeconomy principles in the future CAP national plans. In addition, the European Rural Development Fund is now seen as a way to deploy inclusive bioeconomies in rural areas. The legal proposals of the CAP pot 2020, in turn, consider the bioeconomy as a priority. At the same time, the Rural Bioeconomy Panel and its Thematic Group has been created under the European Network for Rural Development in order to further discuss about the benefits of the bioeconomy for rural areas.

As regards to the Italian level, the two policies still seem to be separated. Indeed, although promoting the issue of rural development several times and supporting the alignment of EU national, regional policies, regulations and funding, the Bioeconomy Strategy adopted by the Italian Council of Ministers in 2017 does not identify any specific

measures aimed at integrating its principles in the CAP. It has to be mentioned, anyway, that it was envisaged the preparation of more detailed action plan. At the same time, neither the Italian National Rural Development Programme nor the regional programmes dedicate a specific action to the incorporation of bioeconomy principles in the programmes. However, several regions (namely Basilicata, Campania, Emilia-Romagna, Molise, Piemonte, Valle d'Aosta and Veneto) indicate some interest in their rural development programmes to the development of bioenergy and the use of agricultural and agro-industrial by-products in terms of ensuring resource efficiency and climate change mitigation. In this context, in view of the forthcoming reform of the CAP, which will provide Member States more flexibility in designing their own rural development programme, and in view of the preparation of the detailed action plan with timetables for the Italian Bioeconomy Strategy, more should be done at both levels in order to ensure a better coordination between the two policies and, as a consequence, to achieve their specific objectives.

In summary, the Bioeconomy is a very complex area. The present work has tried to show that only thinking globally (with the creation of a global governance framework) and acting locally (with a better coordination with the rural development policy) can ensure it to become a veritable revolution which could shape the pathways towards a sustainable future.

## Annexes

Annex 1: Bioeconon	y related p	olicy strateg	gies adopted	worldwide (	cont.)
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Region	Country	ntry Strategy	
Africa			
	Kenya	"National Bioprospecting Strategy"	2011
		"A National Biotechnology Development Policy"	2008
	Mali	"Stratégie Nationale de Développement des Biocarburants en Mali"	2009
		"Stratégie Nationale pour le Développement des Énergies Renouvable"	2006
	Mauritius	"Ocean Economy"	2013
	Mozambique	"Politica e Estrategia de Biocombustiveis"	2009
	Namibia	"National Programme on Research, Science, Technology and Innovation"	2015
	Nigeria	"Biofuel Policy and Incentives"	2007
	Senegal	"Lettre de Politique de Développement du Secteur de	2008,
	6	l'Énergie"	2012
		"National Biofuels Strategy"	2006
	South Africa	"The Bio-Economy Strategy"	2013
	Tanzania	"National Biotechnology Policy"	2013
	Uganda	"Biomass Energy Strategy Uganda"	2014
	U	"National Biotechnology and Biosafety Policy"	2008
		"The Renewable Energy Policy For Uganda"	2007
Americas			
	Argentina	"Bioeconomía Argentina"	2017
		"Plan Provincial de Bioeconomia"	2016
		"Argentina Innovadora 2020"	2012
	Brazil	"Estratégia Nacional de Ciência, Tecnologia e Inovação 2016- 2019"	2016
		"Plano Decenal de Expansão de Energia 2023"	2014
		"PAISS"	2012
		"Biotechnology Strategy"	2007
	Canada	"A Forest Bioeconomy Framework for Canada"	2017
	Colombia	"Política para el Desarrollo Comercial de la Biotecnología a	2011
		partir del Uso Sostenible de la Biodiversidad"	
	Mexico	"Estrategia Intersecretarial de los Bioenergéticos"	2009

