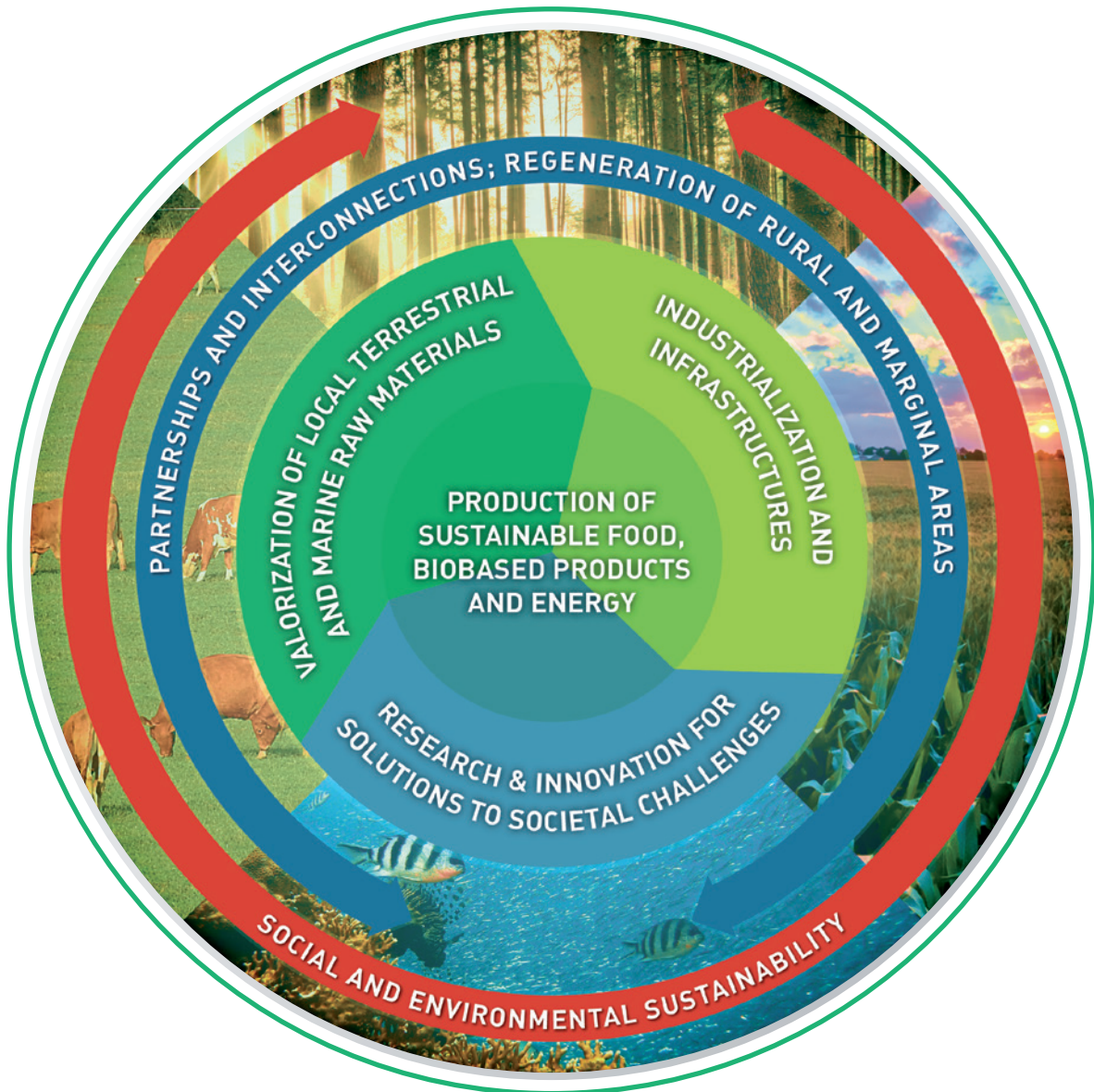


BIT

Bioeconomy in Italy



A unique opportunity to reconnect
ECONOMY, SOCIETY
and the **ENVIRONMENT**

CONSULTATION DRAFT

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PREFACE

The **bioeconomy** comprises those parts of the economy that use renewable biological resources from land and sea – such as crops, forests, fish, animals and micro-organisms – to produce food, materials and energy (*Europe's Bioeconomy Strategy, European Commission, 2012*).

Thus, it includes primary production - such as agriculture, forestry, fisheries and aquaculture - and industrial sectors using and/or processing biological resources, such as the food and pulp and paper industries and parts of the chemical, biotechnological and energy industries. These elements are at the heart of sustainable development that delivers strong communities through a flourishing economy that respects the environment by reducing dependence on fossil fuels and finite materials without overexploiting renewable resources, preventing biodiversity loss and land use change, regenerating the environment and creating new economic growth and jobs, leveraging on local diversities and traditions, in particular in the rural, coastal and industrial areas (including the abandoned ones), in line with the principles contained in the Juncker's Agenda for Jobs, Growth, Fairness and Democratic Change.

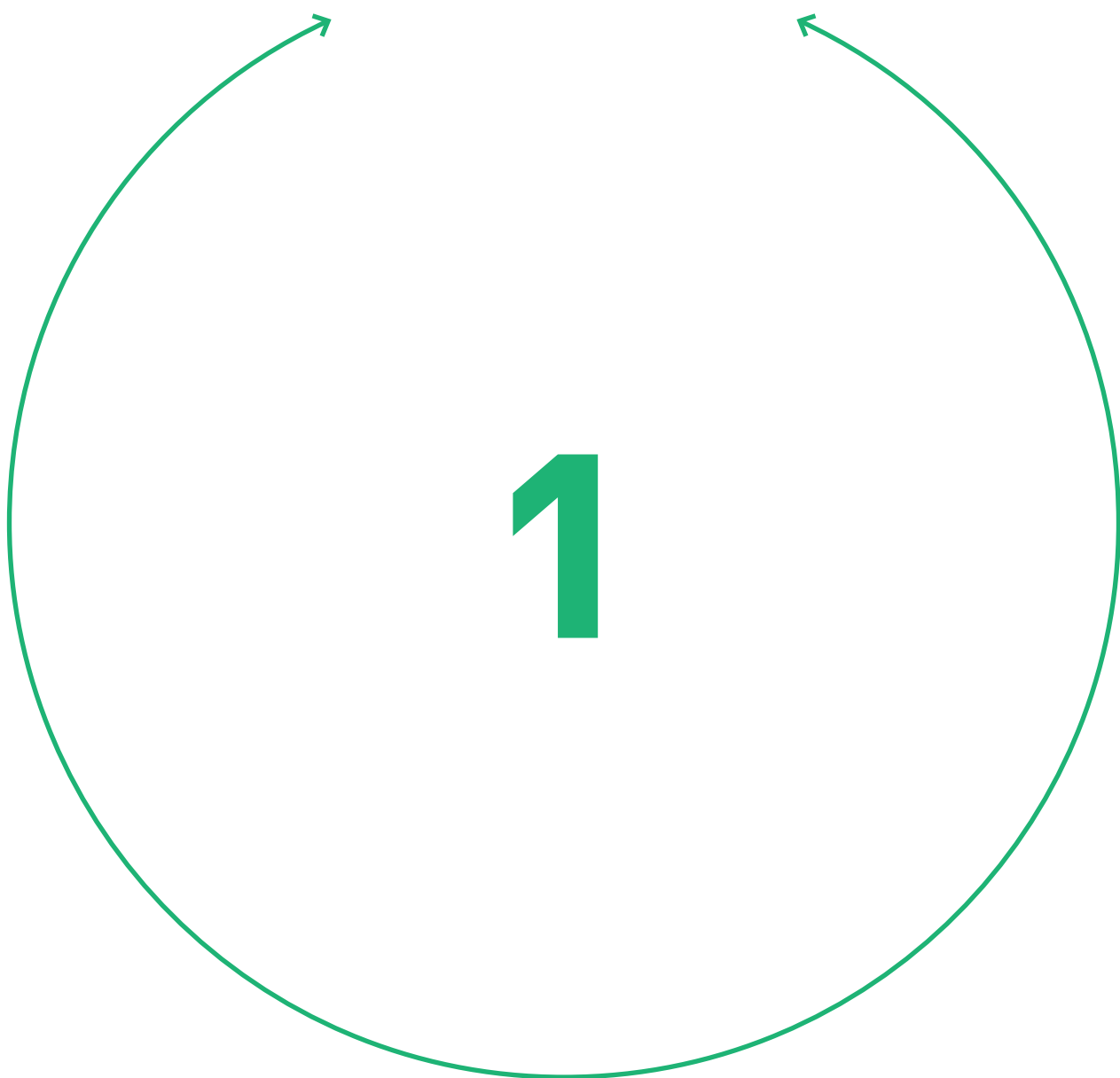
Global population increase, adverse impacts of climate change and ecosystem resilience reduction are calling for an improved use of renewable biological resources i.e., for a more sustainable primary production and more efficient processing systems able to produce food, fiber and other bio-based products with fewer inputs, less waste and greenhouse gas emissions with benefits for human health and environment. A waste management system that fully considers the potential of

agricultural, forestry and municipal (biogenic) wastes are also essential to enable the circular economy.

Italian Bioeconomy, means to encompass the sustainable production of renewable biological resources and the conversion of these resources and waste streams into value added products such as food, feed, bio-based products and bioenergy.

This strategy aims to provide a shared vision of the economic, social and environmental opportunities and challenges associated with the carrying out of an Italian Bioeconomy based on longer, more sustainable and locally routed value chains. It also represents a significant opportunity for Italy to enhance its competitiveness and role in promoting sustainable growth in Europe and in Mediterranean basin.

Bioeconomy strategy will be part of the implementation processes of the National Smart Specialization and in particular of its thematic areas "health, food and life quality" and "sustainable and smart industry, energy and environment" and in synergy with the Italian National Strategy for the Sustainable Development and its principles for ensuring environmental sustainability and economic growth reconciliation.



BIOECONOMY – AN INTRODUCTION

Food security, sustainable management and exploitation of agriculture, forestry, marine biological resources and inland waters as well as the biobased industry are among the most important elements influencing European society and the wider world. Bioeconomy refers to the set of economic activities relating to the invention, development, production and use of biological products and processes across three macro-sectors¹:

1. Agrifood
2. Marine Bioeconomy
3. Forestry and Biobased industry

All these sectors have two complementary and transversal sides. One based on production from raw renewable resources, a second relying on the reuse and recycling of biowaste. In both cases, bioeconomy needs to build on local resources and facilities and an improved interaction and integration between the industrial sectors concerned, public and private stakeholders, existing policies at International, European and Member States level².

A definition of a common framework for a wide range of established and emerging policy, technology and market needs is required by sharing challenges and experiences implemented at global, European, national and regional level.

1 Europe's Bioeconomy Strategy, European Commission, 2012

2 Global Bioeconomy Summit 2015 Communiqué

1. BIOECONOMY – AN INTRODUCTION

1.1 IN THE GLOBAL AND EU CONTEXT

Currently, more than 40 nations worldwide are proposing actions and strategies to boost their bioeconomy, whose economic dimension is steadily increasing: about US\$2 trillion of products in agriculture and forestry, food, bioenergy, biotechnology and green chemistry were exported worldwide in 2014, amounting to 13% of world trade, up from 10% in 2007 [Communiqué of the Global Bioeconomy Summit. Making Bioeconomy Work for Sustainable Development (2015); Beate El-Chichakli et al., 2016, Nature].

In Europe, bioeconomy already worths EUR 2 trillion in annual turnover and account for more than 20 million jobs [Strategy for “Innovating for Sustainable Growth: A Bioeconomy for Europe”, EC, 2012]; it is expected to grow up to a market value of EUR 40 billion and 90,000 new jobs in 2020 [“Growing the European bioeconomy” Third Bioeconomy Stakeholders’ Conference, Turin, EC, 2014]. Furthermore, the food industry is the largest in EU and there is still further potential to grow, with new businesses and industries emerging in both traditional and novel food and non-food sectors. The EU Bioeconomy strategy, currently under revision, will

unlock the potentials of available bio-resources in the different bioeconomy and blue-economy sectors in a sustainable and socially responsible way.

The Mediterranean area deserves a specific focus: it is characterised by high levels of hydric stress that, together with climate change, is negatively impacting on agriculture. Such environment negatively affects standards of living, with social and economic stress as a major cause of instability, which in turn contributes to migration, both internally, from rural to urban territories, and externally, with migrations in particular towards Europe. For food security reasons a sustainable management of water provision and food systems is required to provide clean water and affordable food for the region’s inhabitants. PRIMA³ is an initiative launched and coordinated by Italy, that will make water provision and food systems more efficient, cost-effective and sustainable, helping solving bigger problems in relation to nutrition, health and social wellbeing, and ultimately help address mass migration trends.

3 Partnership for Research and Innovation in the Mediterranean Area: prima4med.org, 4prima.org



1. BIOECONOMY – AN INTRODUCTION



The BLUEMED Initiative⁴, also lead by Italy, aims at create new ‘blue’ jobs and a sustainable industrial growth in the marine and maritime sectors of the same area. The Mediterranean Sea is a basin with unique bio-geo-physical characteristics that prominently contributes to the EU economy by bearing 30% of global sea-borne trade with more than 450 ports/terminals, hosting the 2nd World’s largest market for cruise ships, half of the EU’s fishing fleet and a unique cultural heritage and natural patrimony. However, it is facing prominent environmental challenges related to climate change, growing maritime traffic and pollution, overexploitation of fish stocks, invasions of alien species, etc. At the same time, local biodiversity and deep sea resources, tourism, renewable energy production, marine aquaculture etc. are major local

opportunities for blue growth and jobs not efficiently exploited. BLUEMED was initiated by the EU MS of the area for addressing/implementing such challenges and opportunities via a common and shared Vision and a Strategic R&I Agenda.

Thus, bioeconomy might remarkably contributes to the regeneration, the sustainable economic development and the political stability of the area and, in turn, to the reduction of the migration phenomenon (for example with reference to the implementation of local investment projects with a high social and infrastructural impact, as expressed in the “Migration Compact” document proposed by the Italian Government)⁵ and Italy, also giving the two initiatives it coordinating, can play a key role on such an aim.

⁴ researchitaly.it

⁵ MIGRATION COMPACT Contribution to an EU strategy for external action on migration governo.it

1. BIOECONOMY – AN INTRODUCTION

1.2 AT ITALIAN LEVEL

In Italy the entire Bioeconomy sector (comprising of agriculture, forestry, fisheries, food and beverages production, paper, pulp and tobacco industries, textile from natural fiber, leather, pharmaceuticals, biochemicals and bioenergy) accounted for a total turnover of 251 billion Euro in 2015, and around 1,7 million employees. ¹

Estimates on the entire Bioeconomy rely on National Accounts for most of the sectors involved, while it is worth to note that biochemicals are not easily accounted, since (a part from biofuels) they are not included in the current statistical framework. Estimates based on the Input/Output Table, with different methodology, converge in indicating that chemicals based on renewable resources worth around 2,9 billion euro in 2015, i.e. 5,9% of total chemical production value.