	Paraguay	"Politica y Programa Nacional de Biotecnoloía Agroprecuaria	2011
		y Forestal del Parauay"	
	Uruguay	"Plan Sectorial de Biotechnología 2011-2020"	2012
		"Uruguay Agro inteligente 2010-2015"	2010
	USA	"Strategic Plan for a Thriving and Sustainable Bioeconomy"	2016
		"Strategy for American Innovation"	2015
		"The Farm Bill"	2014
		"The Bioeconomy Blueprint"	2012
Asia/Pacific			
Asia/1 aciiic	Australia	"Oueensland Biofutures 10-Year- Roadman and Action Plan"	2016
	<i>i</i> fustitullu	"National Marine Science Plan 2015-2025"	2010
		"National Collaborative Research Infrastructure Strategy"	2013
		"Opportunities for Primary Industries in the Bioenergy Sector:	2013
		National Research Development and Extension Strategy"	2011
		"Strategic Roadman for Australian Research Infrastructure"	2011
		"Building a Bioeconomy in South Australia"	2011-
		Building a Dioconomy in South Mastuna	2015
			2010
	China	"13 <sup>th</sup> FYP for Science, Technology and Innovation"	2016
		"13 <sup>th</sup> FYP for Strategic Emerging Industries"	2016
		"13 <sup>th</sup> FYP on Bioindustry Development"	2016
		"12 <sup>th</sup> FYP on Bioindustry Development"	2012
		"12 <sup>th</sup> FYP (2011-2015) on Agricultural Science and	2012
		Technology Development"	
		12th FYP for National Strategic Emerging Industries	2012
	т 1:		2007
	India	"National Biotechnology Development Strategy (Biotech	2007,
		Strategy II)	2014
	Indonesia	"Grand Agricultural Strategy"	2015
	mdonesia	"National Energy Policy"	2013
		Turional Energy Toney	2011
	Japan	"Strategic Energy Plan"	2014
		"National Science and Technology Strategy"	2013
		"Biomass Industrialization Strategy"	2013
		"National Strategy and Action Plan for Biodiversity 2012-	2012
		2020"	
		"National Plan for the Promotion of Biomass Utilization"	2010
		"Biomass Nippon Strategy"	2002
	Malaysia	"National Biomass Strategy"	2013
		Bioeconomy Transformation Programme"	2012
		"National Biomass Strategy 2020: New Wealth Creation for	2011
		Malaysia's Palm Oil Industry"	2005 -
		"National Biotechnology Policy"	2020
	New Zealand	"Primary Sector Science Poodman Ta Ao Turoo"	2017
	INCW ZEALAHU	"Biological Industries Desearch Fund"	2017
		"Business Growth Agende"	2013
		"Bioenergy Strategy"	2012
		Dioenergy Strategy	2010