However the potential of substitution of renewable inputs inside the chemical industry is high: according to an estimate⁶ around 40% of chemical products may be theoretically produced with renewable inputs, in the current technological framework (not considering thus economic and environmental sustainability). Beyond this theoretical substitution potential, the share of effective substitution will strongly depend on industrial and environmental policy and technological innovation.

⁶ Intesa Sanpaolo-Assobiotech "Report on Bioeconomy in Europe", December 2015

Agriculture

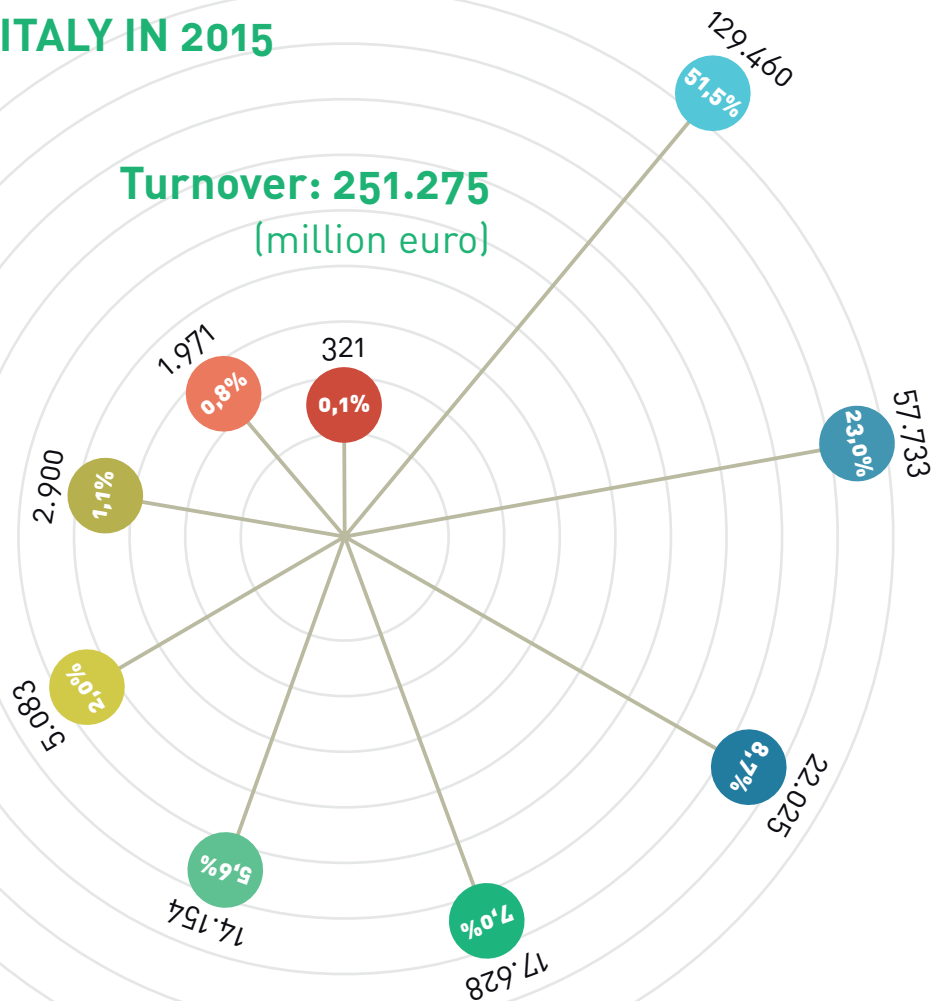
Agriculture is an important economic sector in Italy, accounting for 31 billion euro of contribution to Gross Value Added (2,3%) (ISTAT, 2015). The total agricultural area in Italy amounts to 17.1 million hectares, of which 12.9 million are utilised. In 2015, the value of production of agriculture, forestry and fisheries amounted to 57,7 billions euros. Around 910.000 people are employed in agriculture. Rural development is an important priority, mainly in marginal areas without access to the same services of public interest as towns and cities. Different rural development challenges are emerging in several Regions. Rural diversification is important; sustainability, social media, big data availability and new business models may well bring a new dimension to rural life. Furthermore, thanks to the variety of its territory and the long and diversified historical heritage, Italy enjoys a unique variety and richness in the food traditions. This is considered one of the most important distinguishing features of the Italian agriculture and one of the main strengths of the sector in international competition on the agriculture/food markets.



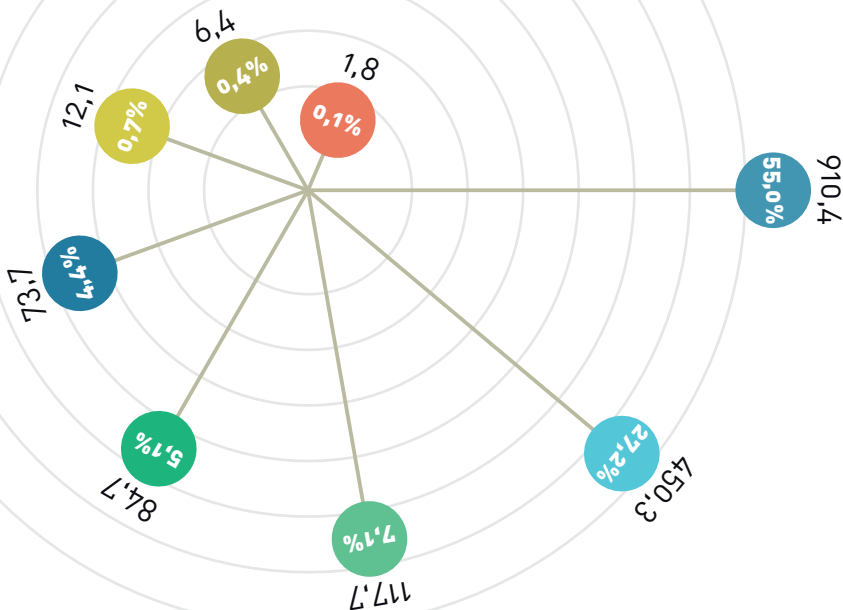
1 BIOECONOMY IN ITALY IN 2015

- Food industries, beverages and tobacco
- Agriculture, forestry and fisheries
- Manufacture of paper and paper products
- Manufacture of textiles and wearing apparel
- Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
- Manufacture of biobased pharmaceutical products
- Manufacture of biobased chemicals and chemical products
- Bioenergy
- Biodiesel

Turnover: 251.275
(million euro)



Employment: 1.657
(th. person employed)



Source:

Agriculture, forestry and fisheries: National Account

Food industries, beverages and tobacco: National Account

Manufacture of textiles and leather: 45% Textile + leather

Manufacture of wood and of pr. of wood and cork, except furniture: National Account and SBS

Manufacture of paper and paper products: National Account and SBS

Manufacture of biobased chemicals: Estimates on Input/Output Table and National Account

Manufacture of biobased pharmaceutical products: 20% of pharmaceuticals

Biodiesel: Prodcom

Bioenergy: Our computation on biomass share (excluding solid urban wastes) on electricity production (quantities) and application of this factor to the value of electricity production in national accounts (SBS)

1. BIOECONOMY – AN INTRODUCTION

Food Industry

In 2015, the Italian food industry, with a turnover of 132 billion Euro (of which around 29 from exports, about 8.8% of Italy's overall exports), 400,000 employees and 54,400 businesses, is the second largest manufacturing sector in Italy, and the third in Europe, behind the German and French food industries. ⁽²⁾

The industry sector is relying mostly on very small SMEs (over than 85% of the companies have less than 9 employees) but, in spite of this, it has proved to be a resilient sector, capable to grow also during the economic crisis period, due to its own structure, especially based on the market success of the Italian production worldwide through well known trademarks and brands and the high value given by the social, cultural and environmental attention embedded in the Italian product is also protected by Geographical Indications (18% of the EU products). ⁽³⁾



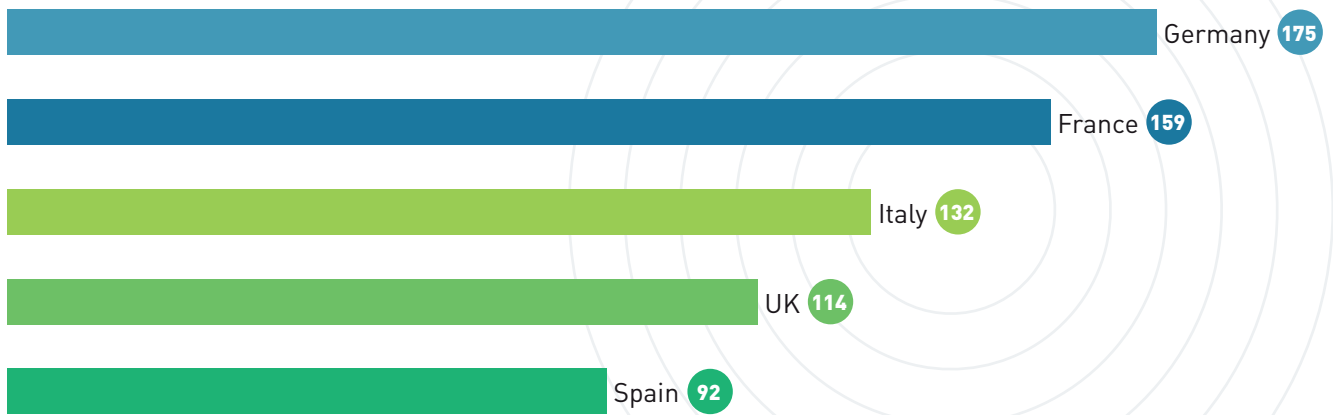
Food Industry sees open up huge opportunities for innovation and growth in the sector of the Bioeconomy. At this regard the National Agrifood Technology Cluster "CL.A.N."⁷, a multi-stakeholder network of the key national players of the agrifood chain, from companies to research centres and institutions, gave an important contribution through the elaboration of a Roadmap that identifies the most relevant challenges and research priorities of the Food Industry with respect the reuse of by-products:

- Obtaining new foods and/or fodders for zootechnical purposes, ingredients and/or bioactive compounds with a high nutritional value obtained from by-products generated by the agrifood processing industries;
- Adopting innovative processes to exploit by-products left over from agroindustry processing, to be placed on the market as new products for the food, fodder and agricultural sector;
- Reducing disposal costs and finding new economic returns from agrifood by-products;
- Analysing techniques to recuperate low cost by-products and their functional components, with a low environmental impact.

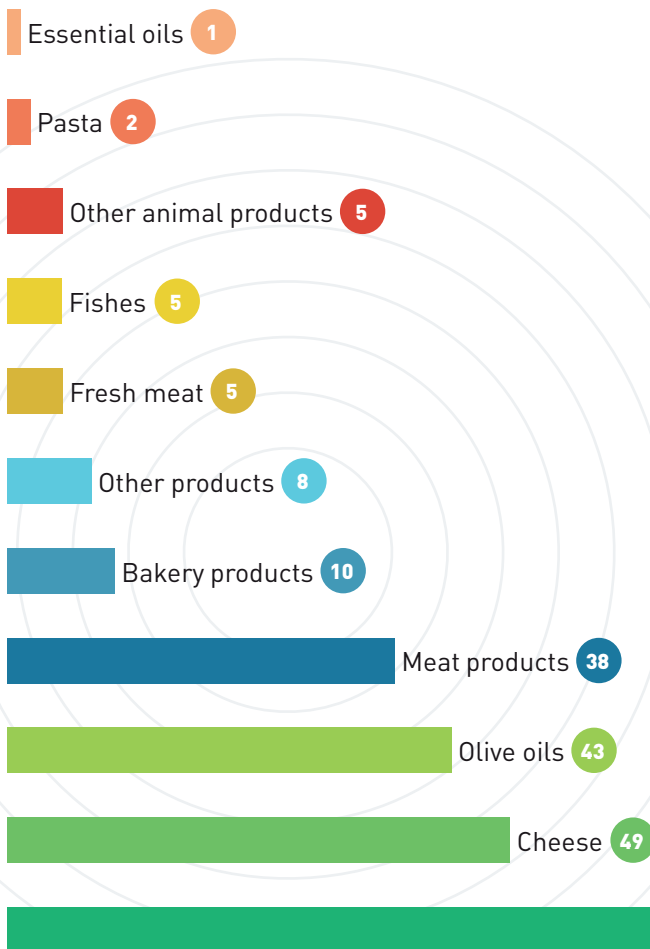
⁷ clusteragrifood.it

1. BIOECONOMY – AN INTRODUCTION

2 Europe's top five food industries



Source: FoodDrinkEurope – Turnover 2014 Bln €



Source: Report Qualivita 2014

3 Composition by sector

Italy has registered:

106 PDO – Protected Designation Origin

161 PGI – Protected Geographical Indication

2 TSG – Traditional Specialty Guaranteed products.



The AGRIFOOD CLUSTER gave an important contribution to the Bioeconomy through the national flagship project So.Fi.A. (Sustainability of Agrifood supply chain) in terms of:

Valorization of dairy by-products, especially residues of ricotta cheese (scotta) and cheese whey for recovery of their bio-molecules. A specific experimental campaign was conducted focused on double ultrafiltration steps followed by nanofiltration on scotta and cheese-whey with the separation and concentration of proteins, lactose and peptides. The liquid intermediates obtained after ultrafiltration were conferred to other partners of the project for post-processing treatment (enzymatic hydrolysis, oxidation) to turn bio-molecules in bio-active and functional substances as pre-biotics, functional peptides, lactulose and lacto-bionic acid.

Strategies for the reutilization and valorization on beef processing by-products and wastes. The production of new food (Bone Chips for gelatin, tallow, and food proteins) and non-food products (tallow and animal flour for the production of energy and depilated hides) to be included in various national and international industrial sectors represents the final goal. The byproducts which could not be valorized otherwise, will be used for the production of electric and thermal energy directed to satisfy the energetic needs of the company. The aim of the So.Fi.A. project, to valorize the beef hides, is the development of a biotechnological method for hair removal and exploitation of proteins, bioactive peptides and collagen of the obtained products and of fleshings generated from processing.

New solutions for the efficiency of processes of fresh-cut vegetables industry and valorization of wasted biomass. Within So.Fi.A., new technologies for reducing wasted biomass production using integrated drying process and associated with energy recovery devices are under study. Furthermore, composting and recycling waste into “on-farm” system are aimed at simplifying biomass management reducing environmental impact.