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	Russia	Roadmap	2013
		"Comprehensive Program for the Development of	2012
		Riotechnology in Pussie by 2020"	2012
		Biotechnology in Russia by 2020	
	0 4 W		2012
	South Korea	"3 <sup>rd</sup> Basic Plan for Science and Technology"	2013
		"Strategy for Promotion of Industrial Biotechnology"	2012
		"Blue-Bio 2016 Plan"	2008
		"2 <sup>nd</sup> Framework Plan for Promotion of Biotechnology, Bio-	2006
		Vision 2016"	
	Sri Lanka	"National Biotechnology Policy"	2010
	SII Lalika	National Biolechnology Folicy	2010
	<b>—</b> 1 ·1 1		0015
	Thailand	"Bioeconomy Roadmap"	2017
		"National Biotechnology Policy Framework" 2004-2011;	
		2012-2021	
		"Alternative Energies Development Plan" 2012-2021	
		"BioPlastics Roadman"	2008
		Dior lastics Roadinap	2000
Europa			
Europe			0014
	Austria	"Research, Technology and Innovation Strategy for Bio-based	2014
		Industries in Austria"	
		"Policy Paper on Bioeconomy"	2013
	Belgium	"Bioeconomy in Flanders" and Action Plan	2014
	DerBrunn		-011
	Donmorl	"Crowth Dian for Water Die and Environmental Solutions"	2012
	Denmark	Growth Plan for water, Blo and Environmental Solutions	2013
		"Growth Plan for Food"	2013
	EU	"A sustainable bioeconomy for Europe: strengthening the	2018
		connection between economy, society and the environment"	
		Undated Bioeconomy Strategy	
		"Innovating for Sustainable Growth: a Bioeconomy for	2012
		Furone"	2012
		Europe	
	TP: 1 1		0014
	Finland	"The Finnish Bioeconomy Strategy"	2014
	France	"A Bioeconomy Strategy for France"	2017
		"Stratégie national de transition écologique vers	2014
		développement durable"	
		"France Europe 2020"	2013
		"The new face of Inductors in Erence"	2013
		The new face of industry in France	2015
		"National Biodiversity Strategy 2011-2020"	2011
	Germany	"National Policy Strategy on Bioeconomy"	2013
	-	"National Research Strategy BioEconomy 2030"	2010
	Ireland	"National Policy Statement on the Riseconomy"	2018
	notallu	"Homossing Our Occor Weelth"	2010
		Hamessing Our Ocean Wealth	2012
		"Delivering our Green Potential"	2012
		"Towards 2030"	2008
	Italy	"Bioeconomy in Italy: A unique opportunity to reconnect	2017
	-,	economy society and environment"	
		content, boolety and environment	
	I ati-	"I strigg Dissource Strate and 2020 (I I DD A)"	2017
	Latvia	Latvian Dioeconomy Strategy 2050 (LI-BKA)	2017
Lithuania	"National Industrial Biotechnology Development Programme"	2007-	
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 		2010	
Netherlands	"Groene Groei: voor een sterke, duurzame economie"	2013	
	Groene Groei – Van Biomassa naar Business"	2012	
	"Framework memorandum on the Biobased Economy"	2012	
	"Green Deal Program"	2011	
 Norway	"Familiar resources – undreamt possibilities"	2016	
•	"Research Programme on Sustainable Innovation in Food and	2012-	
	Bio-based Industries"	2022	
	"National Strategy for Biotechnology"	2011	
	"Marine Bioprospecting – a Source of New and Sustainable		
	Wealth Growth"	2009	
 Portugal	"Estrategia Nacional para o Mar"	2013-	
-		2020	
Spain	"Extremadura 2030"	2017	
-	"Horizon 2030"	2016	
 Sweden	"Swedish Research and Innovation Strategy for a Bio-based	2012	
 	Economy"		
United Kingdom	UK Synthetic Biology Strategy Plan "Biodesign for the Bioeconomy"	2016	
-	"Building high value bioeconomy: opportunities from waste"	2015	
	"Biorefinery Roadmap" Scotland	2015	
	"Science and Innovation Strategy for Forestry"	2014	
	"Agri-tech Industrial Strategy"	2013	
	"Hih-value Manufacturing Strategy"	2012	
	"UK Bioenergy Strategy"	2012	
	"Natural Environment White Paper"	2011	
	UK Biomass Strategy"	2007	
 West Nordic Countries	"Future Opportunities for Bioeconomy in the West Nordic Countries"	2014	

Source: adapted from the Bioeconomy Council (2018).

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## **Events**

- OECD CRP Biological Resource Management for Sustainable Agricultural Systems, *The Circular Bioeconomy*, CRP Governing Board Meeting, 30 November 2018, Paris.
- OECD TAD-ENV, Joint Working Party on Agriculture and the Environment, *Bio-economy and the Sustainability of the Agriculture and Food System: Opportunity and Policy Challenges*, 22-23 October 2018, Paris.

## **Executive Summary**

The Bioeconomy is defined by many as "the production, utilization and conservation of biological resources, including related knowledge, sciences, technology, and innovation, to provide information, products, processes and services across all economic sectors aiming toward a sustainable bioeconomy"<sup>1</sup>. Based on the replacement of fossil (finite and polluting) resources with biological (and renewable) feedstocks, and the application of technology and innovation. The development of the bioeconomy seems to be a way to change the current paradigm of economic development in favour of a new economic system aimed at achieving the Sustainable Development Goals (SDGs) presented in the Agenda 2030. A sustainable bioeconomy can boost the economic growth, create new jobs; contribute to climate change mitigation; preserving the ecosystem; improve public health and ensure a better quality of life. Indeed, it is seen as "the (green) industrial revolution of the Third Millennium"<sup>2</sup>, and "an opportunity to redesign the global system of production and consumption in a manner guaranteeing a secure sustainable base in every respect"<sup>3</sup>.

The work proposed here, organised in three chapter, aims at understanding the principal policy challenges that the implementation of a sustainable, circular bioeconomy is currently facing. The dissertation is based on the study of the main literature regarding the bioeconomy concept and the analysis of the bioeconomy policy strategies adopted around the world. Relevant for the scope of the work is the identification of the main characteristics of the bioeconomy policy cycle, and the interaction between the bioeconomy policy and other relevant policies. In order to assess the latter, the relationship between the mutually linked policies addressing rural development and bioeconomy in the EU and in Italy is taken into account.

The first chapter is devoted to the analysis of the bioeconomy as a whole, its evolution and different definitions; the external factors pushing for its conceptualisation;

<sup>&</sup>lt;sup>1</sup> The Global Bioeconomy Summit, 2018.

<sup>&</sup>lt;sup>2</sup> Il Bioeconomista, <u>https://ilbioeconomista.com/manifesto-english-version/</u>.

<sup>&</sup>lt;sup>3</sup> Rural 21- The International Journal for Rural Development, *Bioeconomy*, visited in February 2019, https://www.rural21.com/english/a-closer-look-at/kategorie/article/bioeconomy-00001228/.

its potential relevancy and links with the SDGs and the concepts of green growth and green economy; and the serious environmental challenges which an unsustainable bioeconomy could contribute to.

In particular, the chapter shows that the emergence of the bioeconomy is gaining increasing attention in both research and policy debates in recent years. Some analysis sees the use of the term increasing considerably in research and policy papers over the last decades. In addition, the growing number of initiatives undertaken by societal stakeholders, business and research networks and NGOs, reflects the dynamic development of the bioeconomy. For instance, the Global Bioeconomy Summit (GBS) is important in this context, since it has been the first bioeconomy related event on a global scale. The Summit, organized by the German Bioeconomy Council in 2015 and 2018 in Berlin, brought together, on the occasion of the second meeting, representatives from more than 70 countries from Africa, the Americas, Asia and Europe, as well as international policy experts and representatives from science and industry, for a total of 700 people. The GBS also set up the International Advisory Committee on the Bioeconomy (IACB), an informal platform composed of leading bioeconomy experts. Other significant initiatives have also been launched around the world, such as: the International Bioeconomy Forum (launched by the European Commission and AgriFood Canada); the World Bioeconomy Forum and the Bioeconomy Investment Summit (focusing on the potentials of the Northern Europe's bioresources); the EU Bioeconomy Stakeholders Panel; the Bio-based Industries Joint Undertaking; the BioEAST (a Central and Eastern European initiative) and the Ibero-American Network of Bioeconomy and Climate Change, REBICAMBLI. Most importantly, almost 50 countries have developed a bioeconomy dedicated or related strategy so far.

The idea of the bioeconomy was firstly conceptualized by scientists, referring to the application of the technology on biological sciences, which could have the potential to transform industrial production processes. In parallel, the European Commission had a central role in the promotion of the "knowledge-based bio-economy", in alignment with the goals on innovation of the Lisbon Strategy of 2000. Germany and other Northenr European countries proved to be very active in pushing the EU in this direction. Other countries and international organisation also developed their own approaches to the concept, such as: the Canadian think tank Pollution Probe, through the document *Towards a biobased economy – issues and challenges* published in 2002; the OECD with

*Biotechnology for sustainable growth and development* and *The Bioeconomy to 2030: Designing a Policy Agenda*, both published in 2009. In the wake of the increasing attention to the topic, some countries such as the US, the Russian Federation, Malaysia and South Africa developed their own bioeconomy strategies.

In spite of the momentum that the topic of bioeconomy has gained recently, a globally agreed definition has not been found so far, and there is little international consensus on what the bioeconomy actually implies. However, three different perspectives can be distinguished in the process of evolution of the bioeconomy concept: the bio-technology approach, based on the importance of technology and innovation; the bio-resource perspective, which puts the need for a sustainable use of biomass at the centre of the debate; and the bio-ecological approach, which highlights the effects of the environment of that kind of shift.