Other relevant initiatives led by food companies: SUSTAINABLE FARMING for an ITALIAN HIGH QUALITY DURUM WHEAT CULTIVATION - landmark project aimed to shift towards more sustainable durum wheat cultivation in order to improve production and soil efficiency through optimization of operations and inputs, as well as for reducing soil degradation. It is pursued by a Handbook for Sustainable Cultivation of Durum Wheat and a Web based Decision Supporting System (DSS) implemented through the incorporation in a standalone entity of all public and private research, on-field trials, agronomic principles, soil-climate-crop modeling, environmental footprint.

EU flagship initiatives: AgriMax project (BIO BASED INDUSTRIES JOINT UNDERTAKING - H2020-BBI-PPP-2015-2-1): Agri and food waste valorisation co-ops based on flexible multi-feedstocks biorefinery processing technologies for new high added value applications. The project combines flexible processing technologies to valorize residues and by-products from the agriculture and food processing industry to extract valuable biocompounds used to produce active ingredients, packaging and agricultural materials among others.

1. BIOECONOMY – AN INTRODUCTION



Forestry

Forest surface in Italy is 11 millions of hectares, covering approximately 37% of the national surface. Thanks to its Mediterranean positioning together with its diverse landscape spanning from sea to high mountain, Italian forests are hosting a wide variety of plant ecosystems. However, forest management has to be improved, as well as accounting of its products and ecosystem services (INFC 2015). It is worth noting that carbon removals by managed forests covered 10% of the overall national Kyoto target for CO₂ emission reduction and that there is a quite active voluntary market of carbon sinks.

More than 70'000 companies are active in the wood transformation industry, employing about 400.000 professionals, for an annual turnover of 40 billions euro, while the industry based on cellulose has an annual turnover of about 8 billions euro, 200 companies and over 20.000 employees. However, such prominent industry is relying for 80% on wood imported from other countries. In addition, the processed wood is converted into a few and traditional low value products while more room should also exist for expanding the role of wood in bio-construction industry.. The current lack of integration and of efficient chains between the primary production and the wood processing industry is limiting the socio economical growth as well as the international competitiveness of the whole value chain.

1. BIOECONOMY – AN INTRODUCTION



SPRING

*Sustainable Processes and Resources
for Innovation and National Growth*

Italian Cluster of Green Chemistry

SPRING's Roadmap built upon its members' priorities and objectives, establish a common ground in the discussion with regional, national and European institutions, which the Cluster considers as key partners for achieving the long term objectives related to the transition towards a new model centered around the concept of "sustainable regions" and present the main innovation breakthrough for Italian Biobased Industries.

- A. Achieving a Near-to-zero waste country by completely reusing biowaste as biochar, biogases, and biobased products.
- B. Reconversion of declined industrial sites for next generation biorefineries.
- C. Maintain and reinforce the Italian excellence in R&D in a global contest facing a more and more aggressive policies developed by the major countries and the growing interest of the most important chemical companies.

Bio-based industry

The bio-based industry is the segment of the bioeconomy that uses renewable biological resources in innovative industrial processes for manufacturing biomass-derived goods/products and services. It thus concerns industrial sectors which traditionally use biological resources as their main feedstock (forest-based sector, starch, sugar, biofuels/bioenergy, biotechnology) and others for which biomass is part of the raw material portfolio (e.g. Chemicals, Plastics, Consumer goods).

Thanks to the levels of innovation already achieved with several proprietary technology developed in the sector of chemistry and industrial biotechnology, the investments made and the range of products and value chains available, Italy is playing a leading role in the bio-based industry.

It constitutes a fundamental sector that supply inputs and knowledge for the production of next generation crop biofuels and bioplastics production, electricity and heating from biomass, organic pharmaceuticals and cosmetics, residential building biological materials, biowaste treatment, anaerobic digestion process to compost the solid wastes and manage the urban, agricultural and industrial biological wastewater, production of biofertilizers, development of biolubricants, essential amino acids feed production for reducing the livestock nitrogen compounds.

Bio-based chemistry is one of the few sectors where our country is a leading player in a high-tech environment with big private investments, important projects of reconversion of industrial sites affected by the crisis,

4 Biorefining and related activities in the country



Piemonte

PILOT PLANT Fatty Alcohol (Rivalta Scrivia – AL)

PILOT PLANT Biomonomers (Novara)

INDUSTRIAL PLANT Lignocellulosic Bioethanol (Crescentino – VC)

FLAGSHIP Succinic Acid (Cannano Spinola – AL)

Lombardia

PILOT PLANT for Biobased Butadiene (Mantova)

Veneto

FLAGSHIP 1.4 BDO from RRM (Adria – RO)

Umbria

PILOT PLANT and **DEMO PLANT** Oleaginous crops and Biolubricants from local crops (Terni)

INDUSTRIAL PLANT Bioplastics based on Starch and Polyesters from vegetable oils (Terni)

Lazio

INDUSTRIAL PLANT Biodegradable Polyesters (Patrica – FR)

Campania

INDUSTRIAL PLANT Levulinic Acid (Caserta)

Puglia

PILOT PLANT and **DEMO PLANT** Aromatic Biochemicals from lignin (Modugno – BA)

FLAGSHIP Aviation Fuel (Modugno – BA)

Sardegna

1 FLAGSHIP basis for Biolubricants and Bioadditives for Rubber (Porto Torres – SS)

1 FLAGSHIP Azelaic Acid and Pterargonic Acid (Porto Torres – SS)

Location TBD

FLAGSHIP for the extraction of Natural Rubber and other valuable products (resins, etc.)

1. BIOECONOMY – AN INTRODUCTION

Italian Flagships

Italy shows important projects of reconversion of industrial sites affected by the crisis, into biorefineries for the production of bio-products and biochemicals from renewable sources, with positive impacts on employment, the environment, product profitability and integration with oil-based products to enable greater specialisation and competitiveness. Some of these projects, coordinated by Italian leading players in bio-based industries sector have been recognized as flagship initiatives in Europe by the BBJ Joint Undertaking.



First2Run: Flagship demonstration of an integrated biorefinery for dry crops sustainable exploitation towards biobased materials production.



BIOSKOH's: Innovation Stepping Stones for a novel European Second Generation BioEconomy.

into biorefineries for the production of bioproducts and biochemicals from renewable sources. Investments of over a billion euro have already been made for the re-industrialisation of decommissioned or no longer competitive sites of national importance and for the construction and launch of four flagship plants, the first of their kind in the world. ④ ⑤

Notably, Italian bio-based industrial sector is characterised by a network of large, medium and small-sized companies which work together, leveraging on the sustainable production and efficient use of biomass, following a cascading approach to increase the added value of agricultural production with complete respect for the biodiversity of local areas, in collaboration with the agricultural world and creating partnerships with local actors.

There are other factors that have contributed to Italy's success in bio-based chemistry: the existence of the Cluster of "Green Chemistry" SPRING⁸, a national platform which brings together the main (more than 100) stakeholders of the value chain, from farmers to associations; a proven, effective collaboration between public and private sector research bodies with strong competences in the main sector of the value chain of biobased industry and all stakeholders in the local areas; a network of large, medium and small-sized companies which work together (main sectors represented: bio-based chemicals, oleochemistry, biolubricants, cosmetics, wheat and corn wet-millers, bioplastics).

8 clusterspring.it

5 Biobased R&D centers and experimental fields

● EXPERIMENTAL FIELDS
● R&D CENTERS

Piemonte

R&D CENTER Biochemicals and Biofuel from renewables (Rivalta Scrivia – AL)

R&D CENTER Bioplastics and Biochemicals from RRM

R&D CENTER Chemistry from renewables (Novara)

EXPERIMENTAL FIELD

EXPERIMENTAL FIELD

Lombardia

R&D CENTER Biolubricants (San Donato Milanese – MI)

R&D CENTER Green Chemistry, process engineering and biolubricants (Mantova)

EXPERIMENTAL FIELD

Emilia Romagna

R&D CENTER and **EXPERIMENTAL FIELD** Bioelastomers (Ravenna)

Umbria

R&D CENTER Oleaginous crops and biolubricants from local crops (Terni)

EXPERIMENTAL FIELD

Lazio

EXPERIMENTAL FIELD Biodegradable Polyesters (Patrica – FR)

Campania

R&D CENTER Biotechnological (Piana di Monte Verna – CE)

EXPERIMENTAL FIELD

Puglia

R&D CENTER Aromatic Biochemicals from lignin (Modugno – BA)

Basilicata

EXPERIMENTAL FIELD

Sardegna

R&D CENTER (Porto Torres – SS)

EXPERIMENTAL FIELD

Sicilia

EXPERIMENTAL FIELD

1. BIOECONOMY – AN INTRODUCTION

Marine bioeconomy

Italy is characterized by over 8000 km of coastline and whose jurisdiction space is 40% under water and thus it can count on remarkable sea-based resources (food, energy, materials).

Currently, bioeconomy related activities, ie, fishery and marine aquaculture, the exploitation of marine algae, microbes, enzymes, and byproducts and biowaste of

fishery and aquaculture products processing, biomonitoring and bioremediation of marine water/sediment systems are responsible for about 15% of the turnover and jobs opportunities of the current Italian blue economy, which were estimated of about € 43 Billion/y and 835,000 employees, respectively⁹ Italy is the second European fish producer and ranks fourth in Europe for aquaculture production. Nevertheless, about 75% of national consumption is covered by imports.



⁹ V rapporto sull'economia del mare, Unioncamere 2016

1. BIOECONOMY – AN INTRODUCTION



1.3 BIOECONOMY AT REGIONAL LEVELS

A flourishing bioeconomy starts with primary producers, and an important requirement for industries is the availability of local competitive biological feedstocks. **Italian Regions**, individually have a very accentuated agricultural and natural landscape specificity, linked to the biodiversity of cultivated plants, animals, related ecosystem services, a diverse cultural heritage, and therefore Italian Regions are particularly motivated in keeping vital rural economies and in realizing regional cycles.

All the regional agriculture and rural development programs support competitiveness and sustainability of the

local productions system, with strong investments on innovation aimed at reducing inputs in agriculture (irrigation, fertilization, pesticides), increasing the value of environmental services, restoring and preserving soil fertility, ensuring food quality and safety, coping with climatic changes. Furthermore, the agriculture development programs also focus on new value chains based on the smart and integral use of agro waste and specialized crops for industrial uses to be grown on marginal lands, creating the needed interface for agroenergy and bio-based industries. Finally Regions identify also specific KETs (green biotechnologies and “omics”, precision farming, nanotechnologies) as driver for innovation and competitiveness of the local systems.

1. BIOECONOMY – AN INTRODUCTION

From the industrial regional perspective, Regions defined Smart Specialization Strategies that, even if not always referring directly to Bioeconomy, identify clear bioeconomy targets, pillars and technological trajectories. Green and agro energies, biomaterial, biopolymers, biochemical, industrial biotechnologies, added value ingredients for food and feed, are a partial list of sectors that are identified, with specificity associated to the local productive system and biofeedstock availability. A recent collaborative work for the elaboration of a [Position Paper on Bioeconomy, developed by the Conference of the Italian Regions](#), monitored the strategic positioning of the Regions with respect to the three main pillars of the Bioeconomy, paving the way to interregional cooperation in bioeconomy, especially among neighboring territories, opening also the needed dialogue with national programs and strategies. **6**

Italian Regions support agro-industrial local projects, with the strategic idea of using local resources in a more innovative efficient way. Some of these initiatives can be referred as [Best Practices](#), showing the potential and the socio-economic impact of bioeconomy development at local level.

Some territories show important projects of reconversion of industrial sites affected by the crisis, into biorefineries for the production of bioproducts and biochemicals from local renewable sources, with positive impacts on employment, the environment, product profitability and integration with regional agriculture system to enable greater specialization and competitiveness.

One recent example refers to production of bio-butandiol.

The factory, which will produce 30 thousand tons per year of bio-butandiol, hired 51 employees at the end of 2015. It will be the first facility in the world capable of producing butandiol (BDO) directly from sugars, and not from fossil sources, through a low-impact process, and the co-products are completely reused. Some of these projects are coordinated by Italian leading players in bio-based industries sector and they have been recognized as flagship initiatives in Europe by the [BBI Joint Undertaking](#), such as:

Other interesting cases are centered on the possibility of using agricultural residues as a source of renewable energy, largely exploited in several regional territories, thanks essentially to the presence of public subsidies to the investments. Agro-energy offers to farmers a potential of integrating incomes and often pushes for cooperation among farmers in order to aggregate the biomass needed to manage a bioenergy plant. The most accepted and spread model is a grid of a diffused small-medium size agro-energy plant producing bio-methane, that in many cases uses zoo-technical waste integrated with solid matter deriving from cultivated crops. An example of such initiative has been supported in Veneto Region, where 14 farmers active in cereal production, cooperated in realizing a 1MW biogas plant fed with the waste of their productions, realizing a 2 MEuro/year turnover, stabilizing the farms jobs and creating new jobs for plant management and service.

The project Biopower in Tuscany faced the challenge of energy production by using renewable sources through a diffused network of small sized plant. The project involves 7 enterprises, reduce the environmental pressure by saving 1.000.000 TEP and produced 17 new jobs.

1. BIOECONOMY – AN INTRODUCTION

Another relevant initiative developed in Tuscany, is related to the production of 20.000 tons of soil compost per year, from local organic matrices by waste recycling of three industrial plants. The initiative provides supplement to industrial fertilizer production lines, as long as organic fertilizer for farmers and public administrations. 30% of mixed compost is used by the industry and the rest by local farmers on various crops in the provinces of Florence, Pistoia and Pisa.

Aquaculture is an important sector in some Italian Regions where a large availability of water and seacoast is present. One of the objective of aquaculture is to reduce the energy consumption and the environmental impact. An initiative developed and sustained by Veneto Region, refers to the cultivation of mussels with a continuous

rope and a biodegradable retention net. The projects allowed a 50% in fuel reduction and waste, and an increase in production up to 9,5 tons/hour.

Microalgae cultures have a strong potential for industrial developments, thanks to the high yield capacity per unit of land used, when compared to green plants, and the production of a variety of fine biochemicals. A Best Practice on microalgae cultures has been supported by Liguria Region and BIOFAT EU project. The industrial pilot initiative is rapidly developing, covers a 8.000 sqm greenhouse surface and employs 15 people, showing the potential of producing oil and fine products for pharmaceutical and cosmetics.