Besides the variance in terms of definitions, it is generally agreed upon that the replacement of fossil resources with biomass for energy and production use has huge potential, from a social, economic and environmental point of view. For instance, it can contribute to climate change mitigation by reducing greenhouse gases (GHGs) emissions; preserving the ecosystem, by revaluating of abandoned land and efficiently using natural resources; boosting the economy; and by improving public health and the quality of lives. In this perspective, the bioeconomy can meet the objectives presented in the Agenda 2030 for sustainable development. In particular, the bioeconomy seems to directly support ten out of 17 Sustainable Development Goals identified by the Agenda. Those dedicated to the achievement of: zero hunger (SDG 2); good health and well-being (SDG 3); clean water and sanitation (SDG 6); affordable and clean energy (SDG 7); decent work and economic growth (SDG 8); sustainable cities and communities (SDG 11); responsible consumption and production (SDG 12); climate action (SDG 13); life below water (SDG 14); and life on land (SDG 15). In addition, bioeconomy can be encompassed within the broader framework of the green economy and green growth concepts, both subcategories of the sustainable development and both focusing on fostering economic growth while ensuring environmental protection and societal well-being.

Also, in 2015 the GBS highlighted the importance to align the principles of a sustainable bioeconomy with those of the circular economy, which already share the aim of adding value to biological waste and residues. The notion of circular economy refers

to an economic system in which "the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised"<sup>4</sup>. In fact, the "cascading-use of biomass" approach, is based on the multiple re-use of biomass in the value chain, when economically and technically feasible.

However, further investigation reveals that implementing a sustainable, circular bioeconomy appears to be not so easy. As a matter of fact, given the potential of the latter in terms of direct contribution to the goals of Agenda 2030, the use of biological feedstocks for production and energy purposes, if not properly managed, can have harmful effects on the ecosystems. All bioeconomy aspirations and assumptions depend on the supplies of biomass. Indeed, the competition between the exploitation of biomass for food use or for industrial use is a primary issue. If we start using land to grow biomass, will there be enough land to grow food? Additionally, as a result, an increase in the price of the food can be expected. Secondly, the use of biological resources can have geographical and geopolitical implications, mainly in terms of biomass trade. The difference between biomass-rich countries and biomass-poor countries could exacerbate phenomena such as land grabbing or could lead biomass exporting countries to overexploit their natural resources, in order to respond to the demand of the biomass importers. Finally, the harvesting of crops for bioeconomy purposes, can increase GHGs emissions in the atmosphere instead of limiting it, because of the indirect land-use change phenomenon (ILUC).

Unfortunately, assessing the sustainability of the bioeconomy has resulted to be quite complicated; no internationally agreed set of indicators and criteria have been fixed so far. Nonetheless, the analysis of the bioeconomy policy around the world conducted in the second chapter indicates that many countries have shown their strong interest in building a structured policy aiming to regulate and promote the sustainable exploitation of renewable biological resources for production and energy use recently. It has been found that Argentina, Finland, France, Germany, Ireland, Italy, Japan, Latvia, Malaysia, Norway, South Africa, Thailand and the United States have adopted dedicated bioeconomy strategies with a holistic approach. Other countries have developed policies addressed to bioeconomy-relevant sectors, such as the bioenergy, the green economy and green growth, forestry, the blue economy and chemistry.

<sup>&</sup>lt;sup>4</sup> European Commission, Closing the loop – An EU action plan for the Circular Economy, Brussels, 2015.

Apart from South Africa, which uses a holistic approach in developing its national bioeconomy strategy in 2013, no other national dedicated bioeconomy strategies have been developed in Africa so far. A specific focus on the area of biotechnology is, instead, supported by Kenya, Tanzania and Uganda. Kenya adopted a national biotechnology policy in 2006 and a policy dedicated to its rich biodiversity in 2011. Tanzania, as well, adopted a national biotechnology policy in 2010 Uganda, in turn, targeted both the sectors of biotechnology and bioenergy with the "National Biotechnology and Biosafety Strategy" in 2008 and a "Biomass Energy Strategy" in 2014. The importance of bioenergy and biofuels is also addressed by Mali, Mozambique, Nigeria and Senegal. By contrast, Mauritius adopted strategies which focus on the blue economy, especially the potential of oceans and their contribution to GDP, touching on marine biotechnology, food processing, aquaculture, marine pharmaceuticals and cosmetics. Finally, Namibia also developed a strategy on research and innovation. What is more, several projects have been supported by international partners in Africa; for instance, the German government and the Swedish Development Agency launched some initiatives on the continent.