6 Strategic positioning of the Regions with respect to the three main pillars of Bioeconomy

(from the Conference of the Italian Regions, elaborated on the Bioeconomy Position Paper)





RAW MATERIALS SOURCES AND THE OPPORTUNITIES OF BIOWASTE: THE IMPACT OF BIOECONOMY ON THE ENVIRONMENT AND THE NATURAL CAPITAL CONSERVATION

From the environmental viewpoint, bioeconomy raises both opportunities and challenges. Opportunities are linked to the gradual shift in production processes from nonrenewable to renewable resources, such to limit the environmental pressure on ecosystems and rather creating higher value to their conservation as providing relevant services for the economy, beyond their intrinsic or existence value connected to other services, including the strategic importance of nature-based solutions to cope with climate change and hydrological risks.

Further, it implies the possibility to decrease the dependence on resources not largely available in Italy. Moreover, producing more from renewables may ease the problem of waste management, as they are easier to be assimilated back by the nature receptors.

However, bioeconomy can also boost a number of challenges. Necessary condition is the sustainability of biological products and processes. Especially in food and fish industry, there are many examples of unsustainable management for both the environment and human health. Then, in many cases there is no need to increase the production of commodities but rather increasing value added and utility for the society by improving the quality of products (i.e. agriculture). It is finally important

to reconcile the economic and the environmental needs: increasing the value added of bioeconomy sectors should not be done by importing raw renewable materials by countries with less stricter environmental regulations, that would possibly result in shifting the environmental damages abroad.

It is clear, thus, that opportunities and challenges to build a sustainable and flourishing Italian bioeconomy are different according to the source of biomass of the bioeconomy sectors according to the need of “using better what we already use” and “using well what we don’t use yet”.

The stock of renewable natural resources, including forests, water, land, landscapes, terrestrial and marine plants and animals species not only supplies food, raw materials, energy, fresh water and medicinal products for the human consumption, but at large, represents the most relevant of the total value of our natural capital. The qualitative and quantitative conservation of the value of this stock offers other benefits to the human society and the environment through a continuous flow regulatory, supporting and cultural ecosystem services that are worth to be accounted for. The need is, thus, to avoid over-exploitation and the creation of implicit trade-offs among natural resource commodification and conservation.

2. RAW MATERIALS SOURCES AND THE OPPORTUNITIES OF BIOWASTE

Agricultural sector based on modern sustainable and organic practices, other than supporting water purification and soil formation, can contribute to genetic diversity conservation by both enhancing the added value of a varied set of underutilized local crops in marginal land, plants and livestock landraces as well as promoting a concept of short distribution chains to avoid unsustainable land use or varieties competition and leakage effects on developing countries. Between 1960 and 2000, the European countryside experienced a dramatic change in land use. Further land abandonment is forecast to continue until 2030¹⁰, according to the Institute for European Environmental Policy and Eurostat survey. Estimates indicate a total decline of agriculture, grasslands and semi-natural habitats of more than 30 million hectares and an increase of urbanization.

On the other hand, part of the future land abandonment can be recolonised by forests and/or provide land for biobased production in marginal conditions without a direct competition against food production, that can represent an opportunity for farmers and local institutions.

As with mineral oil, nature provides us with an enormous range of raw materials from which it is possible to synthesize various chemical intermediates which are similar to those obtained from fossil raw materials as well as a wide variety of molecules and processes for synthesizing which are extremely interesting yet hitherto unexplored. As a consequence of energy-related

and environmental problems, renewable raw materials such as vegetable oils, starch from corn and potatoes, cellulose from straw and wood, lignin and amino acids as well as exploitation of algae are becoming increasingly important as industrial feedstocks. By resorting to physical, chemical and biological processes these materials can be converted into fuel, chemical intermediates, polymers and specialties in general for which mineral oil has to date been used.

Innovative sustainable bioeconomy industries should use the following general approach to raw materials use:

○ **determination of the most suitable species** (identification of autochthonous crops, plants, algae) and biomass at a local level (dedicated low-impact crops or not fragile marine areas) to be used in biorefinery processes, limiting climate-altering gas emissions associated with use of the land as well as sharing the benefits arising from the utilization of local genetic resources;

○ **identification and use of economically marginal and/or contaminated lands**, avoiding the over-use of soil and natural landscapes in line with international policies on climate change and biodiversity, by not distorting the natural capital from the supply of other valuable ecosystem services and in synergy with regional and local policies;

¹⁰ "Agri-environmental indicator - risk of land abandonment" 2013: farmland abandonment due to economic, structural, social or difficult regional factors is estimated to have a higher risk in southern Member States. ec.europa.eu



2. RAW MATERIALS SOURCES AND THE OPPORTUNITIES OF BIOWASTE

- **promotion of the efficient use of biomass** (by extracting all possible value from renewable resources, starting from food and feed components, passing through the production of materials and recovering energy content from products at the end of their life cycle);
- **construction of new supply chains with the agricultural and forestry world**, ensuring competitive conditions in biomass production processes for all participants in the value chain;
- **relying on ecolabelled certified forest products**, preferably from local chains.

Also within the context of the **Common Fisheries Policy**, the sustainable use of fish stock is at the basis of the marine ecosystem functioning as well as of the fisheries and marine bio-based economy future livelihood itself. This is still more crucial in the Mediterranean Sea where the overexploitation and the introduction of invasive alien species threatens local fish and their habitats. To this end, the aquaculture can be a viable solution to the sustainable management of fisheries industry and is not a case that it is prioritized in the EU Blue Growth Strategy. However, caution is required to mitigate potential negative impacts of intensive aquafarm, monitoring the nitrogen and phosphorous release in the coastal zone.

Bio-waste

The increasing use of **biowaste** to produce materials and energy is at the base of a sustainable bioeconomy that reduce the pressure on raw renewable sources and reduce the dependence from fossil fuels.

Biowaste comes both from the primary vegetal production (those arising in-field e.g. cereal straw, sugar cane tops and leaves) (about 10 Million T/y), and livestock production (about 130 Million T/y) along with the byproducts and waste from the primary food biomass processing and food making e.g. husks, hulls, shells, bagasse, etc (about 15 Million T/y). Further, there are forest residuals arising in-field e.g. thinnings, tops and branches (up to 40% of above-ground forest biomass) and residue from primary processing at sawmills or pulp and paper mills e.g. sawdust, chips from off-cuts, black liquor (about 11.5 Million T /y). Finally, the organic fraction of municipal waste collected in the country is above 5.7 Million T/y, this representing about 43% of the overall produced municipal organic waste after 2014¹¹. Such waste streams are currently only partially and poorly valorized and mainly disposed in landfills with relevant external costs and negative environmental impacts. Many of them, and in particular, the agro-food industry by-products, waste and effluents might be cheap and abundant sources of biobased chemicals and materials along with substrates for tailored biotechnological productions which, in turn, can allow preparing value added biobased fine chemicals, materials and biofuels.

11 ISPR; Rapporto Rifiuti Urbani, 2015].



BIOECONOMY IN EVERYDAY LIFE



CARRIER BAGS AND WASTE BAGS

Biodegradable shopping bags, thanks to their dual use (i.e. first carrier bags and then waste bags), facilitate the separate collection of organic waste reducing the risks of littering in the environment. Thanks to biodegradability, compostability, transparency, resistance to humidity and pathogens they have proved to be a key tool to encourage the separate collections of organic waste and to produce high quality compost.



BAGS AND GLOVES FOR FRUIT & VEGETABLE

The switch from traditional plastic products to biodegradable and compostable ones contributes to reduce the

generation of waste that is not easily recyclable and to increase the organic waste collection.



PRODUCTS FOR FOODSERVICE

The use of biodegradable and compostable foodserviceware simplifies post-consumer disposal operations. It can in fact be disposed of with the organic fraction in composting structures, reducing environmental impact and waste management costs.



PACKAGING

These products can be disposed of with the organic waste. Here are some applications:

- Compostable food wrapping paper and trays Extruded and woven nets.

- Non-food packaging such as toilet paper, kitchen roll, napkins, films for magazines, etc.
- Compostable label: standard fruit labels are one of the main pollutants of compost.



NEW FUNCTIONAL COLD PRESSED OILS

An innovative vegetable oil produced using olives and tomatoes only by mechanical processes.

- Olive oil naturally enriched in carotenoids.
- A good alternative to chemical extraction of functional compounds.
- An oil dressing naturally enriched and suitable for vegetarian, vegans and gluten-free diets.

3. BIOECONOMY IN EVERYDAY LIFE



COMPOSTABLE CAPSULE

Biodegradable and compostable capsule can be collected with the organic waste and sent for industrial composting, where the capsule and used coffee are recycled together into compost, with significant reduction of waste and greenhouse gas emissions.



MULCHING FILMS

Biobased and biodegradable mulching film provides an agronomically and environmentally efficient alternative to traditional plastic mulching film.. They biodegrade in the soil so they do not have to be removed at the end of the growing season and allows an efficient control of weeds and the obtaining of equivalent agronomic yields, in terms of quantity and quality.



CARBOXYLIC ACIDS AND COSMETICS

Carboxylic acids are basic constituents of bio-based plastics, they are intermediate in the production of plasticizers, for complex esters used in the lubricants sector and in pharma/cosmetic formulations, herbicide and is used in the formulation of plant protection. Some carboxylic acids and their esters and glycerine are well-known products commonly used in cosmetics applications.



BIOACTIVE COMPOUNDS FROM MEAT BY PRODUCTS

Optimization and validation of modified Response surface methodology to extract bioactive peptides from poultry and fish by-products.



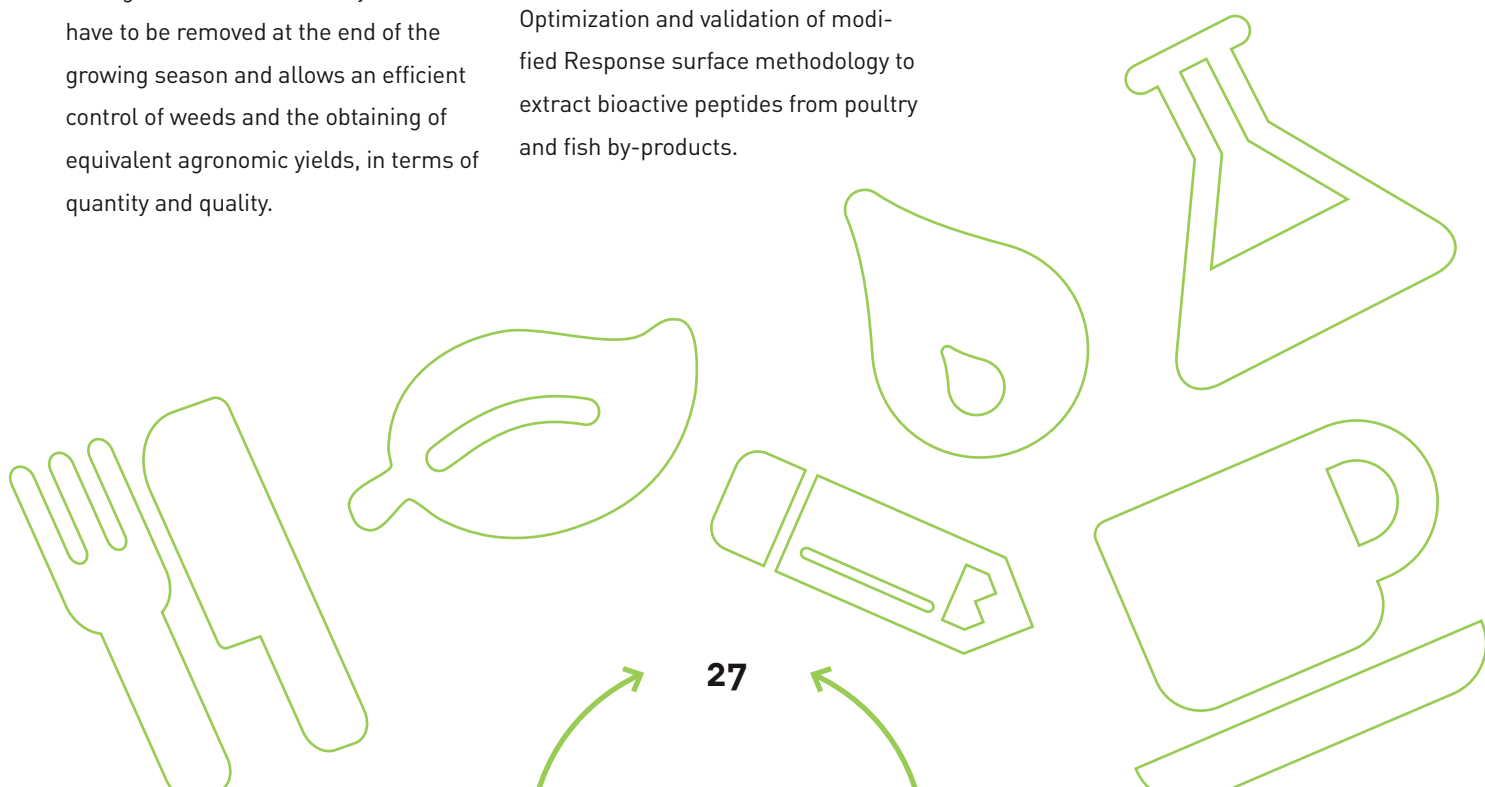
PLASTICIZERS

Plasticizers for specialty elastomers and PVC, as well as an innovative type of bio-extender oil for general purpose elastomers.



LUBRICANTS

They represent an ideal solution for machinery operating in ecologically sensitive areas (such as agricultural, forest, marine or urban), offering advantages in terms of performance and in terms of the environment and safety in case of dispersion in the ecosystems.



3. BIOECONOMY IN EVERYDAY LIFE



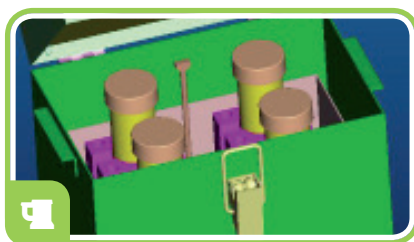
BIOETHANOL

Renewable biochemicals and energy source made by fermenting the sugar and starch components of plant by-products - mainly sugarcane (bioethanol). Next generation of biofuel from lignine or other biomass as algae.



MICROBIOPASSPORT, A TOOL TO MEASURE THE IMPACT OF FOOD ON INTESTINAL HEALTH

The Microbiopassport is the first patented tool for gut microbiota analysis, which translates in user-friendly way the complex output obtained by the next generation sequencing characterization of the intestinal microbial ecosystem and its pervasive effects on human health. The Microbiopassport is being used by several food companies to assess the efficacy of their food products.



BIONSENSOR FOR BACTERIAL CONCENTRATION MEASUREMENT

A portable device for quick and in-situ analysis of bacterial concentration in liquid and semi-liquid food samples.

- Based on impedance analysis.
- Embedded mini-thermal chamber.
- High sensitivity.
- Quick response: 3 to 12 hours depending on the sample bacterial concentration.

Successfully tested with many types of food-samples: ice-cream, raw milk, water, beer.



PORTABLE ELECTRONIC SYSTEMS FOR OLIVE OIL QUALITY CONTROL

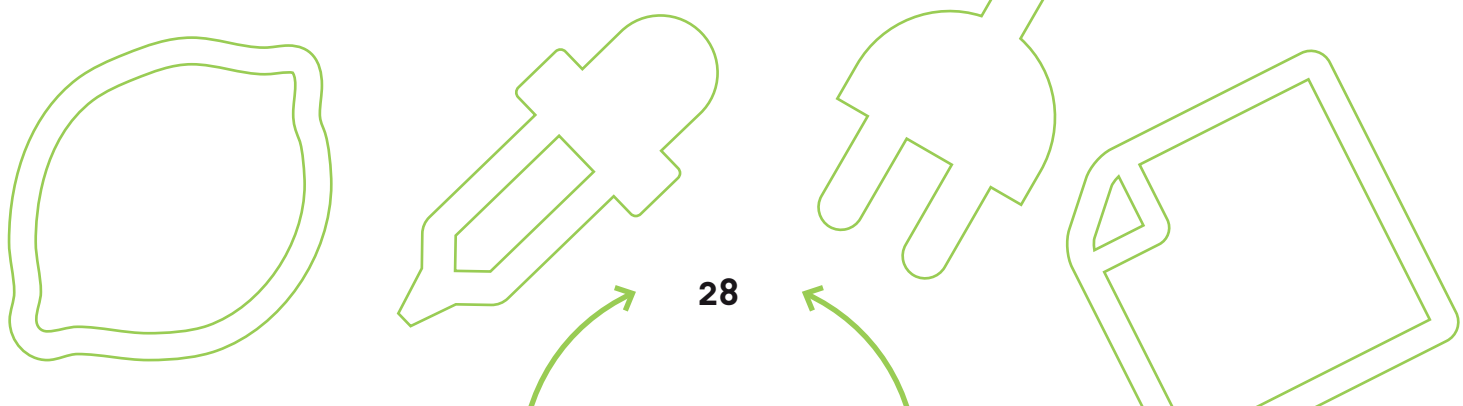
The portable electronic systems allow quick and in-situ analysis of olive oil quality (free acidity and total phenol content).

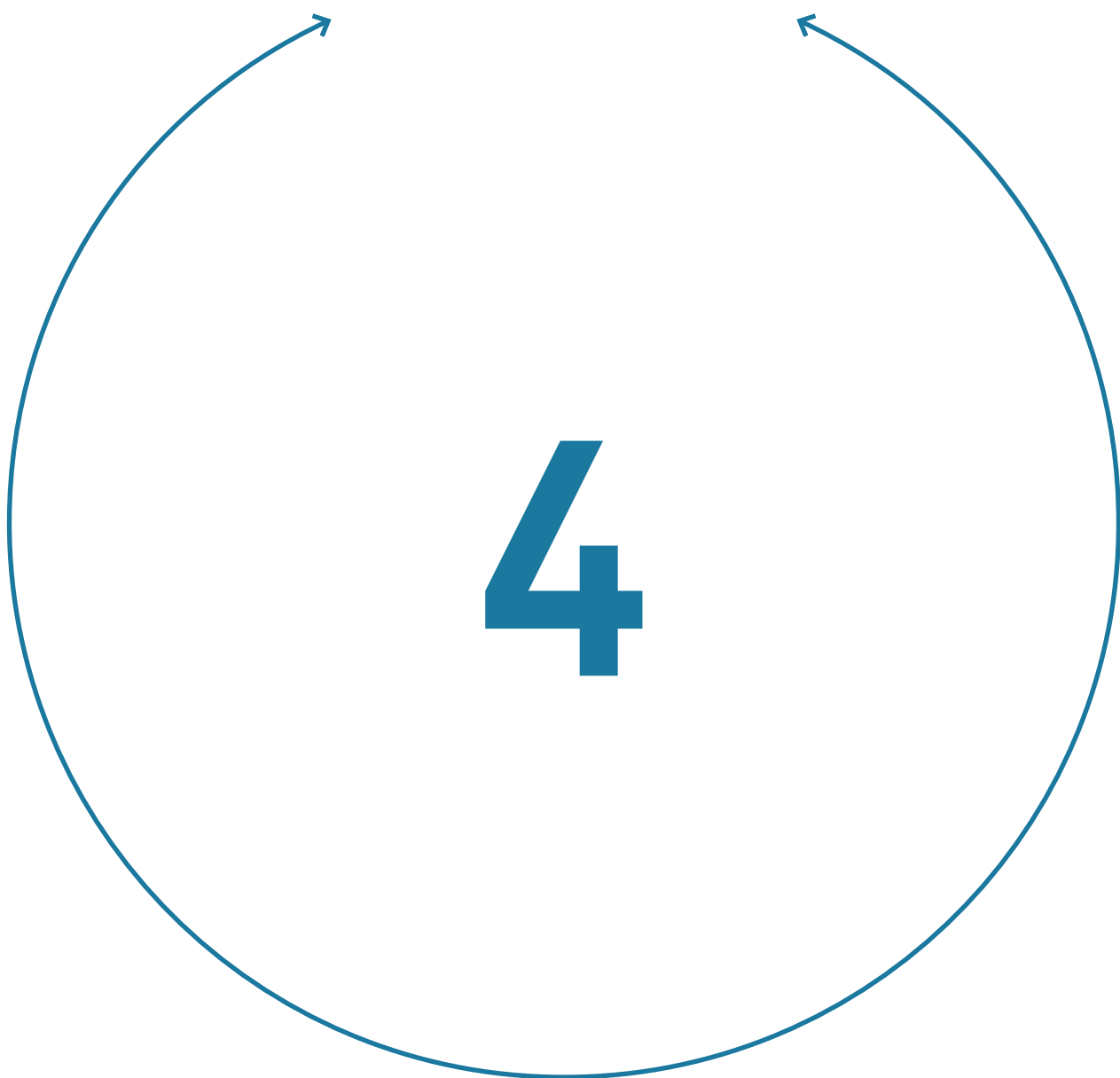
- Based on impedance analysis and optical transmission measurements.
- Battery operated.
- Use of non-toxic reagents.
- Quick response (30 sec for free acidity and 10 min for total phenol content).



BIO-INNOVATION IN RECIPES

Use of natural products to replace products derived from chemical synthesis processes, to support the diversification of products and diets (snacks and sweets using derivatives of an algae called "Spirulina", rich in essential nutrients like proteins, vitamins, minerals, essential amino acids, Omega 3 and 6).





4

SOCIAL DIMENSION OF BIOECONOMY

To meet the challenge of bioeconomy of “reconnecting economy, society and environment” it will not be sufficient simply to employ biomass for industrial applications or to use regenerative instead of fossil raw materials. It is not only to integrate biological knowledge into existing technology. **To meet this challenge, a transition must take place also from a social point of view**, stimulating social awareness and dialogue, as well as better supporting innovation in social structures leading to more conscious behavior. Wider knowledge of what is consumed, especially food products and processes, would imply improvements in health conditions and lifestyle stimulating a demand pull sustainable innovation by companies.

This transition process in economy and society needs to take place in a holistic way, and citizens must become the key players in the needed social transformation that the bio-based economy can perform, in order to exploit the major potential benefits of this process.

Social dialogue and understanding for the challenges and opportunities of bioeconomy play a decisive role in the demand for new products and services, and for the associated innovations and technological developments. Actions such as public procurement needs to be located into participatory actions allowing commitment, understanding and potential for replication.

Bioeconomy, for its intrinsic characteristics, has the potential of achieving a more profound integration among economic, environmental and social objectives. However this is possible only through investment in new capacities of consensus building for public and private sectors:

○ on the part of companies through **business models which involve costumers, workers, users and stakeholders affected by their activities (primarily citizens) in a common vision concerning sustainability**; while the development of new products, services and investments related to bioeconomy create new economic value, jobs, relations and collaborations, it also makes it clear that bioeconomy is able to meet social needs and is aimed at improving human well-being and enhance individuals' capacity to act.

○ on the part of the government, **through a diffuse adoption of a participatory and place-based approach which conveys a new concept of territory as a space of endogenous material and immaterial assets, and networks of economic, social, cultural, institutional relationships and interactions**; bioeconomy is an opportunity for reassembling fragmented knowledge and capabilities in new stocks and flows of productive knowledge, building on new innovation processes; this will also translate in creating a common identity among people in territories.



LEGISLATIVE FRAMEWORK, FUNDING MEASURES AND MARKET PULL MEASURES

The bioeconomy has strong synergies with many EU and National strategic plans, norms and funding measures which give opportunities to enhance action plan and specific measure for bioeconomy. In brief, the legislative and fund framework is composed as follows:

5.1 EU DIRECTIVES

Circular Economy Package. In December 2015, the EU adopted the Circular Economy Package “Closing the loop – An EU action plan for the Circular Economy”¹² defining ambitious targets and timeline to reduce the pressure on natural resources and boost the market for secondary raw materials. The Circular Economy package introduced specific economic instruments and promoted the industrial symbiosis, incentivizing other mechanisms to reduce future waste generation under a circular bioeconomy philosophy (e.g. design for recycling, reduced packaging).

Marine Strategy Framework Directive D.lgs n. 190/2010 (MSFD). The aim of the Directive is to achieve Good Environmental Status (GES) of the EU’s marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend. The

Marine Strategy is the principal instrument to establish and promote an approach based on sustainable development based on preserving and protecting marine biodiversity and finding solutions to current problems as the marine litter, pollution from contaminants, the sustainability of fisheries.

Climate change strategy is a big challenge for the medium and long term future. In the meanwhile, it requires the transformation of the energy system in order to reduce GHG emissions in the atmosphere by increasing the share of clean and renewable energy as well as the energy intensity of the overall system. On the other hand, it implies increasing the resilience and adaptive capacity to cope with climate change impacts. The EU legislative framework for the first aspect (mitigation) is given by the Climate and Energy Package¹³ by 2030 as well as the 2050 Low-Carbon Economy¹⁴. As regards the second pillar (adaptation), the EU has adopted in 2013 the Eu-

¹² ec.europa.eu

¹³ ec.europa.eu

¹⁴ ec.europa.eu

5. LEGISLATIVE FRAMEWORK, FUNDING MEASURES AND MARKET PULL MEASURES

European Adaptation Strategy¹⁵ that, among others objectives, promotes adaptation measures in key vulnerable sectors including green infrastructure and coastal zone management to increase resilience of urban, rural and coastal areas.

5.2 ITALIAN LEGISLATION

The [Environmental Annex to the Stability Law 2014](#) «Measures for promoting green economy and limiting the excessive use of natural resources»¹⁶ defines relevant milestones for the future Italian environmental strategies. The main focus is on green economy and circular economy, in particular through: Green Public Procurement (GPP) with environmental minimum criteria for new purchases by the public sector defined also by Labelling and Certifications (Emas, Ecolabel, Environmental Footprints, Made Green in Italy); incentives for the purchase of post-consumption materials, the management of specific waste fractions (including composting) and incentives to increase the share of collected waste; creation of a Natural Capital Committee, that can provide data on natural biomass consumption and monitor the impact of public policies on natural resources and ecosystem services conservation; the establishment of a system of Payment for Ecosystem and Environmental Services and the production of a catalogue on Environmental Harmful and beneficial Subsidies.

One the most important aspect of the Environmental

Annex is the update of the [Sustainable Development National Strategy](#), built upon the 2030 Agenda for Sustainable Development¹⁷ adopted by the UN in September 2015. Among the 17 Sustainable Development Goals (SDGs) of the UN agenda, some of them are strictly related to bioeconomy:

1. **SDG2** - End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
2. **SDG7** - Ensure access to affordable, reliable, sustainable and modern energy for all.
3. **SDG8** - Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
4. **SDG9** - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
5. **SDG12** - Ensure sustainable consumption and production patterns.
6. **SDG14** - Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
7. **SDG15** - Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and re-

¹⁵ eur-lex.europa.eu

¹⁶ gazzettaufficiale.it

¹⁷ sustainabledevelopment.un.org



5. LEGISLATIVE FRAMEWORK, FUNDING MEASURES AND MARKET PULL MEASURES

verse land degradation and halt biodiversity loss.

With reference to waste, the legislative decree 152/2006 sets the same 65% target on municipal waste as EU within the Circular Economy package. The “[National Program for Waste Reduction](#)”¹⁸ also considers the target of 50% share of “green purchases” by the public sector and defines specific measures for biodegradable waste, valorization of agro-industry byproducts and minimize food waste. Specifically on composting, the recent Decree of Ministries Council Presidency on 7 March 2016¹⁹ defines the requirements for the Italian regions in terms of organic waste to be treated through composting.

The update of the “[National Energy Strategy](#)” and the “[National Plan for Climate and Energy](#)” will provide the framework within which the different sources of energy will develop in order to achieve the targets on GHG emissions reduction and renewable energy share. Moreover, Italy adopted a “National Adaptation Strategy”²⁰ and is realizing the “National Adaptation Plan”. Bioeconomy can play a relevant role in both senses, in terms of providing clean energy sources and ensuring a long-term conservation of natural resources and ecological systems also through nature-based solutions. In the first case, the Ministerial Decree 9 October 2013 n. 139²¹ simplifies the authorization procedures for the

second and third generation biorefineries and their features. In this latter case, the “National Plan for prevention and contrast to the hydrogeological risk for 2015-2020” (in progress) goes in the same direction.

The [National Biodiversity Strategy](#) (NBS), adopted in October 2010, aims to merge and integrate biodiversity conservation targets and sustainable use of natural resources within sectoral policies, while the National ratification of Nagoya Protocol, on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization, is still in progress (but in 2014 at EU level is entered in force the EU Regulation 511/2014 “on compliance measures for users of the Nagoya Protocol Arising from their Utilisation in the Union”).

The [National Marine Strategy](#) D.lgs n. 190/2010 transposing the Marine Strategy Framework Directive at national level and aim to achieve the Good Environmental Status of the Italian marine waters in a sustainable development perspective, thereby the [DM 17/10/2014](#) specify the requirements and targets necessary to achieve the GES, instead the [DM 11/02/2015](#) define the indicators associated to the GES and regulates the elaboration of the monitoring programs necessary to evaluate it.

18 minambiente.it

19 gazzettaufficiale.it

20 minambiente.it

21 gazzettaufficiale.it

5. LEGISLATIVE FRAMEWORK, FUNDING MEASURES AND MARKET PULL MEASURES

5.3 FUNDING PROGRAMMES

Many programs at EU, national, regional and local level can fund and contribute to regulate bioeconomy actions. However it is necessary to enhance the integration of programming in a common strategic framework and strengthen the capability of financial mechanisms to ensure stability for bio - investments in the long run beyond the programming period of public administration budgets.