In the Americas, it can be said that bioeconomy-related topics have been increasingly discussed in both North and South America in the last few years. Nevertheless, as for Africa, only the US, in 2012, became the only country to adopt a bioeconomy dedicated national strategy. However, several countries have adopted strategies in relevant bioeconomy fields. As one of the most active Southern American countries in bioeconomy development, Argentina presented the position paper *Bioeconomia Argentina* in 2017. Relevant is also the *Plan Provincial de Bioeconomia* adopted by the province of Buenos Aires. Brazil, Mexico, Uruguay and Paraguay, in turn, have focused more on biotechnology and bioenergy, while Colombia on biodiversity. Similarly, Northern American bioeconomy strategies are also bioresources-driven, especially focusing on agriculture and forestry. Canada, for example, has a forest-based approach to the bioeconomy.

In the Asia/Pacific region, bioeconomy development in countries such as China, India, Russia, South Korea, Malaysia, Japan, Thailand and Sri Lanka is generally oriented to high-tech emerging industries and industrial innovation. In contrast, Australia and New Zealand are more focused on the growth and value-creation in their primary industries, similar to Canada. In particular, Japan has been one of the first countries in the world to adopt a national bioeconomy strategy. Likewise, Malaysia has been one of the pioneer countries in Asia to focus on the bioeconomy as a whole. Finally, in 2017, Thailand has become the third country in the continent to have a dedicated "Bioeconomy Roadmap". All the others have shown to be very proactive mainly in addressing biotechnology. Indonesia also emerges as a country addressing two bioeconomy related areas: bioenergy and agro-industry.

Finally, the development of national bioeconomy policy strategies in the European Union has been strongly influenced by the work of the European Commission in the field of biotechnology since 1982. The idea of a knowledge-based bio-economy has then led to the adoption of the European Bioeconomy Strategy in 2012, updated in 2018 after the review of an expert group conducted in 2017. The 2018 Bioeconomy Strategy is built on three main action areas: the strengthening and scaling up of the bio-based sectors, while unlocking investments and markets; deploying local bioeconomy. Germany had a leading role in the process of bioeconomy development in the EU. It established a Bioeconomy Council in 2009 and launched a bioeconomy dedicated strategy already in 2010. Germany was followed by the Nordic Countries, Finland, Norway and the Netherlands. Additionally, since 2015, Spain, France Italy, Latvia and Ireland have adopted bioeconomy dedicated strategies. Finally, Austria, Iceland, Estonia and the UK have announced the preparation of a national strategies addressing the bioeconomy.

In summary, the comparative analysis of the bioeconomy strategies and the bioeconomy policy cycle reveals that all the bioeconomy dedicated (or related) policy strategies adopted around the world vary in scope and depth, differing in terms of objectives pursued and actors addressed. At the same time, common goals and general measures are shared by many countries, such as the need to foster technological innovation, economic growth, resource efficiency and ecological sustainability.

The bioeconomy policy cycle also shows some variances on the basis of the country undertaking it. In fact, the pre-decision phase of the cycle, for instance, is strongly influenced by country-specific characteristics and strengths. Globally, the setting of priorities reflects the industrial and economic profile of the individual country as well as its natural resource potential, i.e., the amount of biomass which can be sustainably exploited for production and energy use. Resource-rich countries usually promote

innovation in the primary sector; by contrast, the countries which lack natural resources but have a strong industrial structure, such as Germany and Japan, mainly focus on their industrial and technological leadership. Furthermore, this phase is normally characterised by a participatory approach. Many countries involve industry, civil society representatives and the general public to bioeconomy policy formulation, through public consultation processes. This process is often based on the preparation of workshops, conferences or online surveys. In addition, while top-down approaches are primarily used during the implementation phase, in particular in Finland, Germany, Japan the Netherlands, Norway and the US, many countries seek instead to exploit existing private sector and public research initiatives to implement their bioeconomy strategies. Several local-level approaches are also developing in some regions. Two good examples are the Malaysia Community-based Bioeconomy, the Japan Biomass Town and the bioeconomy plan adopted by the province of Buenos Aires. As regards to the last phase of the policy cycle, an increasing number of countries are launching monitoring and evaluation processes to assess the accountability of bioeconomy development. Several dedicated advisory councils, representing public, private and civil stakeholders, have been established to provide advisory services for bioeconomy development.