This function should be performed by the Cohesion Policy Funds that make available resources along seven (plus three) year programming period in thematic objectives and investment priorities consistent with bioeconomy development. Cohesion Policy Funds, according to their rules, can therefore allow to support investments structured and amortized over the medium to long term

by integrating and stabilizing resources from the ordinary national policy in order to create a funding matrix in which programming and financial needs are blended.

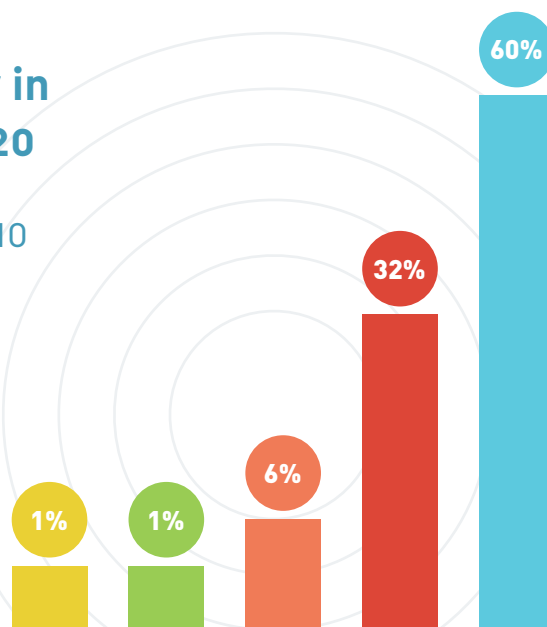
For instance, European Agricultural Fund for Rural Development (EAFRD), among others, focuses on new value chains based on the smart and integral use of agro waste and specialized crops for industrial uses to be grown on marginal lands, creating the needed interface for agro-energy and bio-based industries. Regional EARDF programs identify also specific KETs (green biotechnologies and “omics”, precision farming, nanotechnologies) as driver for innovation and competitiveness of the local systems.

The table below illustrates the funding opportunities opened by the Cohesion Policy resources for the bioeconomy in Italy. **7**

7 Italian Budget for Cohesion Policy in the programming period 2014-2020

Total resources in million EUR 122.866,10
(EU and National contributions)

- European Structural and Investment Funds (ESIFs)
- European Territorial Cooperation programmes
- Fund for European Aid to the Most Deprived (FEAD)
- Complementary Programmes Action Plans for Cohesion
- Italian Development and Cohesion Fund (FSC)



Source: Agency for territorial cohesion elaboration on data from 2014-2020 Partnership Agreement



5. LEGISLATIVE FRAMEWORK, FUNDING MEASURES AND MARKET PULL MEASURES

At European level, a very important role could be played also by direct funding grants from the European Commission or its executive agencies, such as Horizon 2020 that with its three pillars – [Excellent Science](#), [Industrial Leadership](#), and [Societal Challenges](#) – and two specific objectives – [Spreading Excellence and Widening Participation](#) and [Science with and for Society](#) – adds a relevant system of funding (77.028 billion Euros²²). For instance, the societal challenge 2 “Food Security, Sustainable Agriculture and Forestry, Marine, Maritime and Inland Water Research and the Bioeconomy” specifically addresses the main topics of bioeconomy (“using better what we already use” and “using well what we don’t use yet”) with a total budget amounting to 3.851 billion Euros²³, in the period 2014-2020. Some priorities of Bioeconomy are also supported by the societal challenge 3 and 5 and the NMPB pillar of Horizon 2020. Another part of Horizon 2020 budget available for bioeconomy is implemented by one of the seven public private partnerships (PPPs) operating under Horizon: the BioDBased Industries (BBI) Joint Undertaking. It aims to develop new bioRefining technologies to sustainably transform renewable natural resources (waste, agriculture residues) into bioDbased products, materials and fuels.

Other opportunities could be supported also by national and regional ordinary budget, tax incentives, such as Patent box, and private investments too.

At national level, the new Industry 4.0 plan²⁴ provide opportunities for enterprises of the Bioeconomy domain for enhancing research, innovation and competitiveness. The core of Industry 4.0 (I 4.0) is to connect physical and digital systems, complex analyses of big data and real-time settings through use of smart machines, inter-connected and connected to internet, and the plan provides intense financial support to enterprise through hyper-depreciation and super-depreciation scheme (Increase of rate of depreciation to 250% or 140% for innovative digital investments), tax credit for research and development and innovation expenditure (up to 50% of incremental expenditure), support of I 4.0, Venture Capital and Start-ups (30% tax deduction for investments up to 1 million Euros in start-ups and innovative SMEs, 30% tax deduction for investments up to 1 million Euros in start-ups and innovative SMEs, etc.)

A very significant role could be played by [National Technological Clusters](#) as defined by the Italian Ministry for Education, University and Research in the National Research Plan 2015-2020. Clusters have been set up to create permanent dialogue platforms between public research network and enterprises. Clusters directly linked to bioeconomy (Agrifood²⁵, Green Chemistry²⁶, Smart Factory²⁷, Blue Growth and Energy - both under implementation) are priority areas of intervention in the framework of National Research Plan.

22 Estimated final amount in million euro and in current prices (2013) - ec.europa.eu

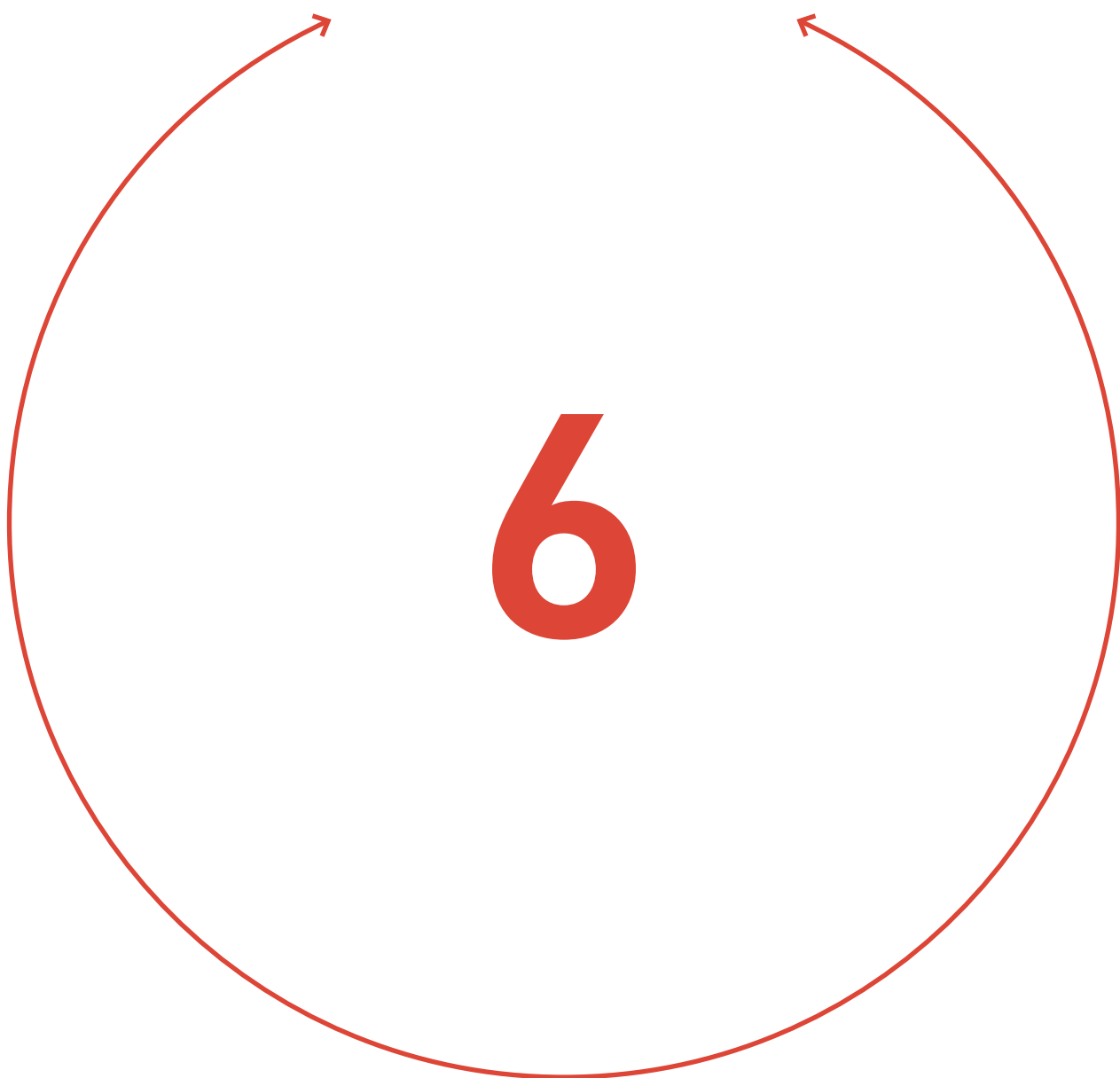
23 See note n. 20

24 sviluppoeconomico.gov.it

25 clusteragrifood.it

26 clusterspring.it

27 fabbricaintelligente.it



CHALLENGES AND ACTION PLAN FOR ITALIAN BIOECONOMY

GENERAL OBJECTIVE:

to increase our current bioeconomy turnover (of about EUR 250 billion/y) and jobs (about 1,850,000) by EUR 50 billion and 350,000, respectively, by 2030.

VISION:

a) TO MOVE *“from sectors to systems”*...

...more efficiently interconnecting the main bioeconomy sectors, from the bioresources production (ie, Agriculture, Livestock, Aquaculture, Forestry, Marine systems), to their processing and final products exploitation (i.e., the food and drinks industry, wood, paper, leather, textile, chemical and pharmaceuticals industries, and energy sector) by creating longer and more sustainable and locally routed value chains, where the actions of different public and private stakeholders integrate across all major sectors.

b) TO CREATE *“value from local biodiversity and circularity”*...

...biowastes valorisation, abandoned lands/industrial regeneration, market initiatives to valorize sustainable and circular productions and biodiversity related chains, prizing of circularity.

c) TO MOVE FROM *“economy to sustainable economy”*...

...via i) shift from non-renewables to renewable resources, ii) avoiding overexploitation of renewable resources (harvest rates not higher than natural regen-

eration growth rates), iii) preservation and exploitation of ecosystem services other than provisioning also through compensation measures, iv) ensuring a pollution and waste generation not higher than unsustainable alternative production processes.

d) TO MOVE *“from concept to reality”*...

...via i) a wider and more coherent political commitment, ii) investments in R&I, education, training, communication, iii) better coordination between regional, national and EU stakeholders/policies, iv) better engagement of a public dialogue, and v) tailored market development actions.

f) TO PROMOTE *“bioeconomy in the Mediterranean area”*...

...via the implementation of PRIMA and BLUEMED initiatives, i.e., by integrating approaches across the different sectors and implementing a long-term oriented, strategic coordination of bioeconomy R&I activities in primis between the European Countries of the area. Such synergies and complementarities among sectors and countries provide added value to regional, national and EU investments by improving Mediterranean primary production and industry potential, creating new jobs, social cohesion and political stability in the area.

6. CHALLENGES AND ACTION PLAN FOR ITALIAN BIOECONOMY

6.1 THE CHALLENGES

✗ PROBLEMS

- Limited profitability due to low average size of farms;
- Land abandoning in less favored areas due to difficult living conditions;
- Depletion of soil organic matter and water scarcity in the southern Regions;
- Soil and watershed pollution;
- Reduction of the land surfaces devoted to agricultural use;
- Impact of climate change on the agricultural system;
- Biological and chemical contaminants in agricultural products;
- Alien pests/plants.

✓ OPPORTUNITIES

- Diversification of rural incomes, reducing vulnerability deriving by price volatility;
- Discovering, protecting and valuing local biodiversity agricultural ecosystem services and reduction of land deterioration;
- Valorization and reuse of agricultural residues for the production of bioproducts and bioenergy;
- Young and skilled farmers entering in the sector thanks to new incomes opportunities;
- Production of native biomass, resilient industrial crops/short rotation forest species (willow etc) in abandoned and marginal lands;
- Boosting the share and productivity of organic farming and livestock;
- Adaptation measures to climate change (e.g. less water/fertiliser demanding crops, use of local varieties, medium- to long-term planning).

Agriculture

6. CHALLENGES AND ACTION PLAN FOR ITALIAN BIOECONOMY

✗ PROBLEMS

- Strong products counterfeiting and imitations;
- Low efficiency of food making chain with high production of byproducts/waste;
- Under exploitation of by-products and production residues due to not proper terms and conditions set by national legislation for the qualification and management of by-products not in line with harmonized EU rules.

✓ OPPORTUNITIES

- Valorization and increasing of “typical/quality” foods (DOP, IGP, STG, etc.);
- Production of ingredients from local food industry byproducts;
- Extensive production of waste to be exploited in biorefining pathways as well as for composting, the latter also contributing to halt the depletion of soil organic matter;
- Innovative and rapid detection methods for food/feed contaminants during storage and processing;

Food
industry



6. CHALLENGES AND ACTION PLAN FOR ITALIAN BIOECONOMY

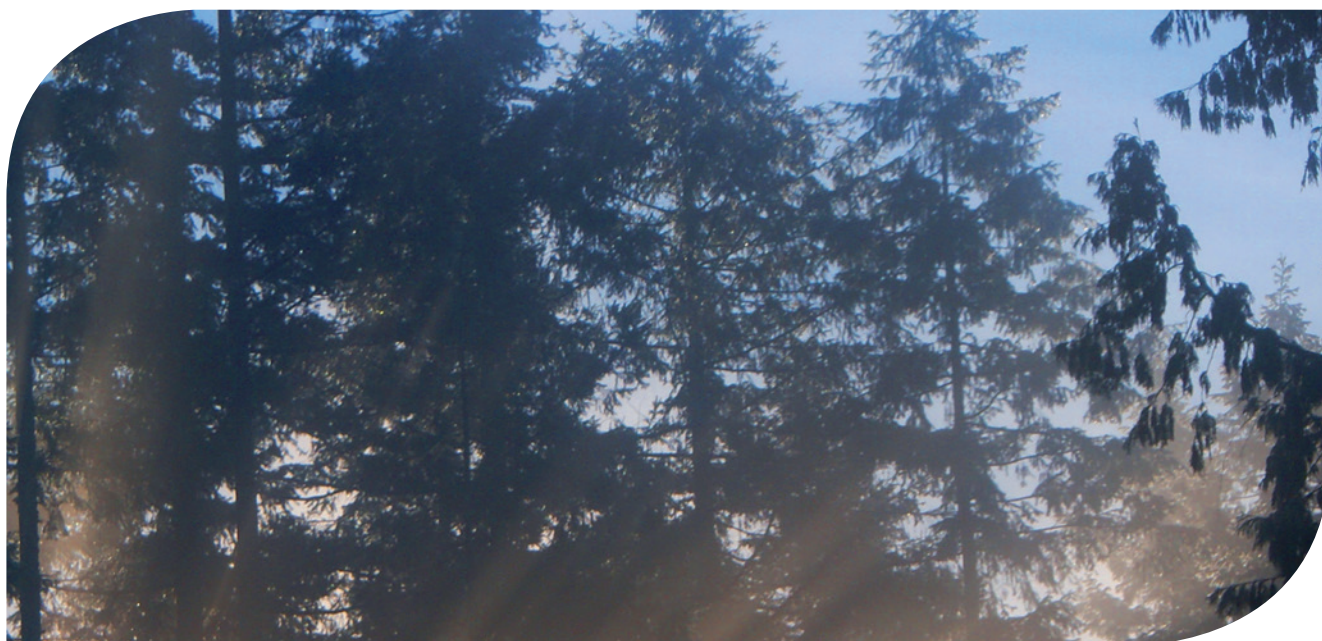
✗ PROBLEMS

- Abandonment of historically managed forests with possible biodiversity depletion and ecosystem degradation;
- National wood processing industry based on imported raw material products of medium- to low-added value;
- Limited management strategies, genetic improvement and valorization of autoctonous forestry production;
- Impact of climate change on forests.

✓ OPPORTUNITIES

- Multipurpose forest management to maintain/enhance production, maintain/improve forest biodiversity and ecosystem services;
- Exploitation of valuable and eco-labelled national raw material in national biorefineries;
- Development and production of high value new wood products, wood-based materials and composites;
- Increase the surface of forests managed according to the Sustainable Forest Management schemes Endorse the creation of local value chain from forests and services to raw material transformation and secondary/tertiary products.

Forest
and wood
processing



6. CHALLENGES AND ACTION PLAN FOR ITALIAN BIOECONOMY



✖ PROBLEMS

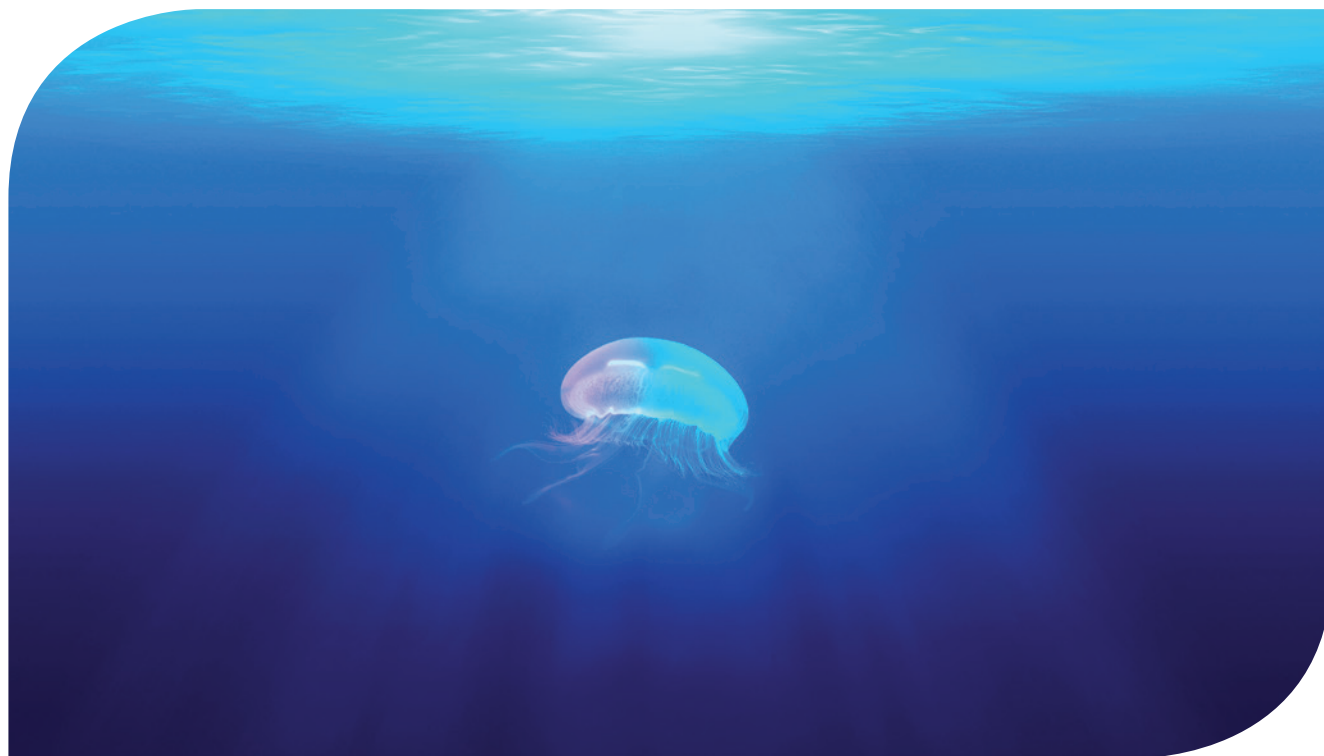
- Limited national availability of low costly biomass;
- Limited market for national biobased products;
- Huge and risky investments needed for research and the build up of industrial flagship investment and infrastructure of bioeconomy;
- Spread of products that doesn't comply to international standards and labelling on biobased and biodegradable products.

✔ OPPORTUNITIES

- Availability of former oil refineries/industrial sites that can be converted into biorefineries;
- Availability of a good collection system for organic waste (to be improved by setting specific targets) and of large amount of national biowaste (Food industry: 15 MT/y; agriculture residues: 10 MT/y livestock effluents; 150 MT/y; Sludge: 3 MT/y, Municipal organic fraction: 12 MT/y);
- Availability of abandoned/marginal lands for the production of industrial biomass and bioenergy;
- Availability of positive case studies on biobased products developed in Italy (i.e. shopping bags example) and price premiums for environmental sustainable products (Made green in Italy).

Biobased
industry

6. CHALLENGES AND ACTION PLAN FOR ITALIAN BIOECONOMY



✗ PROBLEMS

- Unsustainable fishery;
- Underexploitation of aquaculture opportunities;
- Sea pollution (chemical pollutants, litter, etc) and invasive species;
- Increasing import of fish from areas with low environmental regulation and monitoring;
- Lack of innovative solutions to replace the use of fish oil and/or feeds of fish origin in the feeding strategies of farmed marine fishes.

✓ OPPORTUNITIES

- Boost environmental safe marine aquaculture (also off shore);
- Exploitation of marine biological resources and fishery/aquaculture processing waste in biorefinery;
- Sustainable exploitation of deep sea biosystems and land/sea nexus;
- Boosting programmes of fish genetic improvement with new breeding goals while preserving diversity.

Marine
bioeconomy

6. CHALLENGES AND ACTION PLAN FOR ITALIAN BIOECONOMY

✗ PROBLEMS

- Weak cooperation among European Member States of the Mediterranean basins;
- Growing migratory flows toward Europe;
- Lack of integration of knowledge and efforts across sectors and countries;
- Climate context and demographic trends are strongly increasing the pressures on the capabilities of the societies to provide affordable food, good quality water and to ensure healthy seas.

✓ OPPORTUNITIES

- Large availability of biomass, also by-products and waste streams, from local agriculture, livestock production and food industry in Mediterranean countries;
- Cooperation in the context of the PRIMA Initiative and BLUEMED Initiative;
- Creating the conditions to ensure the adoption of knowledge and innovations across countries;
- Improving the sharing and joint exploitation of existing data, knowledge, capacities, project results;
- Advocacy for enhancing public understanding of the value of the blue economy in the Mediterranean;
- cooperation projects in No-European Mediterranean countries, for investments in agrifood sector, territorial regeneration, contrast to desertification, also in the frame of Migration compact and EU strategy for external action on migration.

Euro-Med
Economic
Cooperation



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6.2 THE STRATEGY

The Italian Bioeconomy has enormous potential for growth if the above mentioned challenges are addressed and turned by each sector into improved and resource-efficient and environmentally sustainable productions able to guarantee improved supplies of new, safe and high quality foods and bio-based products, including bioenergy, via competitive and low carbon supply chains.

Further improvements and opportunities for new innovation can derive for a more efficiently interconnection

of the main sectors, from the bioresources production (ie, Agriculture, Livestock, Aquaculture, Forestry, Marine systems), to their processing and final products exploitation (i.e., the food and drinks industry, wood, paper, leather, textile, chemical and pharmaceuticals industries, and energy sector) with the creation of longer, more sustainable and locally routed value chains, where the actions of different public and private stakeholders integrate across all major sectors.

The whole value chain is important: production, refinery and market application and consumption. As areas influence each other, there is an increasing need for





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integral chain management and a holistic systems approach. Indeed, systemic and holistic thinking is fundamental, as there is a striking need to move away from a sectorial perspective. Bioeconomy embraces broad value chains, hence stronger interactions are necessary between stakeholders, different sectors and disciplines to monitor the biomass, from the harvest to the various final products. Furthermore, interconnecting the bioeconomy sectors just does not mean to work at the edge or create bridges between areas, but also strong interconnection among education providers, researchers and innovators should be supported and facilitated.

Special attention should be paid to sustainably add value to **local biodiversity, ecosystem services and circularity** (i.e., biowastes valorisation, abandoned lands/ industrial regeneration, low-distance value chains, National Strategy for the Green Community, etc). Finally, the required R&I actions need to be complemented by i) a wider and more coherent political commitment, ii) investments in R&I, education, training, communication, iii) better coordination between regional, national and EU stakeholders/policies, iv) better engagement of a public dialogue, and v) tailored market development actions.

The present strategy aims to producing new knowledge, technologies, services, capacity building, related to the major sectors of Italian Bioeconomy including also the interfaces among them, and in particular to:

- boost sustainable and locally routed economic growth in the bioeconomy landscape by bridging gaps between research and industry, including an emphasis on Small Medium Enterprises (SMEs);
- support policy integration and coordination, especially between EU, national, regional and local policies;
- ensure that bioeconomy reconciles technologies advances and progress while not undermining environment conservation and ecosystems' resilience;
- support knowledge based economic activities and policy making;
- support cross-disciplinary education and training towards researchers as well as technical career paths;
- sustain informal learning, tertiary education and technology/knowledge transfer to support the jobs in the wide bioeconomy domain;
- promote Bioeconomy in the Mediterranean area via the implementation of PRIMA and BLUEMED initiatives addressed to improve Mediterranean primary production and industry potential, thus creating new jobs, social cohesion and political stability in the area.

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6.3 THE R&I AGENDA

The main R&I needs and opportunities for boosting Italian Bioeconomy are reported below.

PRIORITY

Sustainable agriculture and forestry

a. Boost sustainable and resilient primary production via R&I addressed to:

- explore the sustainability potential of different models of agricultural and forestry production – such as climate smart agriculture and forestry, precision farming, ecological intensification, agro-ecology and regenerative agriculture, ICT to support resilience to climate change, model based adaptation and mitigation and connectivity along the product chain;
- improve water use and management in and by agriculture;
- improve plant salt and drought stress tolerance;
- use biodiversity of genetic resources to improve resilience of animal and plant to stresses related to climate changes without compromising the *in-situ* diversity conservation;

- exploit the role of agriculture (including urban and peri-urban agriculture) and forestry in the circular bio-based society and control contaminants.

b. Improve Resource management via R&I addressed to:

- implement agricultural practices and farming and forestry systems to improve fertility/quality of soils and their various productive and ecosystems functions reducing the rate of soil and watershed pollution caused by intensive agriculture and livestock management;
- reduce gas emission through reduction of nitrogen and phosphate fertilizers;
- increase of photosynthesis and increase of carbon dioxide (CO₂) sequestration;



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- Improve tools and strategies (sensor, networks, DSS, etc.) for the rational water use in and by agriculture;
 - favor the access to genetic resources to valorize the genotypic and phenotypic animal and plant biodiversity towards resilience to climate threats (also using genomics programs and precision agriculture);
 - design and test agriculture (including urban and peri-urban agriculture)) and forest solution to help the circular bio-based society;
 - addition and management of beneficial microorganisms.
-
- c. Improve Multiple functions and benefits of land and rural areas via R&I addressed to:**
-
- Boost the link between the ecological and the socio-economic values of agriculture and forestry systems (e.g. by substantiating authenticity and traceability);
 - exploit the role of forests in mitigating climate change and in contributing to the bioeconomy;
 - Evaluate and develop strategies for the tailored exploitation of national biodiversity and genetic and phenotypic resources;
- Innovative use of abandoned and marginal lands also through multi-purposes nature –based solutions;
 - The creation of locally integrated agro-industrial supply chains.
-
- d. Improve Human and social capital and social innovation via R&I/actions addressed to:**
-
- enhance the skills, human and social capital of farmers, foresters and other actors of the rural economy also through education and digital based technologies;
 - involve young land managers in less developed IT regions in the adoption of good practices, thus creating possibilities for expanding farming and supporting knowledge sharing;
 - support successfully the generation change of the entrepreneurs in the agri-food and forest-wood sectors in the less developed regions;
 - safeguard traditional knowledge on local management practices.