In a global context in which the bioeconomy policy lacks unity, it seems necessary to further discuss the issue of governance. The bioeconomy, indeed, involves a multitude of competing interests, scopes and definitions. What is more, while a great number of countries showed their interest in promoting bioeconomy development through comprehensive political support, only few of them present in their strategies the political management of conflicting goals and their potential risks. It turns out that the creation of a global governance framework, which could identify indicators and specific targets at a global level, to ensure the respect of the objectives presented in the Agenda 2030 and in the Paris Agreement in the implementation of the bioeconomy, is necessary.

Besides, the cross-cutting nature of the bioeconomy, which involves several sectors from agriculture to rural development, forestry, fisheries, food, trade, waste management, energy, pharma and industry, requires a strong coordination among policy makers and stakeholders at different scales, but also among different relevant policies.

Given the significance of the local scale for the bioeconomy – the biomass is usually processed in small-scale biorefineries in rural locations – the interaction between bioeconomy and rural development policy is analysed in the third chapter. Indeed, bioeconomy seems to have a great potential on the process of revitalisation of rural areas. Rural areas suffer from an ageing population, gender imbalances, lack of diversity in the job market, low incomes, inadequate supply of public services and, as a consequence, low quality of life. In addition, rural communities appear to be more vulnerable to external economic and environmental shocks. Nowadays, according to the OECD, rural regions are home to one-quarter of the global population and account for 75% of land area, containing the vast majority of the land, water and natural resources. It is exactly the richness of their biodiversity which makes of these zones a great contributor to the fight against the big global challenges of humankind, especially climate change mitigation and resource security, and to the development of the bioeconomy. At the same time, the sustainable production and use of biological feedstocks, stabilised in rural areas (where the biomass grows) can offer economic diversification to these areas (through the creation of new industries), more income and better livelihoods.

The policies which address rural development and bioeconomy development are, therefore, mutually linked; each of them can foster the implementation of the other. However, in order to ensure that, a high level of coordination between the two policies has to be granted.

The dissertation evaluates, therefore, the level of integration between the second pillar of the Common Agricultural Policy (CAP) – responsible for the rural development policy in the EU – and the bioeconomy strategies, both at the European and the Italian level. It has been found that progress has been made in this direction in the Union. In particular, following the recommendations of the Expert Group which conducted a review of the 2012 Bioeconomy Strategy in 2017, the European Commission has introduced a specific action dedicated to the need to better incorporate the objectives and principles of the bioeconomy in national and rural development programmes (operating under the second pillar of the CAP) in the updated version of the strategy, published in 2018. The document, indeed, now supports the incorporation of the bioeconomy principles in the future CAP national plans. In addition, the European Rural Development Fund is now seen as a way to deploy inclusive bioeconomy as a priority. At the same time, the Rural Bioeconomy Panel and its Thematic Group *Mainstreaming the Bioeconomy* have been created under the European Network for Rural Development in order to further

discuss about the benefits of the bioeconomy for rural areas and improve the integration of the bioeconomy principles in the future RDPs.

At the Italian level, instead, the two policies seem to be still separated. Indeed, although promoting the issue of rural development several times and supporting the alignment of EU national, regional policies, regulations and funding, the Bioeconomy Strategy adopted by the Italian Council of Ministers in 2017 does not identify any specific measures aimed at integrating its principles in the CAP. It has to be mentioned, however, that the preparation of more detailed action plan was envisaged. At the same time, neither the Italian National Rural Development Programme nor the regional programmes dedicate a specific action to the incorporation of bioeconomy principles in the programmes. However, several regions (namely Basilicata, Campania, Emilia-Romagna, Molise, Piemonte, Valle d'Aosta and Veneto) indicate some interest in their rural development programmes to the development of bioenergy and the use of agricultural and agro-industrial by-products in terms of ensuring resource efficiency and climate change mitigation.

In this context, in view of the forthcoming reform of the CAP, which will provide Member States more flexibility in designing their own rural development programmes, and considering the preparation of the detailed action plan with timetables for the Italian Bioeconomy Strategy, it is recommended that the Italian government to put forward key actions to ensure better coordination between the two policies, in order to achieve their specific objectives.

In summary, the bioeconomy is a very complex area. The present work has tried to show that only thinking globally (with the creation of a global governance framework) and acting locally (with a better coordination with rural development policy) can ensure it becomes a veritable revolution which could shape the pathway towards a sustainable future.