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PRIORITY

Sustainable and competitive agri-food sector for a safe and healthy diet

a. Improve Healthy diets, healthy people via R&I addressed to:

- evaluate, educate and exploit national consumer preferences, attitudes, needs, behaviour, lifestyle and education, and communication;
- tackle obesity through food formulations/substitutions, changes in retail and catering practices, and changes in consumer behavior;
- develop smart nutrition solutions (e.g. with improved nutrient bioavailability) for the next decades to establish how food production technologies, new delivery methods, and ICT approaches might be used to provide smart personalized (e.g. metabolic tailored) nutrition solutions and health care;
- further exploit knowledge on gut microbiome to define consumer needs for a healthy diet;
- identification and production of new “typical/quality” foods (DOP, IGP, STG, etc.) and promote methods to defend authenticity and traceability;

- prevention and remediation of biotic and abiotic contamination of food/feed products;
- improve cultivation processes for the proxy personalized nutrition and to enhancement of the nutritional quality of agri-foods;
- exploit alternative food sources (insects, algae etc.).

b. Improve Food safety, security, defense, and integrity via R&I addressed to:

- develop rapid at-line or on-line detection tools for food and feed safety (vs pathogens, allergens, toxins, chemicals, nanomaterials, etc) and integrate such tools in risk analysis protocols;
- establish vulnerability of food and feed to fraud or intentional contamination or adulteration, and develop risk prevention, protection, and mitigation strategies for food business operators;



6. CHALLENGES AND ACTION PLAN FOR ITALIAN BIOECONOMY

- develop innovative packaging and smarter supply chains to support efficient delivery to consumers and prolonged shelf-life reducing waste production;

- develop tools (ICT, devices, apps etc.) for smart food utilization and domestic food management.

c. Boost Sustainable, competitive, and innovative food manufacture via R&I addressed to:

- improve efficiency of the food making value chain by: lowering raw material losses, byproducts and waste production, and water consumption and improving food preservation and distribution and logistics as well as choosing energy-saving technologies;

- integrated exploitation of food processing by- and side-products and waste with the production of added value food ingredients and bioactive products, biochemicals, biomaterials (packaging) and biofuels.

d. Boost Food policies, supply chains, markets, and communities via R&I/actions addressed to:

- promote short local food chains for health and contrast non-market based networks of food provisioning;

- involve public authorities, private sector and civil society in policy design and implementation;

- develop food products and promote ethno food marketing taking account of migration and changing demographics in the country;

- develop innovation support systems and networks for food SMEs, especially micro-SMEs and traditional food producers;

- involve public authorities, private sector and civil society in policy design and implementation facilitating sustainable production choices and business strategies.

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PRIORITY

Bio-based industries

a. Boost production of biobased products and biofuels in the framework of a circular economy via R&I addressed to:

- map biomass supply included novel and alternative feedstocks (biowaste, CO₂, marine biological resources) building on existing knowledge, approaches and tools;
- explore new, innovative, energy saving logistics and preservation/stabilization strategies for different types of biomasses/biowaste - developed, validated and standardised on biomass level;
- Improve efficiency and flexibility (in terms of feedstocks and products) of current biorefining processes and schemes as well as downstream processing;
- Use cost-benefit analyses of bio-based products vs traditional products on a global scale and evidence to establish how alternative uses of renewable resources can influence carbon emissions and natural capital stock;

- foster the demand for bio-based products from a consumers' perspective through gathering evidence on consumers' practices in relation to bio-based products and how these may form new market places and develop new innovative and inclusive business solutions using bio-based services;

- Develop a coherent policy framework and regulations promoting biobased products, education, training in the biobased sector.

b. Foster 'Demonstration plants/test beds for cascading use of biomasses via R&I and actions addressed to:

- create an optimal network of laboratories supported by new infrastructure to form test beds that can develop process technologies and new products in a demo-scale that underpin the development of biorefineries (industrial scale) for maximising biomass use;
- facilitate Spin-off/Start-up policies, Partners Integration, IPR policies and the access to Pilot plants and Demonstrators.

6. CHALLENGES AND ACTION PLAN FOR ITALIAN BIOECONOMY

PRIORITY

Aquatic living resources and marine and maritime bioeconomy

a. Boosting sustainable exploiting of marine resources via R&I addressed to:

- Promote production and processing of seaweed and phytoplankton as possible sources of human edible proteins, fine chemicals, energy, bio-based materials, methane low ruminant feed stocks;
- Exploit sustainably the large micro and meso plankton stocks for producing high value substances and biobased products as well as enzymes for bio and chemical processing;
- Improve sustainability of fishery and marine aquaculture by also promoting improvement of the resilience, robustness and efficiency of the main aquatic production species using smart breeding programs based on genomics and precision phenotyping, including ethical aspects;
- Improve interactions between commercial fishing and game fishing (in an ecosystem based approach) related to new perspectives of ecotourism in remote rural areas;
- Reduce fishery wastes by promoting consumption of neglected species via production of palatable, convenient seafood products;

- Exploit by- and side-products and biowaste from of fishery and aquaculture value chains as well as marine biowaste via integrated biorefinery schemes;
- Exploit sustainably the deep sea biosystems and bioeconomy at the land/sea interface;
- Implement multiple purpose use of offshore production sites, integrating bioresources and energy production in a “building with nature” approach.

b. Fostering the marine environment and biodiversity' via R&I/actions addressed to:

- Promote biomonitoring and bioremediation of existing plastics and microplastics, contaminated sediment systems, mitigation of new pollution, and development of marine degradable bio-based plastics to limit/prevent marine litter and pollution;
- characterize marine ecosystem resilience and regime shifts, in relation to climate change and other natural or anthropic pressures, and development of prevention and mitigation strategies.

6. CHALLENGES AND ACTION PLAN FOR ITALIAN BIOECONOMY

6.4 SUPPORT MEASURES

In order to unlock the innovation potential of the Italian Bioeconomy, it is mandatory that the R&I Agenda which reflect the national strategy is prepared by a set of accompanying measures, presented below. It is noteworthy to underline that these measures are intended to create the framework conditions in order to boost the national bioeconomy, also by creating a market and societal pull towards the relevant examples of bioeconomy products in the everyday life. To this extent, measures aimed at creating competitiveness and productivity in the system should go along with initiatives to enhance corporate social responsibility and social awareness on the role of bioeconomy in a changing climate and ecosystem.

For these reasons, these accompanying measures have the same importance as the R&I action stated in the agenda, they should act in parallel and should mutually enforce themselves:

1. ensuring a strong coordination among the ministries, other public administration and national technological clusters involved in the bioeconomy domain, in order to define an proper and coherent legislative framework and minimizing duplication and fragmentation. A permanent working group on bioeconomy composed by representatives of such organization, will be establish with the aim of:
 - a. collect and sharing data and information;
 - b. guarantee the policy coordination among public authorities, with particular attention to the implementation of European policies addressed to waste prevention and minimization, in order to encourage full exploitation of the resources and circularity;
 - c. monitor the implementation of the bioeconomy strategy;
 - d. propose new measures and action to improve the bioeconomy system also evaluating the social and environmental impact of subsidies on non- renewable resources;
 - e. implement and coordinate international initiatives to boost bioeconomy in Mediterranean basin;



6. CHALLENGES AND ACTION PLAN FOR ITALIAN BIOECONOMY

2. exploring demand-side innovation policy tools such as standardization, to implement strict targets for separate collection of organic waste, labelling, and public procurement. Life cycle thinking and ecodesign approach should steer the transition, in order to find the right balance between fossil based products (that give important contribution in durable goods sector) and bio-based products, especially in sectors where environmental concerns are higher, i.e. by connecting environmental concerns with low-impact solutions which are available and ready to be implemented;
3. stimulating demand for bioeconomy products and services through enforcing green public procurement, promoting communication and information to consumer to increasing the awareness of the consumers to bio-based products, highlighting their positive impacts in social and environmental terms (green jobs, social acceptance, reduced GHG emissions, lower extraction rate of non-renewable resources, benefits for land and terrestrial ecosystem and biodiversity conservation), adjusting fiscal measures and policies in order to increase private demand of biobased product;
4. creating, through a cooperation with the stakeholders, a bioeconomy marketplace, in order to match demand and supply of biomass, technology, services; a database to collect and share data on biomass and biowaste actual and potential availability, technological processes, research project, in order to put into practice and showcase industrial symbiosis, technological innovation and best practices;
5. promoting education and professional training for bioeconomy specialists, through new technical programmes for schools, academic courses, and executive masters on bioeconomy, also in partnership with industrial players;
6. valorizing sustainable urban biowaste production by ensuring that separately collected urban biowaste is used to compost and/or anaerobic digestion, such to minimize the environmental impact (GHG emissions, local pollutants and discharge in water and land receptors) of its management;
7. supporting corporate social responsibility proposing a methodological framework for enterprises to highlight the bio-based content and features of bioeconomy processes and products through the application of life-cycle assessment, extended accounting and green reporting to evaluate the net costs of the bioeconomy production including the carbon balance and the environmental footprint, an promoting voluntarily labelling or other certificate schemes easy-to-understand by final consumers and verified and managed by institutional bodies.



IMPLEMENTATION AND MONITORING

Measuring bioeconomy performance through indicators is a complex activity. Bioeconomy gathers a wide number of different products, commodities, intermediate goods and technologies and it is an economy in evolution.

A great part of its future developments will emerge from markets and industries convergence and transformation and from new markets creation, phenomena for which statistical data and indicators are currently not available. Besides, there is still a high rate of uncertainty on constituents of bioeconomy value chain.

However, it is possible to relate the overall objective to a set of **EU key performance indicators (KPI)**²⁸ to monitor the bioeconomy developments on supply and demand side. These indicators refer to Eurostat and national data and allow to implement benchmarking analysis. ⁸

Indicators are been selected in function of data availability. There is a general problem of data gaps and quality homogeneity especially at the most disaggregated data levels. In some cases, it could be difficult to find data for all bioeconomy subsectors or to distinguish between bio-based and non bio-based products and sectors. Therefore, also the construction of monitoring tools is subjected to an evolutionary process of data availability to meet public awareness and assessment needs. ⁹

Another set of indicators is implemented on the **sustainability dimension of bioeconomy** in order to enhance the social dialogue on these issues. They also refer to EU initiatives²⁹ for evaluating and monitoring EU bioeconomy. ¹⁰

28 Selected indicators are based on results of BERST project consortium, "BioEconomy Regional Strategy Toolkit", Criteria and Indicators describing the Regional Bioeconomy, Cambridge (UK), 31 October 2014 and Correlation of I&M with the developed Criteria, Mol (Belgium), 3 December 2014.

29 Indicators on sustainability dimension are based on the results of Sat-BE consortium, "Systems Analysis Tools Framework for the EU Bio-Based Economy Strategy", Overview of the systems Analysis Framework for the EU Bioeconomy, 9 November 2013 and Tools for evaluating and monitoring the EU bioeconomy: Indicators, 31 December 2013.

7. IMPLEMENTATION AND MONITORING

8 KEY PERFORMANCE INDICATORS AT NATIONAL AND REGIONAL LEVEL

CRITERIA	INDICATORS
BIOMASS AVAILABILITY	Agricultural biomass production [kg/capita] - import of agricultural biomass Blue biomass production [kg/capita] - import of blue biomass Forestry biomass production [kg/capita] - import of forestry biomass Waste biomass production [kg/capita] - import of waste biomass
PRODUCTIVE STRUCTURE	Firms in total bioeconomy sectors [% of total firms] Firms in bioeconomy subsectors [% of total firms] Innovative start up in total bioeconomy sectors [% of total innovative start up] Innovative start up in bioeconomy subsectors [% of total innovative start up]
EMPLOYMENT STRUCTURE	Employment in total bioeconomy sectors [% of total employment] Employment in bioeconomy subsectors [% of total employment]
HUMAN CAPACITY	Tertiary education [% of total population] R&D employment in total bioeconomy sectors [% of total employment] R&D employment in bioeconomy subsectors [% of total employment] University courses in bioeconomy sectors [% of total university courses] Research Institute in bioeconomy sectors [% of total Research Institutes]
INNOVATION	IPRs (patent, trademark, design) applications in total bioeconomy sectors [number of application per 1000 employees] IPRs (patent, trademark, design) applications in bioeconomy subsectors [number of application per 1000 employees]
INVESTMENT	Private R&D expenditure [index (EU=1)] Public R&D expenditure [index (EU=1)]
DEMOGRAPHICS	Population growth [% year] Population 15-65 years [% of total population] GDP (PPP) [index (EU=1)]
MARKETS	Exports of total bioeconomy sectors related goods [% of total exports] Exports of bioeconomy subsectors related goods [% of total exports] Imports of total bioeconomy sectors related goods [% of total exports] Imports of bioeconomy subsectors related goods [% of total exports]

7. IMPLEMENTATION AND MONITORING

9 LEGEND FOR BIOECONOMY SECTORS

PRIMARY BIOMASS SECTORS

FOOD AND FEED PROCESSING

CONSTRUCTION

CHEMICAL & POLIMERS AND BIOREFINERY

PULP & PAPER

TEXTILE & CLOTHING

ENERGY

BIOTECHNOLOGY

10 SUSTAINABILITY INDICATORS

OBJECTIVES	SUSTANAIBLE PRINCIPLE	INDICATORS
Ensuring food security	Social	Change in food price volatility, Change in macronutrient intake/availability, Change in malnutrition or risk of hunger
Managing natural resources sustainbly	Environmental/Social	Change in freshwater availability, Level of water pollution, Change in land use instensity, Rate of biodiversity loss, Secondary material price changes, Organic waste diverted from landfills
Reducing dependence on non-renewable resources	Economic/Environmental	Final energy consumption, Energy intensity of the economy, Share of renewable energy in gross final energy consumption
Coping with climate change	Environmental/Social	Change in greenhouse emissions, Level of emission of air pollutants
Enhancing economic growth	Economic/Social	Change in Employment rate, Job creation in skilled/unskilled labour



ACTORS INVOLVED AND ROAD MAP

The Bioeconomy Strategy was promoted by the Italian Presidency of Council of Ministers. Involved in its implementation are the i) Ministry for the Economical Development (co-coordinator), ii) Ministry of Agriculture, Food and Forestry, iii) Ministry of Education, University and Research, iv) Ministry of the Environment, Land and Sea, v) the Committee of Italian Regions, vi) Agency for territorial cohesion, and VI) the Italian Technology Clusters for Green Chemistry and AgriFood.

Additional Stakeholders of Italian Bioeconomy will provide their inputs. They were consulted in previous workshops and will be consulted in a close future via dedicated workshops. Citizens and all those interested in the topic will be invited to express their views via web site.

A detailed plan with timetables for the measures will be prepared in the context of setting up the strategy's implementation. Most of the measures should get started in 2017. Strategy implementation will be supported by a bioeconomy panel to be set up.

The working group established for the editing of this document was composed by:

Paolo Bonaretti coordinator- Presidency of Council of Ministers; *Cinzia Tonci* co-coordinator - Ministry for the Economical Development; *Fabio Fava* scientific coordinator - Ministry of Education, University and Research; *Riccardo Aleandri* - Ministry of Agriculture, Food and Forestry; *Giacomo Pallante* - Ministry of the Environment and Protection of Land and Sea; *Francesco Cellini* - Committee of Italian Regions; *Daniela Carosi* and *Federica Tarducci* - Agency for territorial cohesion; *Giulia Gregori* - Italian Technology Cluster of Green Chemistry SPRING, *Cristina Di Domizio* - Italian Technology Cluster of AgriFood, and with the support of *Annalisa Zezza* (Ministry of Agricultural, Food and Forestry Policies), *Fabio Eboli* (Ministry of the Environment and Protection of Land and Sea), *Stefania Trenti* (Intesa San Paolo Research Department) and *Vittorio Maglia* (Italian Technology Cluster of Green Chemistry SPRING) as technical experts.



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